APPENDIX E
Compendium of Technical Reports

For the C-470 Corridor
Revised Environmental Assessment

July 2015

This Appendix contains the following reports, ordered alphabetically by topic:

- Air Quality Technical Report
- Biological Resources Technical Report
- Environmental Justice Technical Report
- Geology Technical Report
- Hazardous Materials Phase I Environmental Site Report
- Historic Resource Survey
- Hydraulic Study
- Right-of-Way Technical Report
- Roadway Safety Technical Report
- Traffic Noise Technical Report
- Traffic Operations Technical Report
- Utilities Technical Report
- Visual and Aesthetic Character Technical Report
- Water Quality Technical Report
- Wetland Delineation Report

Air Quality Technical Report

For the C-470 Corridor
Revised Environmental Assessment

June 2015

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LIST OF ACRONYMS

APCD – Air Pollution Control Division

C-470 – Colorado State Highway 470
CAMP – Air quality monitoring site at 2105 Broadway, Denver
CDOT – Colorado Department of Transportation
CDPHE – Colorado Department of Public Health and Environment
CFR – Code of Federal Regulations
CO – Carbon Monoxide

DOT – Department of Transportation
DRCOG – Denver Regional Council of Governments

EA – Environmental Assessment
EL – Express Lanes (tolled)
EPA – Environmental Protection Agency

FHWA – Federal Highway Administration

GHG – Greenhouse Gas
GPL – General Purpose Lanes

MPH – Miles Per Hour
MSAT – Mobile Source Air Toxic

NAAQS – National Ambient Air Quality Standards
NEPA – National Environmental Policy Act
NOx – Oxides of Nitrogen

O_3 – Oxone

$PM_{2.5}$ – Particulate Matter smaller than 2.5 microns in diameter
PM_{10} – Particulate Matter smaller than 10 microns in diameter
POM – Polycyclic organic matter
PPM – Parts per Million

RTP – Regional Transportation Plan

SIP – State Implementation Plan

TIP – Transportation Improvement Program
TMA – Transportation Management Area

USC – United States Code

VHT – Vehicle Hours of Travel
VMT – Vehicle Miles of Travel
VOC – Volatile Organic Compounds

1.0 INTRODUCTION

This Air Quality Technical Report examines potential impacts to air quality as the result of proposed improvements to Colorado State Highway 470 (C-470) in the southwestern part of the Denver metropolitan area.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in **Figure 1**. In 2013, the Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) initiated a Revised Environmental Assessment (EA) for the 13.75-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the Revised EA differs slightly from the Express Lanes (EL) alternative identified in the previous EA that was approved by CDOT and FHWA in 2006.

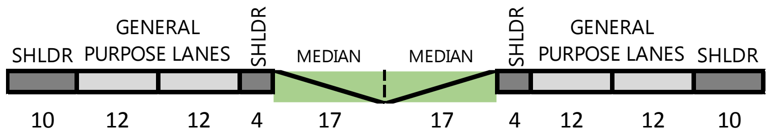
Figure 1. C-470 Corridor and its Surrounding Vicinity

1.1 Project Description

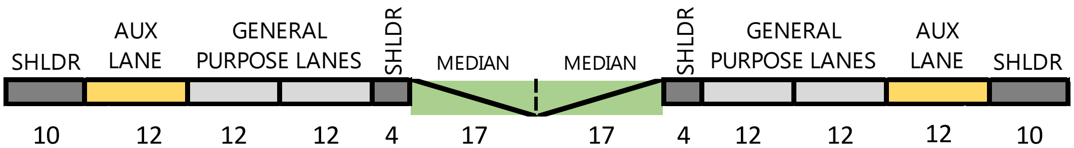
The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide, as shown in **Figure 2**. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged. C-470 would receive maintenance as needed to maintain the safety and functionality of the existing four-lane freeway.

The C-470 Proposed Action would add express lanes and auxiliary lanes to improve traffic flow, and would reconstruct more than half of the existing pavement to address structural deficiencies. It is expected to be built in two phases. A $269 million construction project to be built by the end of 2017 would provide interim improvements with currently available funds. Additional improvements resulting in the ultimate configuration would complete the Proposed Action by the year 2034. For details, see **Figure 3.**

Figure 2
Existing C-470 Typical Cross Sections

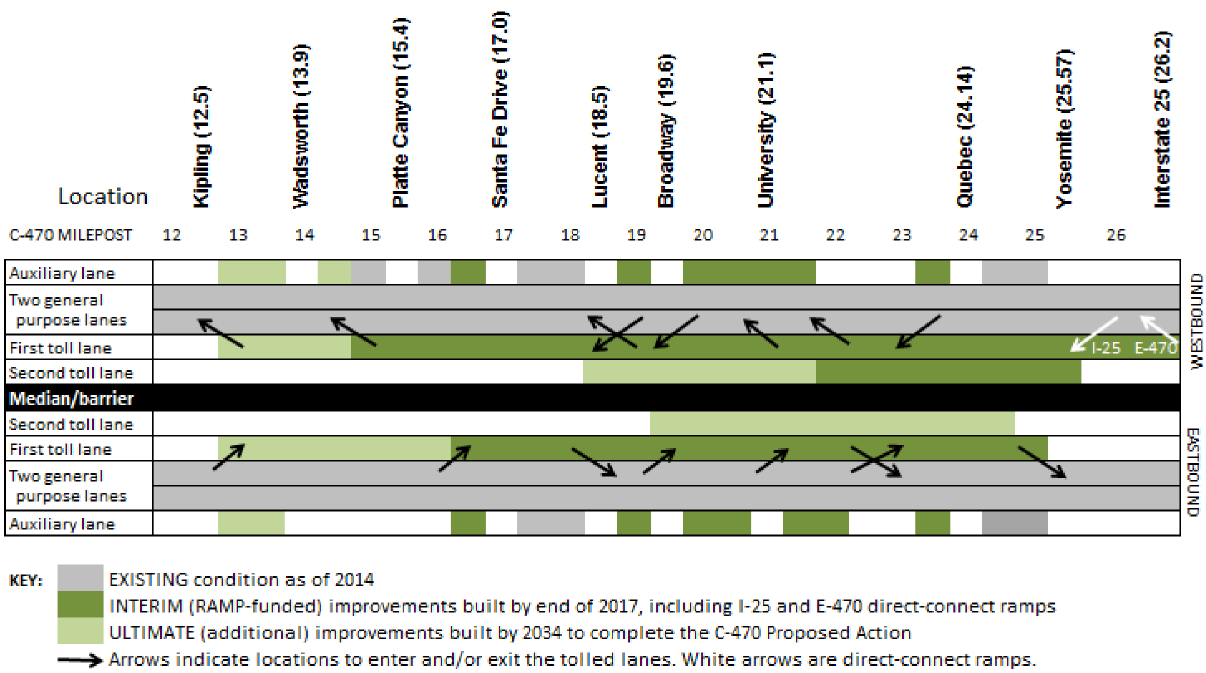


EXISTING TWO LANES EACH DIRECTION – KIPLING PKWY TO QUEBEC ST
TOTAL WIDTH 110 FEET



EXISTING TWO LANES PLUS AUXILIARY EACH DIRECTION – QUEBEC ST TO I-25
TOTAL WIDTH 134 FEET

Figure 3
C-470 Existing, Interim and Ultimate Configuration

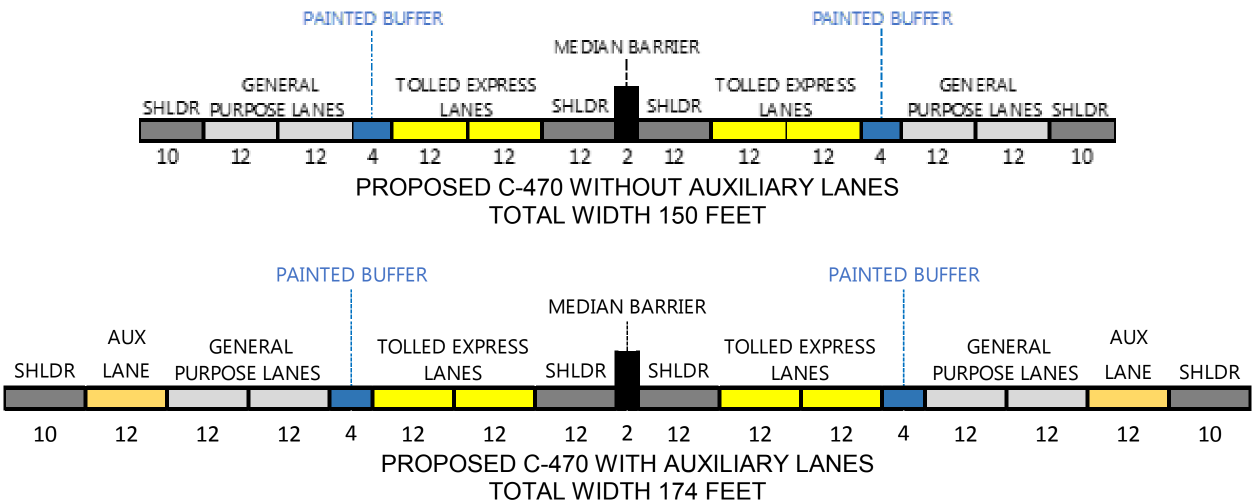


In the more heavily travelled, eastern half of the project, the Proposed Action would add <u>two tolled Express Lanes in each direction</u>, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, <u>auxiliary lanes</u> will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross-section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes.

In the less heavily travelled, western half of the project, the Proposed Action would add only one tolled Express Lane in each direction, but would be designed to accommodate an additional lane in the future. Westbound, the second toll lane would end at Lucent Boulevard, and the westbound single toll lane would end about one mile east of Kipling Parkway. Eastbound, the first toll lane would begin east of Kipling. The second eastbound toll lane would begin in the vicinity of Broadway.

The new proposed typical sections are shown in **Figure 4**, with typical widths of 150 feet and 174 feet.

Figure 4
Typical Cross Sections for C-470 Proposed Action



The Proposed Action includes no new interchanges and no major interchange modifications, except for the addition of two "direct-connect" ramps in the western half of the I-25/C-470 interchange. A new westbound ramp will enable exiting E-470 traffic to reach the rightmost westbound C-470 lane without having to merge across several lanes of through traffic. A new westbound lane will carry southbound I-25 traffic directly into the westbound C-470 tolled express lane without having to merge across those same lanes.

1.2 Air Quality Legislative and Regulatory Background

Air pollutant emissions from transportation systems can be harmful to human beings, the natural environment, and the integrity of man-made materials. Emissions may also contribute to regional haze, degrading visibility. Some pollutants contribute to degradation of the tropospheric ozone layer that protects Earth from solar radiation.

Air quality is regulated under the 1970 Clean Air Act (United States Code, Title 42, Chapter 85), as amended in 1977 and 1990. The purpose of the Clean Air Act is to protect and enhance air quality to promote public health, welfare, and the productive capacity of the nation. The Clean Air Act mandated the U.S. Environmental Protection

Agency (EPA) to establish National Ambient Air Quality Standards, or NAAQS, for air pollutants determined to be harmful to human health (primary standards) and the natural and man-made environment (secondary standards).

Federal air quality conformity regulations were developed during the 1990s to ensure that transportation plans, programs and projects would not jeopardize attainment of the NAAQS. These regulations comprise Section 176 of the Clean Air Act, and are also enforceable through Colorado's State Implementation Plan (SIP) for air quality. Under the SIP, emissions budgets are established for non-attainment and attainment-maintenance areas to ensure future NAAQS compliance.

1.3 Comparison of the 2006 Analysis and the 2015 Analysis

An air quality analysis was prepared for the C-470 EA that was approved by CDOT and FHWA in 2006. Since that time, major updates to transportation assumptions and vehicle emission methodology have occurred. Thus an entirely new air quality analysis is necessary at this time, using current modeling methods and most recent planning assumptions.

The prior air quality analysis was prepared using the EPA-mandated on-road mobile source emissions model in place at that time, MOBILE6.2, which has subsequently been replaced by a new modeling tool, the Motor Vehicle Emissions Simulator (MOVES). EPA created MOVES as a state-of-the-art model for estimating emissions from all on-road vehicles including cars, trucks, motorcycles, and buses. MOVES can be used to estimate exhaust and evaporative emissions as well as brake and tire wear emissions from all types of on-road vehicles for any part of the country, except California. Since its initial introduction, the MOVES model has been revised several times. The version currently used is MOVES2014.

The 2006 EA air quality analysis was based on transportation assumptions consistent with the regional transportation planning documents that were applicable at that time, adopted in 2004 and 2005. These have been updated during the past nine years. The currently applicable planning documents are:

- DRCOG 2040 Fiscally Constrained Regional Transportation Plan, February 2015
- DRCOG 2016-2021 TIP, April 2015

DRCOG transportation plans are based on the latest available regional socioeconomic forecasts for population and employment, which were updated in 2010.

Since 2006, there have also been changes in the applicable transportation conformity regulations (discussed later in this report), and developments with respect to NAAQS:

- In 2008, EPA tightened the 8-hour standard for ozone from the previous 0.80 ppm, to 0.75 ppm.
- In 2010, EPA completed a court-ordered review of the NAAQS for carbon monoxide, and retained the previous standards with no change.
- In 2010, EPA added a one-hour standard for nitrogen dioxide (NO_2).

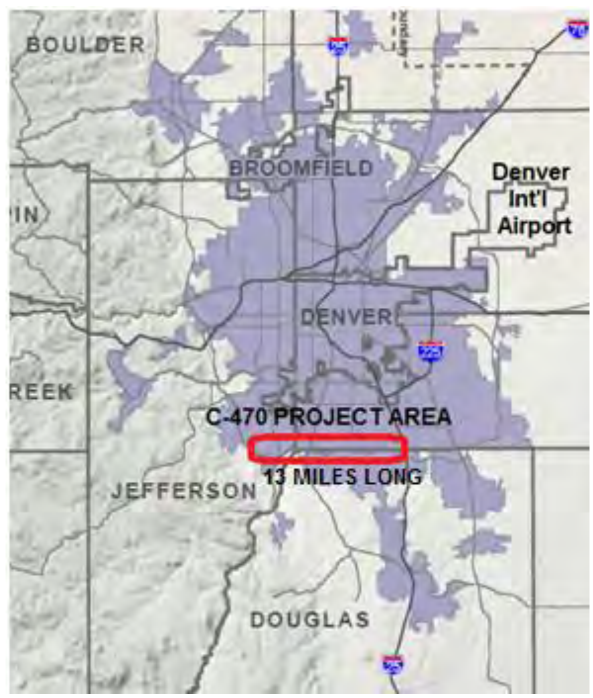
- In 2012, based on the 2008 tighter 8-hour ozone standard, EPA classified the Denver region as being in “marginal” nonattainment status for ozone.
- In 2012, EPA tightened the annual standard for fine particulate matter to 12 micrograms per cubic meter, without changing the daily standard for $PM_{2.5}$.
- In December 2014, EPA published a Proposed Rule to tighten the 8-hour ozone standard to a lower value in the range of 0.065 to 0.070 ppm.

2.0 AFFECTED ENVIRONMENT

2.1 General Project Setting

The C-470 project corridor, 13.75 miles long, is located in the southwestern quadrant of the Denver metropolitan area, as indicated in Figure 5. Its setting is largely suburban, with no central business district, no concentration of industry, no crossing freeways and no intermodal transfer facilities. There is no airport in the immediate project vicinity. Freight railroad tracks cross C-470 only at Santa Fe Drive, with a future light rail extension to Lucent Boulevard also crossing at that location. There is a fairly high concentration of parks and open space along the corridor, including Chatfield State Park that fronts the highway for three miles.

Figure 5
Project Area in Relation to the Denver Urbanized Area

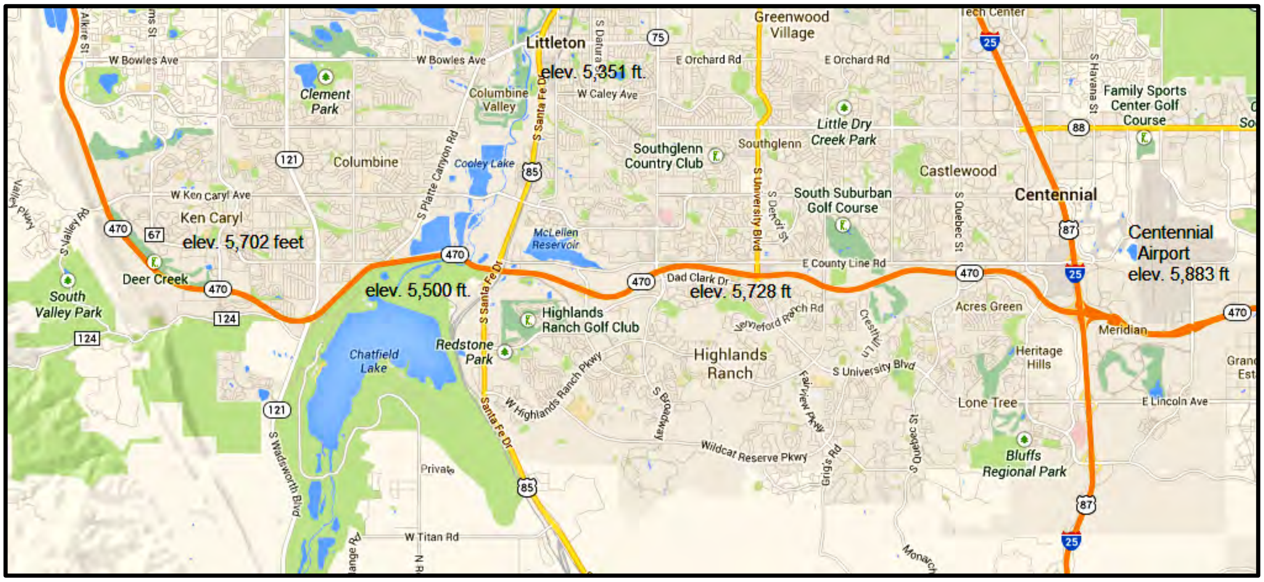


The Front Range of the Rocky Mountains Range greatly limits development at the western end of the project corridor. In winter months, this mountainous terrain can restrict air flow, trapping pollutants in the project area during thermal inversion conditions.

Representative elevations in the vicinity of the project area are shown in Figure 6. A relative low spot, influencing air and water drainage, is the South Platte River, flowing northward from the Chatfield Dam (elevation 5,500 feet) along Santa Fe Drive down toward Denver, the Mile High City (elevation 5,280 feet).

Given the lack of other notable emission sources within the C-470 project area, motor vehicle emissions are the predominant source of local air pollutant emissions.

Figure 6
Representative Elevations near the C-470 Project Area



Background concentrations of pollutants from motor vehicles and other sources in the metro area of 2.9 million residents are substantial. As an example, violations of the national air quality standard for ozone have been recorded at the six-square mile, largely “undeveloped” Chatfield State Park. The proximity of this monitor to C-470 is coincidental, not a cause-and-effect situation. These violations resulted from metro area emissions cooking in the atmosphere and drifting miles southward and rising as the air heats up during hot summer days. Violations have also been recorded two miles north (downslope) of C-470, by a monitor at University Boulevard and Belleview Avenue. There have been violations elsewhere in the region as well, far from C-470. Thus, it is clear that ozone is a regional air quality issue.

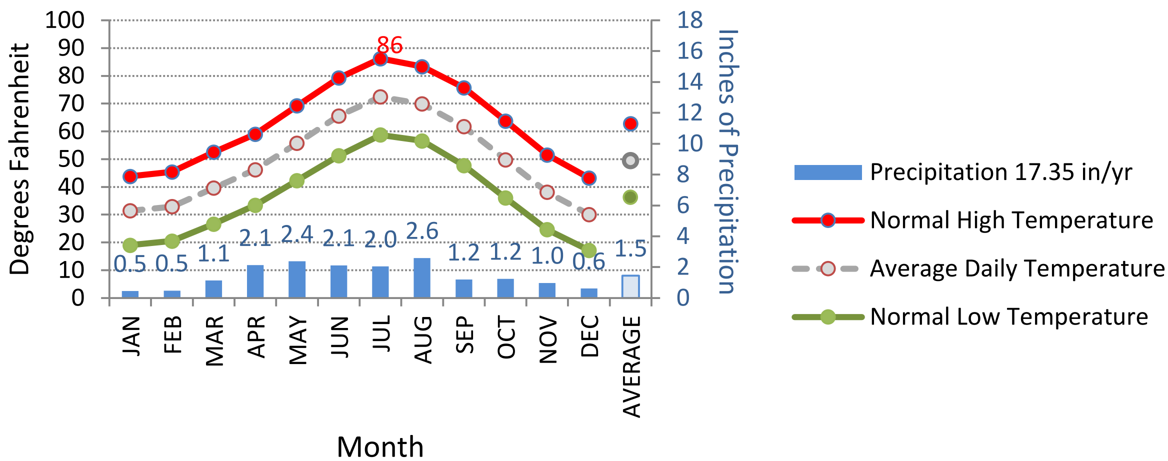
2.2 Climate and Meteorological Parameters

Robust, historic weather data applicable for the C-470 project area are available from the Centennial Airport, located just east of the project, as seen earlier in Figure 3. Normal monthly temperatures and precipitation recorded at the Centennial Airport over a recent 30-year period are displayed in Figure 4. The climate is generally characterized by low relative humidity, light precipitation, and abundant sunshine.

Figure 7 shows that normal daytime high temperatures in summer reach 86 degrees Fahrenheit in July, comparing to the annual average daily high in the low sixties. Daily summer temperatures can occasionally be extreme (100 degrees Fahrenheit or more). Hot summer days are conducive to the formation of ground-level ozone pollution.

Normal daily low temperatures are coolest on December nights, dipping to 18 degrees, compared to the annual average low of 37. December also has the shortest days of the year, in terms of daylight between sunrise and sunset. Coupled with calm winds, cool temperatures and short days may result in thermal inversions that trap polluted air close to the ground overnight. Cool nights also are associated with increased fireplace use, although the Denver region sometimes issues temporary bans on woodburning.

Figure 7
Normal Monthly Temperatures and Precipitation at Centennial Airport, 1981 to 2010



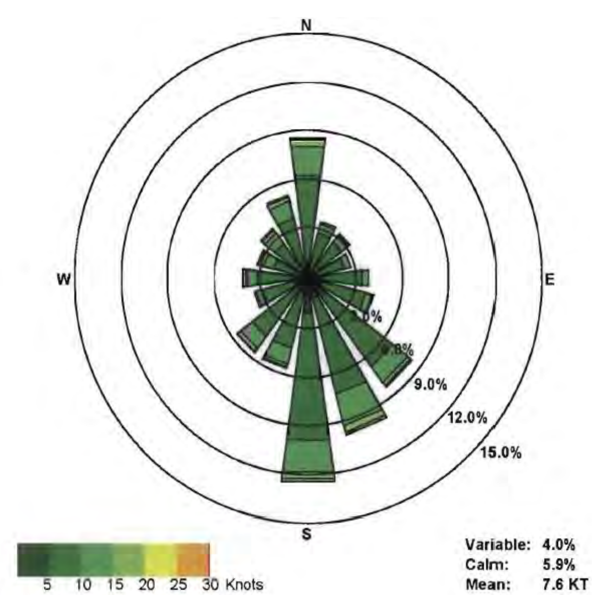
Source for Figures 7 and 8: NOAA, 2015

Precipitation at the Centennial Airport has averaged 17.35 inches per year, or nearly 1.5 inches per month. On a monthly basis, more than two inches of rain is normal between May and August, often produced by late afternoon thunderstorms. Fall and winter months are fairly dry, with heaviest snowfalls occurring in March or April.

Wind speed and direction recorded at the Centennial Airport are presented by the wind rose shown in Figure 8.

In Figure 8, each concentric band indicates an additional three percent of the readings when the wind blew in a given direction, and the color variations indicate the wind speeds recorded. The most prominent winds were northerly and southerly. The average wind speed was 7.6 knots, and almost six percent of the readings were considered calm conditions.

Figure 8
Wind Speed and Direction at Centennial Airport



The concentration of a pollutant in the atmosphere depends on the amount of pollutant released, the nature of the source, and the ability of the atmosphere to transport and disperse the pollutant. The main determinants of transport and dispersion are wind, atmospheric stability or turbulence, topography, and the existence of inversion layers.

The Denver metropolitan area is located in the South Platte River drainage area, with mountains located to the west and relatively high terrain to the south and north. Under certain meteorological conditions, the local topography has the tendency to trap pollutants, resulting in elevated ambient concentrations. The pollutants can be trapped under strong inversions that inhibit dispersion and cause poor air quality.

Regarding visibility, twelve national parks or wilderness areas in Colorado are designated as impaired for visual air quality by the Federal Land Manager responsible for the respective area(s). Federal laws and regulations call for prevention of significant deterioration in visibility for these designated Class I areas. A Regional Haze Plan adopted by Colorado in 2011 and approved by the U.S. Environmental Protection Agency in December 31, 2012 details the issue and measures being taken to address it. Much of this plan focuses on reducing pollutant emissions from power plants.

The Class I visibility area closest to the C-470 project area is Rocky Mountain National Park, located about 85 miles north-by-northwest from the C-470 project area. Given the distance, normal prevailing directions, and topographical factors involved, transportation facilities in the C-470 project area are not expected to meaningfully impact any Class I visibility areas.

2.3 Sensitive Receptors

Persons considered to be sensitive to poor air quality include children, the elderly, and those with pre-existing serious health problems affected by air pollution. Sensitive air quality receptors are the places where sensitive individuals are likely to spend time, including schools and schoolyards, parks and playgrounds, daycare centers, nursing homes, hospitals, and residential communities. (EPA, 2013). It was noted above that the C-470 project area is largely suburban and that it includes a considerable amount of parkland and open space. Not surprisingly, there are sensitive receptors along the C-470 corridor.

Generally, the eastern portion of the C-470 project area is abutted by commercial development and the western portion is abutted by parks and open space, but there are locations where the adjacent land is residential, including homes or apartment buildings. For example, Figure 9 is a photograph taken from C-470 to the north, between University Boulevard and Colorado Boulevard. Note the C-470 (Centennial) Trail in the foreground.

A detailed distribution of the more than 800 residences within 500 feet of the highway can be found in the Noise Technical Report for the C-470 Revised EA.

Figure 9
Photo of Residences Adjacent to C-470

Most potential air quality sensitive receptors are located near C-470 but beyond 500 feet distant from it. However, some notable receptors include:

- Children's Hospital South, opened in December 2013 at 1811 Plaza Drive, south of C-470 and west of Lucent Boulevard
- Wind Crest Senior Living Community for up to 700 senior citizens, opened in 2007 at 3235 Mill Vista Road, south of C-470 and west of Erickson Boulevard
- Fly'n B Park, opened in 2010, south of C-470 and east of Erickson Boulevard
- Wolhurst Community, more than 300 residences for persons aged 55 or older (identified in the C470 EA as a low income population), north of C-470 and west of Santa Fe Drive
- Denver Christian School, Highlands Ranch preschool to grade 8 campus, enrolling 350 students, at 1733 E. Dad Clark Drive, south of C-470 and west of University Boulevard (see Figure 7, noting the white basketball backboards and green athletic fields that face the highway).
- SkyView Academy, preschool to grade 12 charter school at 6161 Business Center Drive, Highlands Ranch (south of C-470, west of Quebec Street.

The list above is not intended to be comprehensive but merely to demonstrate that there are numerous potential receptors in proximity to C-470, including several that have been built since the 2006 C-470 EA was completed. Easy access to C-470 is touted as a positive attribute by some of these new developments on their websites.

Figure 10
Photo of Preschool to Grade 8 School Adjacent to C-470

2.4 Attainment Status

National ambient air quality standards (NAAQS) for various air pollutants have been established by EPA pursuant to the Clean Air Act, and air quality monitoring stations exist in metropolitan areas to determine whether or not the respective NAAQS are being met. Some of these standards have been changed and tightened over time. In cases where monitoring detects violations of the NAAQS, EPA takes formal action to designate the region as a “non-attainment” area. Non-attainment areas are given deadlines within which to attain the NAAQS, and when successful, they can be reclassified as attainment/maintenance areas. Table 1 below indicates that the C-470 project area is part of an air shed that currently is classified as non-attainment for ozone pollution. EPA has re-designated PM_{10} and carbon monoxide to attainment status. These pollutants are in the last few years of their respective sustained attainment/maintenance plans.

Table 1
2015 Air Quality Classification of the Denver Metropolitan Area

Pollutant	Most Recent Violation	Current Classification	Applicable State Implementation Plan
Ozone (O_3)	Ongoing (2010-2014)	“Marginal” Nonattainment	8-Hour Ozone Attainment Plan (Dec. 2008) deemed adequate for conformity effective Mar. 2010
Carbon Monoxide (CO)	1996	Attainment/ Maintenance	CO Maintenance Plan (Dec. 2005) approved by EPA effective Oct. 2007
Particulate Matter (PM_{10})	1993	Attainment/ Maintenance	PM_{10} Maintenance Plan (Dec. 2005) approved by EPA effective Jan. 2008
Other pollutants	None	Not applicable – no violations ever recorded in the region	

The four “other” pollutants referenced in Table 1 are fine particulate matter ($PM_{2.5}$), lead, sulfur oxides, and nitrogen dioxide. NAAQS have been established for these pollutants but no violations have ever been recorded in the Denver region. Monitored concentrations of these pollutants have been extremely low and no increases are foreseen.

The various pollutants listed in Table 1 are related to motor vehicle use in different ways:

- CO is a pollutant emitted directly from vehicle tailpipes as a byproduct of carbon-based fuel combustion.
- PM_{10} refers to solid or liquid particles up to ten microns in diameter, which can include dust that is kicked up off the pavement and re-entrained in the air by the passage of motor vehicles.
- Ozone is a compound formed in the atmosphere by photochemical reactions involving vehicle emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs). VOCs are not a specific chemical compound but refer to a class of compounds with similar properties and common constituents.

Some other types of pollutants generated by motor vehicles include greenhouse gas emissions (carbon dioxide, methane and others) and Mobile Source Air Toxics (MSATs). No NAAQS have been established for these pollutants. MSATs are discussed in this Air Quality Technical Report. Greenhouse gas emissions are addressed separately in the C-470 Revised EA.

Regarding ozone, the EPA in April 2012 classified the Denver region as “marginal” nonattainment, which means that monitored concentrations do not greatly exceed the NAAQS. The marginal nonattainment designation did not impose any new planning requirements on the State of Colorado, but the Denver region must meet the 8-hour ozone standard before 2015 or new requirements may be imposed.

Notwithstanding the above, however, EPA in December 2014 published a Proposed Rule to tighten the 8-hour ozone standard to a new lower value in the range from 0.65 0.065 to 0.070 ppm. It is unlikely that the Denver region would meet the proposed range of NAAQS, which may result in new planning requirements and further emission reduction efforts. In the long-term, continued improvements in motor vehicle technology will help to reduce mobile source emissions. Accomplishing near-term reductions may be more challenging.

2.5 Air Quality Trends in the Denver Region

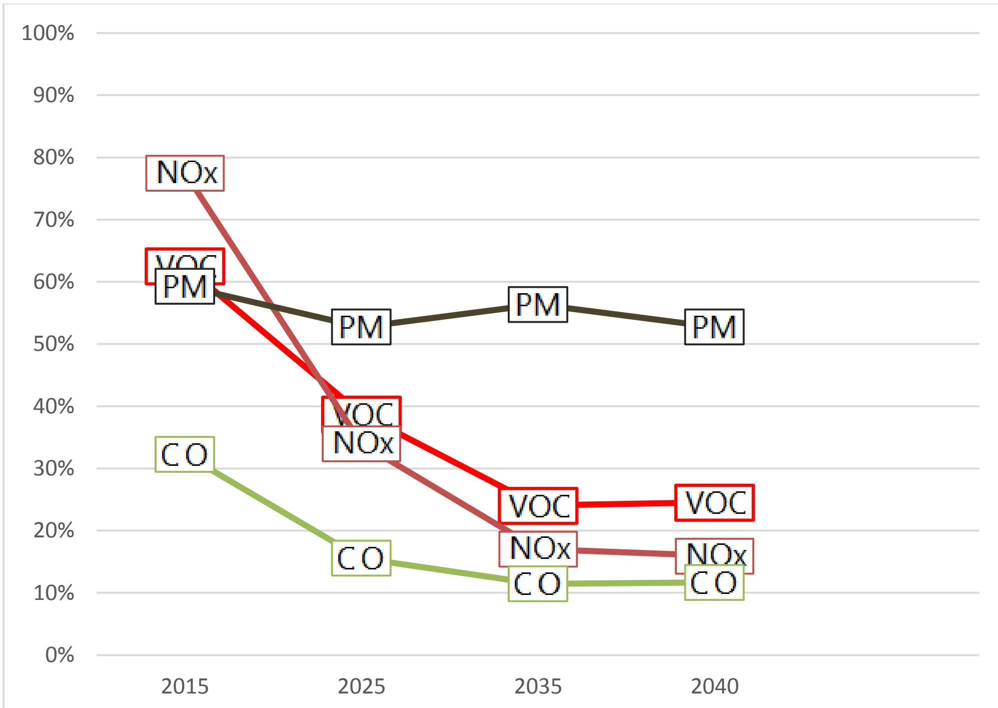
Monitoring for gaseous pollutants (carbon monoxide, sulfur dioxide, oxides of nitrogen and ozone) began in 1965 when the Federal Government established the CAMP station in downtown Denver at the intersection of 21st Street and Broadway Street. Ambient air pollution concentrations have diminished greatly nationwide and in Denver since the NAAQS were established pursuant to the 1977 Clean Air Act Amendments.

The *Colorado 2013 Air Quality Data Report* (CDPHE, 2015) provides some examples of the impressive magnitude of improvement that have been achieved over several decades, largely due to cleaner motor vehicles and fuels. For example, the CO maximum 8-hour concentration recorded in the Denver region in 1974 was 33.9 ppm, and in 2013 the maximum was 4.4 ppm, a reduction of 87%. For the 8-hour ozone standard, the maximum concentration in 1973 was 0.264 ppm and in 2012 the maximum was 0.106 ppm, a reduction of 60%.

A look forward into the future is provided from the conformity analysis for the DRCOG 2040 RTP. As a tool for predicting and ensuring NAAQS compliance, Colorado’s air quality State Implementation Plans include established emission budgets for on-road mobile sources in the Denver region. Each budget is a given number of tons per day for that pollutant. Figure 11 shows that DRCOG expects transportation emissions to remain well under these various budgets through the year 2040.

Based on this information, there is no reason for concern that the region would experience NAAQS violations in the future for CO or PM_{10}, with or without implementation of the C-470 Proposed Action. C-470 accounts for a fairly small percentage of total regional VMT, and this will remain true with or without the addition of tolled express lanes.

Figure 11
DRCOG-Predicted Regional Transportation Emissions
As a Percentage of Allowed Emission Budgets, 2015 – 2040



For ozone, the region faces the challenge of meeting the existing 8-hour NAAQS, and could face a tougher standard in the near future. Since ozone is a regional pollutant, not readily analyzed for individual roadway projects, a project-level analysis is not required. A regional ozone analysis is conducted as part of the DRCOG air quality conformity determination.

2.6 Conforming Regional Transportation Plan

The C-470 Proposed Action received a $100 million allocation of RAMP funding from the State Transportation Commission in 2013. A $269 million interim construction project is anticipated in the 2017-18 timeframe, and the ultimate configuration is planned for completion before 2035. Project funding is reflected in both of the current, adopted regional transportation documents which have been demonstrated to meet all applicable conformity requirements:

- DRCOG 2040 Fiscally Constrained Regional Transportation Plan, February 2015
- DRCOG 2016-2021 TIP, April 2015

3.0 METHODOLOGY AND COORDINATION

Air quality analysis for future years is conducted using adopted regional growth assumptions and transportation network assumptions consistent with the adopted DRCOG Regional Transportation Plan. Emission rates for specific future years are provided by CDPHE, using the EPA-approved MOVES2014 emission factor model, which takes into account local meteorology and vehicle fleet characteristics. With all of these assumptions as given, the analysis basically focuses on how the Proposed Action would affect traffic volumes and speeds on an hourly basis at locations within the study area. All of these factors are discussed in interagency consultation between CDOT and CDPHE at the outset of the air quality analysis to ensure agreement of appropriate modeling methods. Interagency consultation for this project was conducted by letter. CDOT's proposed methodology letter describing the proposed methodology received CDPHE concurrence on January 15, 2015. This letter is provided in Attachment A.

Future traffic volumes and speeds within the C-470 project area were predicted using traffic simulation models that took into account the effects of toll prices that would vary by time of day. Traffic in the express lanes would travel at a higher speed than the traffic in the adjacent general purpose lanes, and the model takes this into account.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Changes to Transportation and Traffic Circulation

With the No-Action Alternative, traffic on four-lane C-470 would become much more congested than it is today, and for a larger portion of the day. Some motorists intending to use C-470 would divert to the nearby arterial street system, where emissions would be generated in closer proximity to a large number of sensitive air quality receptors.

With the Proposed Action, all lanes would operate with less congestion and at higher speeds than in the No-Action Alternative. Through pricing that varies by time of day, CDOT would manage the tolled express lanes to ensure that they operate at a high level of service. The tolled express lanes would carry less traffic, at higher speeds, than the adjacent general purpose lanes. The speed difference between the less congested toll lanes and the more congested general purpose lanes would be greatest during the morning and evening peak periods. The availability of the added toll express lanes would accommodate additional trips on C-470, thus reducing the need for trips to divert to the nearby arterial streets.

The Proposed Action would carry more VMT on C-470 than the No-Action Alternative, but at higher speeds. The results in 2035 would be a projected reduction of Vehicle Hours of Travel by 8% in the 6:00am to 1:00pm time period and 24% reduction during the 1:00pm to 8:00pm time period. The added capacity would have negligible effects overnight between 8:00pm and 6:00am, when existing capacity is adequate to handle the day's lowest traffic demand.

4.2 Criteria Pollutant Emissions

Air pollutant emissions output from the MOVES model were projected based on predicted future traffic on C-470, its ramps and connecting arterial streets for the years 2025 (Proposed Action interim configuration) and 2035 (Proposed Action ultimate configuration) for comparison with the No-Action Alternative. Traffic volumes and speeds for each link for ten different time periods of the day were submitted to APCD, which ran the MOVES2014 model with weather and vehicle fleet characteristics consistent with DRCOG regional transportation modeling.

Table 2 reports the resulting emission projections for carbon monoxide, ozone's precursor emissions (VOC and NOx), and particulate matter ($PM_{2.5}$ and PM_{10}). Emissions were projected for winter temperatures (February) and summer temperatures (July) for all pollutants. Since ozone is typically more of a summertime problem while CO and PM are typically wintertime concerns, Table 2 below reports the key season findings, and not the similar but less relevant off-season findings.

Table 2
Projected C-470 Criteria Pollutant Vehicle Emissions (tons per day)

Pollutant	Month	2025 No-Action	2025 Interim Project	2035 No-Action	2035 Proposed Action
Carbon Monoxide	Feb	4.0	4.7	2.6	3.3
Volatile Organic Compounds (VOC)	Jul	0.13	0.15	0.07	0.11
Oxides of Nitrogen (NOx)		0.42	0.48	0.23	0.26
Particulate Matter ($PM_{2.5}$) exhaust	Feb	0.02	0.02	0.01	0.02
Particulate Matter (PM_{10}) exhaust		0.08	0.08	0.03	0.14
$PM_{2.5}$ road dust	Ann. Avg.	0.17	0.19	0.21	0.23
PM_{10} road dust		0.69	0.78	0.80	0.94

In most cases, projected emissions for the Proposed Action are higher than emissions for the No-Action Alternative, because the Proposed Action accommodates nearly 50% more vehicle miles of travel. However, the emissions difference is not a 50% increase but generally about 20% because the traffic would be less congested and the vehicles operating more efficiently. In no case is there a difference of as much as one ton per ton, and most of the differences are a matter of pounds. Note for example, that the difference in NOx in 2035 is 0.26 tons versus 0.23 tons. This difference of .03 tons is 60 pounds per day.

Despite increased VMT for both the Proposed Action and No-Action Alternative in the future, compared to existing and 2025, emissions for most pollutants in 2035 will be decreasing. For example, compare 4.7 tons of CO for the Proposed Action in 2025 declining to 3.3 tons per day in 2035, even as VMT increase during that decade. However, particulate matter in road dust will not decline over time but instead will increase as VMT does. Therefore road dust particulate matter emissions in 2035 would exceed 2025 levels for both alternatives.

4.3 CO Hotspot Predicted Concentrations

Carbon monoxide hotspot concentrations were predicted with the EPA-approved CAL3QHC model for the most congested signalized intersection in the C-470 project area for a hypothetical scenario of worst case conditions. This analysis was conducted for the intersection of South Quebec Street at County Line Road, where future traffic Level of Service is predicted to be LOS F for both the Proposed Action and the No-Action Alternative. The modeled network for hotspot analysis also included the C-470 northern ramps intersection with Quebec Street. In Figure 12, traffic signal icons identify these two signalized intersections that were analyzed together in the CAL3QHC model run.

Figure 12
CO Hotspot Modeling Site: Quebec Street Intersection with County Line Road

This scenario uses 2035 projected traffic levels (higher traffic volumes than in 2025 or 2015) and 2015 CO emission factors (higher than the emission rates in 2025 and 2035, that will decline due to improved vehicle fuel efficiency). As noted previously, this approach was proposed by CDOT and accepted by APCD based on the assumption that actual hotpot concentrations in 2025 and 2035 could not be worse than this scenario. The results of the hotspot modeling are presented in Table 3.

Table 3
Predicted Worst Case CO Concentrations*(parts per million)

Metric	CAL3QHC Microscale Modeled Prediction			
	8-hour average		1-hour average	
	No-Action Alternative	Proposed Action	No-Action Alternative	Proposed Action
Intersection Contribution	3.4	3.8	5.9	6.7
Background Concentration	0.7	0.7	2.1	2.1
Total Concentration	4.1	4.5	8.0	8.8
National standard	9.0		35.0	
Demonstrates conformity?	Yes	Yes	Yes	Yes

** Worst-case future (2035) traffic with worst-case 2015 emission rates at the corridor's most congested, signalized intersection. Does not reflect an actual expected future condition.*

The results of the CO hotspot modeling for the 8-hour average indicate worst-case concentrations of 4.1 ppm and 4.5 ppm for the two alternatives, both meeting the NAAQS of 9.0 ppm. For the 1-hour average NAAQS of 35.0 ppm, the alternatives resulted in total concentrations of 8.0 and 8.8 ppm. The modeled scenario was constructed to produce higher concentrations than would actually occur at the site in 2015, 2025 or 2035. Based on these results, it is concluded that there would be no future violations of the CO 8-hour NAAQS within the C-470 project area for either alternative.

4.4 Particulate Matter Hotspot Analysis

Microscale analysis was not conducted for particulate matter because C-470 carries minimal (1.2%) heavy truck volumes and the Proposed Action would not encourage increased diesel truck use. Also, the C-470 corridor has no truck stops, intermodal terminals or other sites where a large amount of diesel truck activity would be concentrated. CDPHE concurred with this assessment in interagency consultation as documented in Attachment A.

4.5 Mobile Source Air Toxics

The MOVES2014 model was also applied to predict future emissions of MSATs within the project area. For this analysis, traffic only on C-470 and its ramps was included, as vehicle classification data regarding heavy trucks was not available for connecting arterials. As noted previously, C-470 carries a smaller percentage of heavy trucks (1.2%) than any other major highway in the Denver region, and the Proposed Action would not attract additional heavy truck traffic as the proposed express lanes would discourage heavy truck use through high tolls. Table 4 presents the prediction future MSAT emissions. Note that the results are presented in terms of pounds per day.

As with predicted emissions presented earlier for other pollutants, the results in Table 4 reflect slightly higher emissions for the Proposed Action than for the No-Action Alternative because C-470 with more lanes would be able to carry more traffic. However, emissions in 2035 would decline from 2025 levels due to continuing Federally-mandated improvements in motor vehicle fuel efficiency. Again, the declining emission rates would more than compensate for increased VMT, resulting in lower future MSAT emissions despite increased traffic.

Table 4
Estimated Emissions of MSATs on C-470 (pounds per day)

Pollutant	2025 No-Action	2025 Interim Project	2035 No-Action	2035 Proposed Action
Benzene	5.9	6.9	3.0	4.8
Formaldehyde	2.5	2.9	1.5	2.7
1,3-Butadiene	0.2	0.2	<0.1	<0.1
Acrolein	0.1	0.2	0.1	0.1
Naphthalene	0.3	0.3	0.2	0.3
Polycyclic organic matter (POM)	0.1	0.2	0.1	0.1
Diesel particulate matter	4.1	4.8	1.9	3.0

4.6 Pollutant Emissions from Project Construction Activities

During construction, the use of heavy equipment operation and earth moving machinery would create exhaust emissions and fugitive dust. Storage piles of construction material also would have potential to generate fugitive dust.

4.7 Conformity Conclusion

Based on the analysis performed for this project, it is concluded that the Proposed Action demonstrates air quality conformity at both the project and regional level.

5.0 MITIGATION

With the No-Action Alternative, no mitigation would be provided.

With the Proposed Action, no mitigation would be required for pollutant emissions resulting from vehicle use of the new roadway components. However, regarding construction air quality impacts, all contractors would be required to obtain a construction permit and develop a fugitive emissions particulate emissions control plan to be implemented during construction in accordance with the Colorado Air Quality Control Commission Regulation No. 1, Part 3D, and Regulation No. 3, Applicable Permit Requirements. The contractor would also be required to minimize airborne dust during construction through construction phasing to prevent exposing bare dirt on the whole site at once; stabilize soils through seeding and mulching; and suppressing dust through regular watering and applications of dust palliatives as appropriate.

6.0 REFERENCES

Colorado Department of Public Health and Environment (CDPHE), Air Pollution Control Division, 2015. Colorado 2013 Air Quality Data Report. Retrieved May 2015 from http://colorado.gov/airquality/tech_doc_repository.aspx#annual_reports

Denver Regional Council of Governments (DRCOG), 2015a. CO and PM10 Conformity Determination for the DRCOG Fiscally Constrained 2040 Regional Transportation Plan and the Amended 2012-2017 Transportation Improvement Program and 2016-2021 Transportation Improvement Program. Retrieved May 2015 from https://drcog.org/sites/drcog/files/resources/FINAL%20TIP%202016-2021%20CO_PM10%20Conformity.pdf

National Oceanic and Atmospheric Administration, National Climate Data Center, 2015. Climate Data Online: Dataset Discovery. Retrieved January 2015 from http://www.ncdc.noaa.gov/cdo-web/datasets

EPA's Urban Environmental Program in New England, website accessed 08-04-2013; http://www.epa.gov/region1/eco/uep/sensitivereceptors.html

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ATTACHMENT A
CDPHE METHODOLOGY CONCURRENCE

COLORADO
Department of Transportation

Environmental Programs Branch
4201 E. Arkansas Ave, Shumate Bldg
Denver, CO 80222-3400

January 15, 2015

Chris Colclasure, Planning & Policy Program Mgr
Air Pollution Control Division
Colorado Department of Public Health & Environment
4300 Cherry Creek Drive South
Denver, CO 80901

Dear Sir:

The Colorado Department of Transportation (CDOT) is requesting your concurrence with the following air quality analytical methodology for the C-470 Corridor Revised Environmental Assessment.

As part of a Revised Environmental Assessment (EA) for proposed tolled express lanes on State Highway C-470 in the Denver metro area, the Colorado Department of Transportation is updating air quality analysis to satisfy requirements of the National Environmental Policy Act and air quality conformity regulations. This letter describes our proposed analytical methodology and supporting rationale. We request that APCD review these details and provide your written concurrence. Factors outside our control have put the air quality analysis on a critical time path for the revised EA, so CDOT is eager to resolve any methodological issues expeditiously. CDOT will provide any additional information you may need or to answer any questions about the proposed project, methodology and assumptions.

PROJECT BACKGROUND
CDOT and FHWA approved an EA completed in 2006 which proposed tolled express lanes on C-470 between I-25 and Kipling Parkway, a distance of 13.75 miles, affecting the southern portion of the Denver metro area. However, the project lacked funding and unified local support, so it did not proceed to construction at that time. As a part of the EA, air quality analyses were performed in consultation with APCD staff, and the results met all applicable air quality requirements under NEPA and transportation conformity.

Project funding has now been secured for 2015 and public consensus has been achieved so the project is ready to move forward. However, the approved EA is nine years old and therefore is being revised to update the air quality analysis and other resource analyses as needed before a decision document of Finding of No Significant Impact can be issued.

PROJECT CHANGES, 2006 to 2015
The main feature of the 2015 Proposed Action, as in the 2006 EA, is constructing two tolled express lanes between I-25 and Kipling Parkway. The existing two lanes in each direction will continue to act as (free) general purpose lanes. The 2015 action newly adds extensive auxiliary lanes, which will greatly improve merge and diverge movements near interchanges, improving travel speeds and safety. Additionally,

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previously proposed ramps to provide new C-470 access at Colorado Boulevard have been eliminated. New direct-connect ramps have been added to allow motorists to enter or exit the express lanes at I-25 without having to merge across all lanes of C-470. Thus, the 2015 Proposed Action is similar, but not identical, to the action that underwent earlier air quality analysis.

CHANGES IN REGIONAL PLANNING CONTEXT

The 2006 preferred action was analyzed for a 2025 planning horizon year, and was not yet included in the conforming DRCOG 2025 Regional Transportation Plan. The 2015 Proposed Action has been added to the DRCOG 2035 Metro Vision Regional Transportation Plan, and will need to be analyzed for a 2035 planning horizon year. A near-term interim project will build much of the Proposed Action by 2018, and the remainder of the project will be completed by 2035. Unlike the 2006 analysis, the 2015 analysis can be based on a known project phasing approach.

NEW AIR QUALITY EMISSION FACTORS

EPA-developed MOVES emission factors are available now to replace the MOBILE6.2 emission factors that were used in the previous C-470 air quality analysis. These analyses will use the recently released MOVES2014 emissions model. CDOT would acquire revised inventories, emissions factors, and background concentrations from APCD for our new analysis.

CARBON MONOXIDE MICROSCALE ANALYSIS

Although the last violation of the national carbon monoxide standard in the Denver region was in 1995, microscale CO analysis is conducted to show that a proposed action will not cause or contribute to a future National Ambient Air Quality Standard (NAAQS) violation. Traffic level of service (LOS) analysis was performed in 2006 for 31 signalized intersections at or near C-470 interchanges, and three congested intersections underwent CO microscale analysis for 2025 and interim years. The most congested (LOS F) intersection with the most traffic was Quebec Street at County Line Road, 500 feet north of the C-470 westbound ramp intersection. It produced the highest predicted 2025 CO concentration at 6.80 parts per million (ppm), including an assumed background concentration of 3.0 ppm. The other two modeled intersections yielded 6.54 ppm and 4.55 ppm. The national CO standard for an 8-hour average is 9.0 ppm, and our worst operating intersection was well below that.

New LOS analysis of the same 31 intersections for the year 2035 finds that the same intersection (Quebec/County Line) is again projected to be the most congested (LOS F) with by far the highest traffic volume, so it is again the top candidate for hotspot analysis. In 2035, it will carry 13 percent more traffic than was modeled in the 2025 microscale analysis. For 2035, the second busiest LOS F intersection is Quebec Street at the C-470 westbound ramps, roughly 500 feet away from the intersection previously modeled.

The C-470 Proposed Action (interim and ultimate improvements) will not modify the geometry of the Quebec/County Line or Quebec/WB C-470 ramp intersections. It will only affect the amount of traffic approaching these intersections and their signal timing. CDOT proposes to model the combined two-intersection complex for 2035 traffic conditions. CDOT also proposes to utilize a worst case analysis, which utilizes the highest traffic volumes expected over the project planning timeline (2035) with the worst emissions rates expected over that same timeframe (current 2015 emission rates). The results of this type of analysis adequately simulate the highest potential carbon monoxide concentrations possible over the 20-year timeframe, eliminating the need for interim year analyses. If the results of a worst-case analysis are less than the NAAQS for CO, then no violation is likely to be caused by the project actions. If the results indicate a higher concentration than the NAAQS, then a more extensive analyses will be required comparing No Build and Build traffic and emissions for 2035. EPA approved this approach for the I-70 East Supplemental DEIS.

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PM10 MICROSCALE ANALYSIS

C-470 has among the lowest truck percentages of any major highway in the Denver region, as the corridor has little industrial develpment and no significant intermodal facilities. The proposed C-470 express lanes will have a toll structure that discourages commercial truck use. No PM10 hotspot modeling is recommended because the total diesel truck volume is less than 1.5 % on C-470, the percentage of diesel vehicles is not projected to increase, and no change in truck circulation patterns are expected as a result of the Proposed Action.

CRITERIA POLLUTANTS

In addition to micro-scale analyses for conformity purposes, CDOT will also include qualitative discussion of criteria pollutants affecting regional ozone nonattainment, including ozone, nitrogen oxides, volatile organic compounds, and other criteria pollutants.

MSAT EMISSION ANALYSIS

Multiple segments of the 13.75-mile project area would exceed an AADT of 140,000 vehicles per day in 2035 under the Proposed Action, triggering the need for a quantitiative MSAT analysis. Despite the minimal truck volumes, CDOT proposes to conduct quantitative inventory of priority MSAT emissions for the Proposed Action and No-Action alternatives. EPA identified seven priority compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers which will be included in this analysis:

acrolein;
benzene;
1,3-butidiene;
diesel particulate matter plus diesel exhaust organic gases (diesel PM);
formaldehyde;
naphthalene; and
polycyclic organic matter.

CDOT proposes to limit this analysis to the year 2035 and to only assess freeway mainline traffic for this analysis. Meaningful differences in MSAT emissions for the two alternatives are not anticipated.

GREENHOUSE GAS EMISSIONS

Per current FHWA guidance, CDOT plans to provide a summary assessment of the direct, indirect and cumulative effects of GHG emissions from the project, including a comparative analyses of global, statewide and project generated GHG emissions.

Thank you for your consideration of our proposed analytical approach. For your convenience, a concurrence signature block is provided below for your possible use. If you feel there is a need for an interagency consultation meeting regarding this project, please contact me at (303) 757-9016 (jill.schlaefer@state.co.us) so that a meeting can be scheduled as soon as possible. Again, if you or your staff has any questions regarding this project-level air quality analysis, please let me know.

Cordially,

Jill Schlaefer
Air Quality and Noise Programs Manager

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APCD CONCURRENCE:
For the Air Pollution Control Division of the Colorado Department of Public Health and Environment, I concur that the project-level analytical approach described above for the C-470 Corridor Revised EA re-analysis is acceptable and appropriate for this project.

Christopher L. Williams
Signature

Jan. 15, 2015
Date

Planning and Policy Program Manager
Title

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ATTACHMENT B
CAL3QHC MODEL RUN FOR
THE NO-ACTION ALTERNATIVE

```
                        CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION
2.0 Dated 95221                               PAGE  1

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2035 PR

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      TIME :  9:23: 8

         The MODE flag has been set to C for calculating CO averages.

       SITE & METEOROLOGICAL VARIABLES
       -------------------------------
       VS =   0.0 CM/S       VD =   0.0 CM/S       Z0 = 175. CM
        U =  1.0 M/S         CLAS =   4  (D)      ATIM =  60. MINUTES
MIXH =  1000. M   AMB =  0.0 PPM

       LINK VARIABLES
       --------------
         LINK DESCRIPTION     *          LINK COORDINATES (FT)           *
LENGTH  BRG TYPE   VPH    EF       H   W    V/C QUEUE
                        *   X1         Y1         X2         Y2     *
 (FT)   (DEG)            (G/MI)  (FT) (FT)        (VEH)
      ------------------------*-----------------------------------------*--
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387.   359. AG   1821.  27.0   0.0 56.0
       2. QBC NB Q            * 216136.1  319669.7  216137.5  319539.2 *
131.   179. AG    220. 100.0   0.0 36.0 0.62   6.6
       3. QBC NB LT Q         * 216103.4  319670.3  216149.7  318258.8 *
1412.   178. AG    196. 100.0   0.0 23.0 1.82  71.7
       4. QBC NB RT Q         * 216155.3  319669.4  216156.7  319629.1 *
40.   178. AG     19. 100.0   0.0 10.0 0.28   2.0
       5. QBC NB DPTR         * 216135.1  319738.8  216128.5  320138.8 *
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       6. QBC SB APPR         * 216090.0  320138.8  216070.4  319738.6 *
401.   183. AG   2060.  18.0   0.0 44.0
       7. QBC SB Q            * 216074.0  319812.3  216186.3  322104.1 *
2295.     3. AG    141. 100.0   0.0 24.0 1.36 116.6
       8. QBC SB LT Q1        * 216100.7  319812.5  216100.0  319902.2 *
90.   360. AG    190. 100.0   0.0 21.0 0.81   4.6
       9. QBC SB LT Q2        * 216097.2  319942.4  216171.0  321338.9 *
1398.     3. AG     95. 100.0   0.0 10.0 1.63  71.0
      10. QBC SB RT Q         * 216061.6  319812.2  216062.4  319845.6 *
33.     1. AG     19. 100.0   0.0 10.0 0.23   1.7
      11. QBC SB DPTR         * 216070.4  319738.6  216069.9  319455.0 *
284.   180. AG   2848.  18.0   0.0 56.0
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      13. CLR EB Q            * 216025.3  319710.6  214409.1  319730.6 *
1616.   271. AG    176. 100.0   0.0 24.0 1.40  82.1
      14. CLR EB LT Q         * 216028.2  319733.9  215437.4  319733.9 *
591.   270. AG    220. 100.0   0.0 20.0 2.26  30.0
```

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      16. CLR EB DPTR         * 216101.8  319709.7  216640.7  319716.8 *
539.    89. AG   1603.  20.5   0.0 44.0
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      18. CLR WB Q            * 216176.4  319767.6  217358.1  319776.3 *
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      19. CLR WB LT Q1        * 216177.7  319744.0  217970.2  319757.7 *
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524.   180. AG    211. 100.0   0.0 22.0 2.10  26.6
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      27. QBCS NB DPTR        * 216144.5  319168.7  216139.7  319323.0 *
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      28. QBCS SB APPR        * 216069.9  319455.0  216072.0  319162.0 *
293.   180. AG   2847.  18.0   0.0 56.0
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32.     0. AG      9. 100.0   0.0 17.0 0.40   1.6
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      34. 470 WB TRL Q        * 216190.4  319174.4  216190.8  319174.4 *
0.    90. AG     61. 100.0   0.0 12.0 0.00   0.0
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9459.    98. AG     61. 100.0   0.0 12.0 2.33 480.5
      36. 470 WB RT Q1        * 216202.4  319222.8  216217.2  319212.6 *
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      37. 470 WB RT Q2        * 216265.1  319176.8  216282.9  319174.5 *
18.    97. AG      9. 100.0   0.0 12.0 0.23   0.9
      38. 470 WB DPTR         * 216107.2  319178.2  215662.9  319097.7 *
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PAGE 2
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DATE : 6/10/15
TIME : 9:23: 8

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	*	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
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3. QBC NB LT Q	*	120	104	3.0	533	1600	42.05	2	3
4. QBC NB RT Q	*	120	20	0.0	369	1600	42.05	2	3
7. QBC SB Q	*	120	75	3.0	1451	1600	42.05	2	3
8. QBC SB LT Q1	*	120	101	3.0	303	1600	42.05	2	3
9. QBC SB LT Q2	*	120	101	3.0	303	1600	42.05	2	3
10. QBC SB RT Q	*	120	20	0.0	306	1600	42.05	2	3
13. CLR EB Q	*	120	90	3.0	931	1600	43.86	2	3
14. CLR EB LT Q	*	120	112	3.0	176	1600	43.86	2	3
15. CLR EB RT Q	*	120	20	0.0	615	1600	43.86	2	3
18. CLR WB Q	*	120	75	3.0	1236	1600	43.86	2	3
19. CLR WB LT Q1	*	120	97	3.0	782	1600	43.86	2	3
20. CLR WB LT Q2	*	120	97	3.0	782	1600	43.86	2	3
21. CLR WB RT Q	*	120	20	0.0	258	1600	43.86	2	3
24. QBCS NB Q	*	120	58	3.0	1162	1600	42.05	2	3
25. QBCS NB LT Q1	*	120	112	3.0	165	1600	42.05	2	3
26. QBCS NB LT Q2	*	120	112	3.0	165	1600	42.05	2	3
29. QBCS SB Q	*	120	68	3.0	2270	1600	42.05	2	3

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1600       42.05       2      3
      31. QBCS SB RT Q2       *     120        10         0.0         577
1600       42.05       2      3
      34. 470 WB TRL Q        *     120        65         3.0           1
1600       42.26       2      3
      35. 470 WB LT Q         *     120        65         3.0        1550
1600       42.26       2      3
      36. 470 WB RT Q1        *     120        10         0.0         329
1600       42.26       2      3
      37. 470 WB RT Q2        *     120        10         0.0         329
1600       42.26       2      3

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      2. Rec 2                *    216231.9   319803.2        6.0   *
      3. Rec 3                *    216201.9   319802.8        6.0   *
      4. Rec 4                *    216181.9   319806.8        6.0   *
      5. Rec 5                *    216167.1   319820.2        6.0   *
      6. Rec 6                *    216160.7   319840.2        6.0   *
      7. Rec 7                *    216160.7   319870.2        6.0   *
      8. Rec 8                *    216160.6   319910.2        6.0   *
      9. Rec 9                *    216045.1   319906.2        6.0   *
     10. Rec 10               *    216044.8   319866.4        6.0   *
     11. Rec 11               *    216044.6   319836.3        6.0   *
     12. Rec 12               *    216040.9   319816.3        6.0   *
     13. Rec 13               *    216026.7   319802.2        6.0   *
     14. Rec 14               *    216006.7   319798.6        6.0   *
     15. Rec 15               *    215976.7   319798.9        6.0   *
     16. Rec 16               *    215936.7   319799.2        6.0   *
     17. Rec 17               *    215922.3   319677.1        6.0   *
     18. Rec 18               *    215962.3   319676.7        6.0   *
     19. Rec 19               *    215992.3   319676.3        6.0   *
     20. Rec 20               *    216012.3   319673.2        6.0   *
     21. Rec 21               *    216024.9   319657.6        6.0   *
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PAGE   3
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2035 PR

      DATE :   6/10/15
      TIME :   9:23: 8


       RECEPTOR LOCATIONS
       ------------------
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         RECEPTOR        *       X           Y           Z         *
     --------------------------*-----------------------------------*
     22. Rec 22          *     216028.9    319637.6        6.0     *
     23. Rec 23          *     216028.9    319607.6        6.0     *
     24. Rec 24          *     216028.8    319567.6        6.0     *
     25. Rec 25          *     216175.6    319569.8        6.0     *
     26. Rec 26          *     216174.2    319609.8        6.0     *
     27. Rec 27          *     216173.3    319639.7        6.0     *
     28. Rec 28          *     216178.3    319659.7        6.0     *
     29. Rec 29          *     216192.4    319673.9        6.0     *
     30. Rec 30          *     216212.4    319678.6        6.0     *
     31. Rec 31          *     216242.4    319678.8        6.0     *
     32. Rec 32          *     216282.4    319679.0        6.0     *
     33. Rec 33          *     216337.2    319192.8        6.0     *
     34. Rec 34          *     216280.7    319195.5        6.0     *
     35. Rec 35          *     216254.6    319206.4        6.0     *
     36. Rec 36          *     216229.8    319224.0        6.0     *
     37. Rec 37          *     216215.9    319238.3        6.0     *
     38. Rec 38          *     216204.0    319254.8        6.0     *
     39. Rec 39          *     216190.7    319283.9        6.0     *
     40. Rec 40          *     216184.8    319311.6        6.0     *
     41. Rec 41          *     216182.6    319368.1        6.0     *
     42. Rec 42          *     216027.8    319368.9        6.0     *
     43. Rec 43          *     216026.8    319312.3        6.0     *
     44. Rec 44          *     216021.6    319270.2        6.0     *
     45. Rec 45          *     216010.6    319241.2        6.0     *
     46. Rec 46          *     216000.6    319223.8        6.0     *
     47. Rec 47          *     215988.5    319207.9        6.0     *
     48. Rec 48          *     215965.8    319187.2        6.0     *
     49. Rec 49          *     215926.7    319170.8        6.0     *
     50. Rec 50          *     215982.8    319122.1        6.0     *
     51. Rec 51          *     216010.8    319127.1        6.0     *
     52. Rec 52          *     216039.0    319129.7        6.0     *
     53. Rec 53          *     216042.0    319101.5        6.0     *
     54. Rec 54          *     216042.2    319073.3        6.0     *
     55. Rec 55          *     216173.2    319047.8        6.0     *
     56. Rec 56          *     216173.2    319087.8        6.0     *
     57. Rec 57          *     216173.2    319116.2        6.0     *
     58. Rec 58          *     216176.0    319144.3        6.0     *
     59. Rec 59          *     216204.3    319143.4        6.0     *
     60. Rec 60          *     216232.4    319139.7        6.0     *
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PAGE   4
      JOB: QBC/CLR NO BUILD 2035 PR                                RUN: NOBLD
2035 PR

       MODEL RESULTS
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       REMARKS : In search of the angle corresponding to
                 the maximum concentration, only the first
                 angle, of the angles with same maximum
                 concentrations, is indicated as maximum.

 WIND ANGLE RANGE:  10.-360.

 WIND   * CONCENTRATION
 ANGLE *      (PPM)
 (DEGR)* REC1  REC2  REC3  REC4  REC5  REC6  REC7  REC8  REC9  REC10 REC11
REC12 REC13 REC14 REC15 REC16 REC17 REC18 REC19 REC20
 ------*----------------------------------------------------------------------
-------------------------------------------------------
  10.  *   0.0   0.0   0.0   0.1   0.2   0.3   0.3   0.3   2.8   3.0   3.0
2.6   1.8   1.2   0.8   0.6   3.0   3.3   3.6   3.9
  20.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   3.1   3.2   3.2
3.1   2.2   1.6   1.0   0.8   3.2   3.5   4.0   3.9
  30.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.9   2.8   3.1
2.9   2.3   1.8   1.2   1.0   3.3   3.7   3.8   3.8
  40.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.7   2.7   2.7
2.7   2.1   1.6   1.2   0.9   3.3   3.8   3.6   3.6
  50.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5   2.5   2.6
2.6   2.1   1.6   1.3   0.9   3.5   3.6   3.5   3.7
  60.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.2   2.3   2.5
2.4   1.9   1.6   1.2   0.9   3.6   3.8   3.6   3.8
  70.  *   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0   2.0   2.2   2.3
2.3   2.0   1.5   1.3   1.0   3.7   3.8   4.1   4.1
  80.  *   0.8   0.8   0.8   0.6   0.4   0.3   0.0   0.0   2.1   2.4   2.6
2.7   2.3   2.3   2.0   1.7   3.8   3.8   4.0   4.3
  90.  *   1.8   1.8   1.9   1.7   1.2   1.0   0.6   0.5   2.6   3.0   3.5
3.6   3.4   3.3   3.1   2.8   3.1   3.2   3.6   3.8
 100.  *   2.8   2.9   2.9   2.7   2.1   1.7   1.2   0.8   3.1   3.7   4.1
4.2   4.0   4.2   3.9   3.8   2.2   2.5   2.9   3.3
 110.  *   3.1   3.1   3.1   2.8   2.2   2.0   1.5   1.2   3.5   3.7   4.1
4.0   3.9   3.9   3.8   3.8   1.7   2.0   2.4   2.7
 120.  *   2.8   2.9   3.0   2.7   2.3   1.9   1.4   1.3   3.5   3.9   3.8
3.7   4.1   3.8   3.8   3.7   1.6   1.9   2.3   2.6
 130.  *   2.6   2.6   2.6   2.5   2.2   1.7   1.5   1.3   3.6   3.9   3.8
3.8   4.2   3.9   3.9   4.0   1.7   1.9   2.2   2.9
 140.  *   2.4   2.4   2.4   2.3   2.1   1.6   1.4   1.2   3.9   3.9   4.1
4.2   4.5   4.3   4.1   4.1   1.7   2.0   2.4   2.9
 150.  *   2.3   2.3   2.3   2.3   1.8   1.6   1.4   1.2   4.4   4.3   4.7
4.9   4.9   4.6   4.3   4.2   1.5   2.1   2.5   3.0
 160.  *   2.3   2.3   2.3   2.3   1.9   1.7   1.2   1.1   4.8   5.0   5.4
5.5   5.2   4.8   4.5   3.9   1.5   1.8   2.3   3.0
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 170.  *   2.3   2.4   2.6   2.6   2.6   2.5   2.3   1.9   5.0   5.6   5.9
5.7   5.1   4.7   4.1   3.5   0.8   1.5   2.0   2.7
 180.  *   2.7   3.0   3.6   3.8   3.9   3.5   3.2   2.9   4.1   4.3   4.6
4.7   4.2   3.7   3.1   2.7   0.4   0.6   1.0   1.7
 190.  *   3.2   3.8   4.4   4.4   4.2   3.9   3.5   3.1   2.4   2.6   3.1
3.1   2.8   2.7   2.5   2.4   0.0   0.1   0.2   0.4
 200.  *   3.7   4.3   4.5   4.3   3.7   3.5   3.2   2.8   1.4   1.6   1.9
2.1   2.3   2.3   2.3   2.3   0.0   0.0   0.0   0.0
 210.  *   3.9   4.2   3.8   3.7   3.2   2.9   2.7   2.6   1.2   1.4   1.7
2.0   2.3   2.4   2.4   2.4   0.0   0.0   0.0   0.0
 220.  *   3.7   3.7   3.4   3.4   2.9   2.9   2.6   2.6   1.1   1.5   1.7
2.1   2.4   2.5   2.5   2.5   0.0   0.0   0.0   0.0
 230.  *   3.6   3.5   3.1   3.1   3.0   2.9   2.8   2.7   1.1   1.5   1.9
2.2   2.6   2.8   2.8   2.8   0.0   0.0   0.0   0.0
 240.  *   3.6   3.4   3.3   3.2   3.0   3.0   2.9   2.8   1.0   1.4   1.8
2.2   2.8   2.9   2.9   2.9   0.0   0.0   0.0   0.0
 250.  *   3.5   3.4   3.4   3.4   3.2   3.0   2.9   2.4   0.7   1.1   1.6
2.2   2.8   3.0   2.9   2.8   0.1   0.1   0.1   0.1
 260.  *   3.1   3.0   3.3   3.2   2.7   2.6   2.4   2.0   0.3   0.7   1.1
1.6   2.3   2.4   2.4   2.2   0.5   0.5   0.6   0.5
 270.  *   2.3   2.4   2.5   2.4   2.2   2.2   1.9   1.6   0.1   0.2   0.5
0.9   1.3   1.5   1.4   1.3   1.2   1.3   1.4   1.3
 280.  *   1.6   1.5   1.5   1.6   1.5   1.7   1.5   1.3   0.0   0.0   0.1
0.2   0.5   0.6   0.6   0.4   2.1   2.3   2.4   2.1
 290.  *   0.9   1.0   1.1   1.2   1.4   1.6   1.5   1.3   0.0   0.0   0.0
0.0   0.1   0.1   0.1   0.1   2.7   2.9   2.9   2.7
 300.  *   0.8   0.9   1.0   1.2   1.6   1.5   1.4   1.4   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   2.8   2.9   3.0   2.9
 310.  *   0.7   0.9   1.0   1.2   1.5   1.5   1.4   1.4   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   2.8   2.8   2.8   2.7
 320.  *   0.8   0.8   1.1   1.3   1.5   1.4   1.4   1.4   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   2.7   2.7   2.7   2.6
 330.  *   0.7   0.8   1.1   1.4   1.5   1.5   1.4   1.4   0.1   0.1   0.1
0.0   0.0   0.0   0.0   0.0   2.6   2.5   2.5   2.3
 340.  *   0.5   0.8   1.0   1.2   1.3   1.4   1.3   1.3   0.3   0.3   0.3
0.2   0.0   0.0   0.0   0.0   2.3   2.3   2.3   2.3
 350.  *   0.3   0.6   0.8   0.8   1.1   1.2   1.2   1.3   0.8   0.8   0.8
0.6   0.4   0.2   0.1   0.0   2.4   2.4   2.5   2.6
 360.  *   0.1   0.3   0.3   0.6   0.6   0.8   0.8   0.8   1.8   1.9   1.9
1.7   1.1   0.8   0.4   0.2   2.6   2.8   3.1   3.1
 ------*----------------------------------------------------------------------
------------------------------------------------------
 MAX   *   3.9   4.3   4.5   4.4   4.2   3.9   3.5   3.1   5.0   5.6   5.9
5.7   5.2   4.8   4.5   4.2   3.8   3.8   4.1   4.3
 DEGR. *  210   200   200   190   190   190   190   190   170   170   170
170   160   160   160   150    80    70    70    80
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PAGE  5
      JOB: QBC/CLR NO BUILD 2035 PR                                            RUN: NOBLD
2035 PR

       MODEL RESULTS
       -------------

       REMARKS : In search of the angle corresponding to
                 the maximum concentration, only the first
                 angle, of the angles with same maximum
                 concentrations, is indicated as maximum.

 WIND ANGLE RANGE:  10.-360.

 WIND  * CONCENTRATION
 ANGLE *      (PPM)
 (DEGR)* REC21 REC22 REC23 REC24 REC25 REC26 REC27 REC28 REC29 REC30 REC31
REC32 REC33 REC34 REC35 REC36 REC37 REC38 REC39 REC40
 ------*--------------------------------------------------------------------------
------------------------------------------------------
  10.  *   3.9   3.9   3.6   3.5   1.3   1.4   1.5   1.6   1.9   2.0   2.0
2.0   0.5   0.5   0.5   0.7   0.6   0.6   0.7   0.9
  20.  *   4.0   3.9   3.8   3.6   1.1   1.3   1.5   1.6   1.9   2.0   2.0
2.0   0.4   0.5   0.5   0.6   0.6   0.6   0.7   0.7
  30.  *   3.7   3.9   3.6   3.6   1.0   1.2   1.4   1.7   2.0   2.1   2.1
2.0   0.4   0.4   0.4   0.4   0.4   0.6   0.6   0.6
  40.  *   3.6   3.6   3.7   3.9   1.1   1.3   1.5   1.9   2.1   2.2   2.2
2.2   0.2   0.3   0.4   0.4   0.4   0.4   0.4   0.4
  50.  *   3.7   3.7   3.9   4.0   1.1   1.3   1.6   1.9   2.2   2.3   2.3
2.3   0.2   0.2   0.2   0.2   0.2   0.3   0.4   0.4
  60.  *   3.7   4.1   4.1   4.2   1.0   1.3   1.7   2.0   2.3   2.4   2.4
2.4   0.1   0.1   0.1   0.1   0.1   0.2   0.2   0.2
  70.  *   4.1   4.3   4.2   4.1   0.9   1.3   1.7   2.0   2.5   2.7   2.6
2.6   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
  80.  *   4.2   4.4   4.1   3.7   0.6   0.8   1.3   1.6   2.1   2.3   2.3
2.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  90.  *   4.0   3.9   3.8   3.4   0.3   0.5   0.8   1.0   1.3   1.6   1.5
1.3   0.4   0.4   0.4   0.3   0.2   0.2   0.2   0.2
 100.  *   3.2   3.4   3.3   3.1   0.2   0.2   0.3   0.4   0.6   0.6   0.6
0.6   0.5   0.6   0.5   0.5   0.5   0.5   0.4   0.3
 110.  *   3.1   3.3   3.2   3.1   0.2   0.2   0.2   0.2   0.2   0.2   0.2
0.2   0.6   0.6   0.5   0.5   0.4   0.4   0.4   0.3
 120.  *   3.0   3.2   3.2   3.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.1   0.5   0.6   0.5   0.5   0.5   0.4   0.4   0.4
 130.  *   3.2   3.4   3.2   3.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.1   0.5   0.5   0.5   0.5   0.5   0.4   0.4   0.4
 140.  *   3.2   3.4   3.2   3.4   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.1   0.5   0.5   0.5   0.5   0.4   0.4   0.4   0.4
 150.  *   3.4   3.6   3.5   3.6   0.1   0.2   0.2   0.1   0.1   0.1   0.1
0.1   0.5   0.5   0.5   0.5   0.4   0.4   0.4   0.3
 160.  *   3.6   3.8   3.7   3.9   0.2   0.2   0.3   0.2   0.1   0.1   0.1
0.1   0.5   0.5   0.5   0.4   0.4   0.4   0.3   0.3
```

170.	*	3.1	3.4	3.4	3.4	0.8	0.9	0.9	0.8	0.6	0.3	0.1	0.1	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.5
180.	*	2.0	2.2	2.2	2.3	2.1	2.2	2.5	2.1	1.3	1.1	0.6	0.3	0.5	0.6	0.6	0.6	0.8	0.8	1.1	1.2
190.	*	0.8	0.8	0.9	0.8	3.1	3.4	3.6	3.2	2.4	1.8	1.2	0.8	0.7	0.8	0.9	1.1	1.2	1.4	1.8	2.2
200.	*	0.0	0.2	0.1	0.1	3.5	3.8	4.0	3.7	3.0	2.3	1.7	1.3	0.8	1.1	1.3	1.4	1.5	1.7	2.4	2.7
210.	*	0.0	0.0	0.0	0.0	3.3	3.8	3.9	3.7	3.0	2.4	2.1	1.5	1.1	1.4	1.5	1.4	1.7	2.1	2.3	2.5
220.	*	0.0	0.0	0.0	0.0	3.2	3.6	3.7	3.5	3.0	2.4	1.9	1.6	1.2	1.4	1.5	1.4	1.8	2.1	2.2	2.4
230.	*	0.0	0.0	0.0	0.0	3.2	3.5	3.6	3.3	2.8	2.3	2.0	1.6	1.1	1.3	1.4	1.5	1.6	2.1	2.2	2.3
240.	*	0.0	0.0	0.0	0.0	3.1	3.3	3.3	3.0	2.6	2.2	1.9	1.6	1.1	1.3	1.4	1.4	1.6	1.8	2.1	2.3
250.	*	0.0	0.0	0.0	0.0	3.0	3.1	3.1	3.0	2.6	2.3	1.9	1.7	1.2	1.2	1.3	1.5	1.6	1.9	2.1	2.2
260.	*	0.2	0.1	0.0	0.0	3.0	3.1	3.3	3.2	3.1	2.7	2.5	1.9	1.1	1.2	1.2	1.5	1.6	1.7	2.1	2.2
270.	*	0.8	0.5	0.3	0.1	3.2	3.6	3.9	3.9	3.8	3.5	3.2	2.9	1.0	1.2	1.4	1.5	1.6	1.8	2.1	2.2
280.	*	1.6	1.0	0.6	0.4	3.6	4.1	4.4	4.4	4.2	4.0	3.5	3.2	0.9	1.3	1.4	1.7	1.7	1.8	2.2	2.3
290.	*	2.0	1.5	1.1	0.7	3.9	4.3	4.5	4.5	4.1	3.7	3.4	3.3	1.1	1.4	1.6	1.8	1.8	1.9	2.3	2.4
300.	*	2.3	1.8	1.3	1.0	4.4	4.6	4.5	3.9	3.5	3.0	2.9	3.0	1.1	1.5	1.6	1.8	1.9	2.2	2.5	2.7
310.	*	2.2	1.8	1.4	1.1	4.5	4.5	4.1	3.5	3.0	2.8	2.7	2.9	1.4	1.9	2.1	2.2	2.4	2.7	2.8	3.1
320.	*	2.1	1.8	1.5	1.2	4.5	4.2	3.7	3.3	3.0	2.8	2.9	2.9	1.3	1.9	2.2	2.3	2.5	2.8	3.3	3.4
330.	*	2.0	1.6	1.4	1.2	4.0	3.7	3.6	3.1	2.7	2.7	2.7	2.7	1.4	1.9	2.1	2.5	2.8	3.1	3.3	3.5
340.	*	2.0	1.6	1.3	1.2	3.9	3.6	3.2	3.0	2.7	2.9	2.8	2.6	1.3	1.7	2.0	2.2	2.4	2.7	3.1	3.4
350.	*	2.3	2.2	1.8	1.7	3.3	3.1	2.9	2.6	2.5	2.6	2.5	2.4	0.6	0.9	1.4	1.8	2.0	2.3	2.8	3.0
360.	*	3.1	3.0	2.8	2.8	2.4	2.3	2.4	2.1	2.3	2.4	2.2	2.1	0.5	0.8	0.9	1.0	1.1	1.4	1.6	1.8
MAX	*	4.2	4.4	4.2	4.2	4.5	4.6	4.5	4.5	4.2	4.0	3.5	3.3	1.4	1.9	2.2	2.5	2.8	3.1	3.3	3.5
DEGR.	*	80	80	70	60	310	300	290	290	280	280	280	290	310	310	320	330	330	330	320	330

PAGE 6
JOB: QBC/CLR NO BUILD 2035 PR RUN: NOBLD 2035 PR

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 10.-360.

WIND ANGLE (DEGR)	REC41	REC42	REC43	REC44	REC45	REC46	REC47	REC48	REC49	REC50	REC51	REC52	REC53	REC54	REC55	REC56	REC57	REC58	REC59	REC60
	CONCENTRATION (PPM)																			
10.	0.9	3.3	3.4	3.3	2.8	2.4	2.1	1.7	1.0	2.2	2.9	4.6	5.1	5.2	0.9	1.0	1.3	1.3	1.1	0.9
20.	0.7	3.9	3.7	3.4	3.0	2.7	2.6	2.2	1.8	2.3	2.9	4.2	4.5	4.5	0.6	0.6	0.7	0.8	0.9	0.8
30.	0.6	4.1	3.9	3.8	3.3	2.8	2.7	2.3	1.5	2.4	2.8	3.9	4.1	4.2	0.4	0.5	0.7	0.7	0.8	0.8
40.	0.6	3.8	3.8	3.6	3.1	2.8	2.5	2.3	2.0	2.4	2.7	3.8	3.9	4.0	0.3	0.5	0.7	0.8	0.9	0.7
50.	0.4	3.6	3.3	3.0	2.7	2.5	2.3	2.1	1.8	2.2	2.5	3.4	3.3	3.1	0.3	0.3	0.4	0.6	0.7	0.6
60.	0.3	3.1	2.9	2.8	2.5	2.2	2.1	1.7	1.3	1.7	2.1	2.9	2.8	2.9	0.3	0.3	0.4	0.6	0.6	0.6
70.	0.2	2.9	2.6	2.4	2.3	2.1	1.9	1.5	1.2	1.8	2.0	2.8	2.4	2.5	0.2	0.2	0.3	0.5	0.6	0.6
80.	0.2	2.8	2.5	2.4	2.1	2.0	1.7	1.5	1.3	1.7	2.1	2.6	2.7	3.0	0.3	0.3	0.4	0.7	0.7	0.7
90.	0.2	2.7	2.7	2.5	2.5	2.2	2.0	1.8	1.5	1.9	2.3	2.9	3.1	3.4	0.4	0.5	0.5	0.8	0.9	0.9
100.	0.2	2.9	2.8	2.8	2.5	2.2	2.0	1.8	1.5	2.0	2.3	2.8	3.0	3.2	0.5	0.4	0.5	0.7	0.7	0.7
110.	0.3	2.8	2.8	2.7	2.3	2.0	1.8	1.8	1.5	1.9	2.1	2.8	2.9	3.0	0.3	0.3	0.3	0.5	0.5	0.5
120.	0.3	3.1	2.8	2.7	2.0	1.7	1.8	1.6	1.5	1.9	2.3	2.9	3.1	3.1	0.3	0.3	0.3	0.2	0.2	0.2
130.	0.3	3.2	2.9	2.6	2.1	1.8	1.8	1.6	1.6	1.8	2.2	3.1	3.2	3.2	0.3	0.3	0.2	0.2	0.2	0.2
140.	0.3	3.2	2.9	2.7	2.0	2.0	2.0	1.8	1.5	1.8	2.4	3.2	3.4	3.4	0.3	0.2	0.2	0.2	0.2	0.2
150.	0.3	3.3	3.0	2.6	2.3	2.2	2.0	1.8	1.5	1.9	2.6	3.5	3.7	3.7	0.3	0.2	0.2	0.2	0.2	0.2
160.	0.2	3.3	3.0	2.7	2.3	2.1	1.9	1.7	1.1	1.7	2.5	3.7	3.9	3.9	0.2	0.2	0.2	0.2	0.2	0.2

```
 170.  *   0.7   2.9   2.6   2.3   2.0   1.9   1.5   1.0   0.7   1.1   1.9
3.8   4.1   4.1   0.4   0.5   0.5   0.5   0.3   0.2
 180.  *   1.6   1.7   1.6   1.3   1.1   1.1   0.9   0.5   0.2   0.6   1.1
2.7   3.1   3.2   1.0   1.0   1.0   1.0   0.7   0.5
 190.  *   2.5   0.6   0.5   0.4   0.3   0.3   0.2   0.2   0.1   0.1   0.3
1.3   1.8   1.9   1.5   1.7   1.9   1.6   1.0   0.6
 200.  *   2.8   0.2   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.1
0.5   0.8   0.9   2.0   2.1   2.2   2.1   1.4   1.2
 210.  *   2.7   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.0   0.0
0.2   0.4   0.5   2.2   2.4   2.3   2.2   1.8   1.4
 220.  *   2.7   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.0   0.0
0.2   0.3   0.3   2.3   2.4   2.4   2.1   1.8   1.3
 230.  *   2.6   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.0   0.0
0.1   0.2   0.2   2.3   2.3   2.2   1.7   1.6   1.4
 240.  *   2.5   0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.0   0.0
0.1   0.2   0.2   2.2   2.1   2.0   1.5   1.4   1.3
 250.  *   2.5   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.0   0.0
0.0   0.1   0.1   2.0   2.1   1.9   1.4   1.2   1.1
 260.  *   2.4   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.1
0.1   0.0   0.0   2.0   2.0   1.7   1.3   1.0   1.1
 270.  *   2.5   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1
0.1   0.0   0.0   2.1   2.0   1.4   1.3   1.3   1.2
 280.  *   2.5   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1
0.1   0.1   0.0   1.9   1.8   1.4   1.5   1.5   1.2
 290.  *   2.6   0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.0   0.1   0.1
0.1   0.1   0.1   1.9   1.7   1.3   1.8   1.8   1.7
 300.  *   2.9   0.2   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.2   0.2
0.2   0.3   0.2   2.3   1.9   1.4   2.0   2.0   1.8
 310.  *   3.2   0.3   0.2   0.2   0.1   0.1   0.1   0.1   0.1   0.2   0.2
0.2   0.4   0.3   2.1   1.9   1.8   2.5   2.4   2.2
 320.  *   3.5   0.5   0.4   0.4   0.3   0.2   0.2   0.2   0.1   0.2   0.3
0.3   0.5   0.4   2.4   2.3   2.4   3.0   3.0   2.7
 330.  *   3.8   0.6   0.6   0.4   0.4   0.4   0.4   0.4   0.2   0.4   0.5
0.5   0.8   0.7   2.7   2.8   2.8   3.6   3.3   2.8
 340.  *   3.9   0.7   0.7   0.6   0.6   0.6   0.4   0.4   0.4   0.5   0.5
0.9   1.1   1.1   3.1   3.1   3.3   3.8   3.0   2.6
 350.  *   3.1   1.4   1.3   1.2   1.0   0.9   0.8   0.7   0.4   0.7   0.9
1.7   2.2   2.2   3.0   3.2   3.6   3.8   2.8   2.3
 360.  *   1.9   2.4   2.3   2.1   1.8   1.5   1.4   1.2   1.0   1.2   1.7
3.1   3.8   3.8   2.2   2.2   2.4   2.7   1.5   1.3
 ------*-----------------------------------------------------------------------
-------------------------------------------------------
 MAX   *   3.9   4.1   3.9   3.8   3.3   2.8   2.7   2.3   2.0   2.4   2.9
4.6   5.1   5.2   3.1   3.2   3.6   3.8   3.3   2.8
 DEGR. *  340    30    30    30    30    30    30    40    40    30    10
10    10    10    340   350   350   340   330   330

 THE HIGHEST CONCENTRATION OF     5.90 PPM OCCURRED AT RECEPTOR REC11.
```

PAGE 7
JOB: QBC/CLR NO BUILD 2035 PR RUN: NOBLD 2035 PR

DATE : 6/10/15
TIME : 9:23: 8

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

CO/LINK (PPM)
ANGLE (DEGREES)

LINK #	REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15	REC16	REC17	REC18	REC19	REC20
	210	200	200	190	190	190	190	190	170	170	170	170	160	160	160	150	80	70	70	80
1	0.6	0.7	0.9	1.0	1.0	0.8	0.7	0.5	0.5	0.5	0.6	0.5	0.7	0.5	0.4	0.4	0.2	0.1	0.2	0.4
2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1
3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.0	1.0	0.9	0.6	0.3	0.0	0.0	0.0	0.1	0.1	0.1	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.3	0.3	0.4	0.3	0.4	0.5	0.5	0.5	0.6	0.8	1.0	1.2	1.1	1.0	0.7	0.6	0.5	0.6	0.8	1.1
12	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.6	1.0	1.1	1.0	0.4
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.5	0.4	0.5	0.8
17	1.1	1.1	1.1	1.0	0.9	0.7	0.5	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.6	0.7	0.5

```
      18  *   0.3   0.3   0.3   0.1   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.2   0.1   0.2   0.2
      19  *   0.3   0.3   0.2   0.1   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.2   0.2   0.2   0.3
      20  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.0   0.0   0.1
      21  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      22  *   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.4   0.6
0.8   0.9   1.1   1.2   1.2   1.3   0.1   0.2   0.1   0.0
      23  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1
0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0
      24  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      25  *   0.0   0.0   0.0   0.1   0.1   0.0   0.0   0.0   0.0   0.1
0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      26  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      27  *   0.0   0.1   0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0
      28  *   0.2   0.3   0.3   0.3   0.3   0.3   0.2   0.2   0.2   0.2
0.2   0.3   0.1   0.2   0.2   0.1   0.0   0.0   0.0   0.0
      29  *   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   1.0   1.0
1.0   0.8   0.6   0.4   0.3   0.2   0.2   0.2   0.3   0.4
      30  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      31  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      32  *   0.1   0.2   0.1   0.2   0.2   0.2   0.2   0.2   0.1   0.2
0.2   0.2   0.1   0.1   0.1   0.0   0.0   0.0   0.0   0.0
      33  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      34  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      35  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      36  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      37  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      38  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

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PAGE  8
JOB: QBC/CLR NO BUILD 2035 PR                               RUN: NOBLD 2035
PR

      DATE :  6/10/15
      TIME :  9:23: 8


      RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
      THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

          *    CO/LINK  (PPM)
          *    ANGLE (DEGREES)
          *  REC21 REC22 REC23 REC24 REC25 REC26 REC27 REC28 REC29 REC30
REC31 REC32 REC33 REC34 REC35 REC36 REC37 REC38 REC39 REC40
   LINK # *    80    80    70    60   310   300   290   290   280   280
280   290   310   310   320   330   330   330   320   330
   -------*------------------------------------------------------------
---------------------------------------------------------
      1  *   0.6   0.7   0.7   0.7   1.5   1.4   1.3   1.2   1.0   0.7
0.5   0.2   0.3   0.3   0.5   0.7   0.8   0.9   0.9   1.5
      2  *   0.1   0.2   0.2   0.2   0.6   0.5   0.5   0.2   0.1   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      3  *   0.1   0.2   0.2   0.3   0.3   0.2   0.2   0.1   0.0   0.0
0.0   0.0   0.1   0.2   0.2   0.2   0.3   0.3   0.3   0.3
      4  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      5  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      6  *   0.0   0.0   0.0   0.0   0.1   0.0   0.0   0.1   0.0   0.1
0.1   0.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      7  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      8  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      9  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     10  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     11  *   1.2   1.3   1.3   1.4   0.7   0.7   0.7   0.7   0.6   0.5
0.4   0.2   0.1   0.1   0.2   0.3   0.4   0.4   0.3   0.5
     12  *   0.1   0.0   0.0   0.0   0.4   0.6   0.7   0.8   0.8   0.7
0.6   0.3   0.1   0.1   0.1   0.2   0.2   0.2   0.2   0.2
     13  *   0.0   0.0   0.0   0.0   0.1   0.2   0.2   0.2   0.3   0.3
0.2   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
     14  *   0.0   0.0   0.0   0.0   0.1   0.2   0.2   0.2   0.3   0.3
0.2   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
     15  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     16  *   0.7   0.6   0.5   0.4   0.0   0.0   0.0   0.2   0.4   0.7
0.8   1.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     17  *   0.4   0.3   0.4   0.4   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

```
        18  *   0.2   0.2   0.2   0.1   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        19  *   0.3   0.3   0.2   0.2   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        20  *   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        21  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        22  *   0.0   0.0   0.0   0.0   0.4   0.5   0.5   0.6   0.5   0.5
  0.5   0.5   0.1   0.1   0.1   0.2   0.2   0.2   0.2   0.2
        23  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        24  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        25  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        26  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        27  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.1   0.3   0.3   0.2   0.2   0.3   0.4   0.0
        28  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.3   0.4   0.4   0.3   0.3   0.3   0.5   0.3
        29  *   0.4   0.5   0.5   0.5   0.3   0.3   0.2   0.2   0.2   0.2
  0.2   0.2   0.1   0.2   0.2   0.2   0.2   0.3   0.3   0.3
        30  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        31  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        32  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        33  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        34  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        35  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        36  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        37  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        38  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

```
PAGE   9
       JOB: QBC/CLR NO BUILD 2035 PR                                     RUN: NOBLD
2035 PR

       DATE :  6/10/15
       TIME :  9:23: 8


       RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
       THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

            *    CO/LINK  (PPM)
            *    ANGLE (DEGREES)
            *  REC41 REC42 REC43 REC44 REC45 REC46 REC47 REC48 REC49 REC50
REC51 REC52 REC53 REC54 REC55 REC56 REC57 REC58 REC59 REC60
   LINK # *   340    30    30    30    30    30    30    40    40    30
10    10    10    10   340   350   350   340   330   330
   -------*------------------------------------------------------------
---------------------------------------------------------
       1  *   1.7   0.7   0.7   0.7   0.6   0.6   0.6   0.4   0.4   0.4
0.4   0.5   0.5   0.4   0.2   0.5   0.6   0.4   0.3   0.4
       2  *   0.1   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0   0.0
0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       3  *   0.3   0.3   0.3   0.3   0.2   0.2   0.2   0.2   0.2   0.2
0.2   0.2   0.3   0.3   0.5   0.4   0.4   0.4   0.3   0.2
       4  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       5  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       6  *   0.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.0
       7  *   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.1   0.1   0.1   0.1   0.0   0.1   0.1   0.0   0.0   0.0
       8  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       9  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      10  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      11  *   0.6   0.6   0.3   0.2   0.2   0.2   0.2   0.1   0.1   0.1
0.3   0.3   0.3   0.2   0.2   0.3   0.3   0.3   0.2   0.2
      12  *   0.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
      13  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1
      14  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.1   0.0   0.0   0.1   0.1   0.1
      15  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      16  *   0.1   0.2   0.2   0.2   0.2   0.1   0.1   0.1   0.1   0.1
0.1   0.1   0.1   0.1   0.0   0.0   0.1   0.0   0.0   0.0
      17  *   0.1   0.2   0.2   0.2   0.2   0.2   0.2   0.1   0.1   0.1
0.1   0.1   0.1   0.1   0.0   0.1   0.1   0.0   0.0   0.0
```

```
        18  *   0.0   0.1   0.1   0.1   0.1   0.0   0.0   0.1   0.1   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        19  *   0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        20  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        21  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        22  *   0.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1
        23  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        24  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.3   0.0   0.0   0.0   0.0   0.0
        25  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        26  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        27  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.1
0.0   0.1   0.1   0.2   0.4   0.7   0.9   1.2   0.8   0.5
        28  *   0.0   1.2   1.4   1.4   1.2   1.0   0.9   0.8   0.6   0.9
0.9   1.6   1.3   1.1   0.6   0.4   0.3   0.6   0.6   0.4
        29  *   0.3   0.6   0.5   0.5   0.4   0.4   0.4   0.3   0.2   0.3
0.4   0.5   0.5   0.4   0.3   0.3   0.3   0.3   0.3   0.2
        30  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        31  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        32  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.6   1.4   2.0   0.1   0.0   0.0   0.0   0.0   0.0
        33  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.1   0.1   0.2   0.2   0.3   0.3
        34  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        35  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.2
        36  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        37  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        38  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1
0.1   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

ATTACHMENT C
CAL3QHC MODEL RUN FOR THE PROPOSED ACTION

CO hotspot analysis was conducted for a worst-case scenario involving 2035 traffic volumes and speeds with 2015 emission factors

```
CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221   PAGE  1
JOB: QBC/CLR INTERIM 2035 PR                              RUN: INTERIM 2035 PR
DATE :  6/10/15
TIME :  9:12:53

The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES
-------------------------------
VS =   0.0 CM/S       VD =   0.0 CM/S       Z0 = 175. CM
U =  1.0 M/S         CLAS =   4  (D)      ATIM =  60. MINUTES     MIXH =
1000. M   AMB =  0.0 PPM

LINK VARIABLES
--------------
         LINK DESCRIPTION     *         LINK COORDINATES (FT)          *
LENGTH  BRG TYPE  VPH    EF      H   W    V/C QUEUE
                              *   X1        Y1        X2        Y2     *
(FT)   (DEG)            (G/MI)  (FT) (FT)       (VEH)
      -------------------------*----------------------------------------*--
--------------------------------------------------------
       1. QBC NB APPR         * 216139.7  319323.0  216135.9  319709.5 *
387.   359. AG   1820.  25.3   0.0 56.0
       2. QBC NB Q            * 216136.1  319669.7  216137.3  319553.6 *
116.   179. AG    231. 100.0   0.0 36.0 0.59   5.9
       3. QBC NB LT Q         * 216103.4  319670.3  216166.5  317744.0 *
1927.   178. AG    199. 100.0   0.0 23.0 2.42  97.9
       4. QBC NB RT Q         * 216155.3  319669.4  216157.0  319618.6 *
51.   178. AG     19. 100.0   0.0 10.0 0.36   2.6
       5. QBC NB DPTR         * 216135.1  319738.8  216128.5  320138.8 *
400.   359. AG   1174.   3.9   0.0 56.0
       6. QBC SB APPR         * 216090.0  320138.8  216070.4  319738.6 *
401.   183. AG   2031.  17.2   0.0 44.0
       7. QBC SB Q            * 216074.0  319812.3  216214.9  322688.0 *
2879.     3. AG    149. 100.0   0.0 24.0 1.52 146.3
       8. QBC SB LT Q1        * 216100.7  319812.5  216099.8  319934.7 *
122.   360. AG    194. 100.0   0.0 21.0 0.97   6.2
       9. QBC SB LT Q2        * 216097.2  319942.4  216188.4  321668.2 *
1728.     3. AG     97. 100.0   0.0 10.0 1.94  87.8
      10. QBC SB RT Q         * 216061.6  319812.2  216062.3  319841.4 *
29.     1. AG     19. 100.0   0.0 10.0 0.20   1.5
      11. QBC SB DPTR         * 216070.4  319738.6  216069.9  319455.0 *
284.   180. AG   3313.  17.2   0.0 56.0
      12. CLR EB APPR         * 215702.0  319714.6  216101.8  319709.7 *
400.    91. AG   1955.  25.9   0.0 44.0
      13. CLR EB Q            * 216025.3  319710.6  209295.1  319793.8 *
6731.   271. AG    173. 100.0   0.0 24.0 2.72 341.9
      14. CLR EB LT Q         * 216028.2  319733.9  215636.8  319733.9 *
391.   270. AG    220. 100.0   0.0 20.0 1.79  19.9
      15. CLR EB RT Q         * 216023.0  319693.2  215944.7  319693.8 *
78.   270. AG     20. 100.0   0.0 11.0 0.55   4.0
```

```
      16. CLR EB DPTR          * 216101.8  319709.7  216640.7  319716.8 *
539.    89. AG   1872.  25.3   0.0 44.0
      17. CLR WB APPR          * 216640.7  319771.0  216103.0  319767.0 *
538.   270. AG   2967.  18.0   0.0 44.0
      18. CLR WB Q             * 216176.4  319767.6  218274.3  319783.0 *
2098.    90. AG    135. 100.0   0.0 24.0 1.28 106.6
      19. CLR WB LT Q1         * 216177.7  319744.0  219309.9  319767.9 *
3132.    90. AG    182. 100.0   0.0 21.0 1.95 159.1
      20. CLR WB LT Q2         * 216466.2  319752.4  225625.1  319752.4 *
9159.    90. AG     91. 100.0   0.0 10.0 3.89 465.3
      21. CLR WB RT Q          * 216175.3  319785.0  216203.3  319785.3 *
28.    89. AG    20. 100.0   0.0 12.0 0.20   1.4
      22. CLR WB DPTR          * 216103.0  319767.0  215702.0  319766.2 *
401.   270. AG   2414.  23.8   0.0 44.0
      23. QBCS NB APPR         * 216144.5  318742.0  316144.5  319168.7 *
*****    90. AG   1739.  25.3   0.0 56.0
      24. QBCS NB Q            * 216144.5  319113.8  216144.5  318983.0 *
131.   180. AG    155. 100.0   0.0 36.0 0.54   6.6
      25. QBCS NB LT Q1        * 216116.0  319098.2  216116.0  317665.7 *
1432.   180. AG    203. 100.0   0.0 22.0 2.33  72.8
      26. QBCS NB LT Q2        * 216121.7  318959.2  215890.6  315186.0 *
3780.   184. AG    102. 100.0   0.0 11.0 4.67 192.0
      27. QBCS NB DPTR         * 216144.5  319168.7  216139.7  319323.0 *
154.   358. AG   1563.  25.3   0.0 56.0
      28. QBCS SB APPR         * 216069.9  319455.0  216072.0  319162.0 *
293.   180. AG   3312.  17.2   0.0 56.0
      29. QBCS SB Q            * 216071.6  319214.2  216058.0  321156.7 *
1943.   360. AG    195. 100.0   0.0 36.0 1.26  98.7
      30. QBCS SB RT Q1        * 215982.5  319174.2  216012.5  319220.0 *
55.    33. AG      9. 100.0   0.0 17.0 0.70   2.8
      31. QBCS SB RT Q2        * 216046.0  319272.0  216046.4  319326.7 *
55.     0. AG      9. 100.0   0.0 17.0 0.70   2.8
      32. QBCS SB DPTR         * 216072.0  319162.0  216053.9  318742.0 *
420.   182. AG   3983.  17.2   0.0 56.0
      33. 470 WB APPR          * 216630.6  319117.3  216107.3  319178.2 *
527.   277. AG   1932.   4.4   0.0 32.0
      34. 470 WB TRL Q         * 216190.4  319174.4  216191.2  319174.3 *
1.     92. AG     64. 100.0   0.0 12.0 0.00   0.0
      35. 470 WB LT Q          * 216189.8  319163.6  227238.6  317690.0 *
*****    98. AG     64. 100.0   0.0 12.0 2.67 566.2
      36. 470 WB RT Q1         * 216202.4  319222.8  216214.0  319214.8 *
14.   125. AG      9. 100.0   0.0 12.0 0.18   0.7
      37. 470 WB RT Q2         * 216265.1  319176.8  216279.1  319175.0 *
14.    97. AG      9. 100.0   0.0 12.0 0.18   0.7
      38. 470 WB DPTR          * 216107.2  319178.2  215662.9  319097.7 *
452.   260. AG   1437.   4.4   0.0 32.0
```

PAGE 2
JOB: QBC/CLR INTERIM 2035 PR RUN: INTERIM 2035 PR

DATE : 6/10/15
TIME : 9:12:53

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
2. QBC NB Q	120	82	3.0	778	1600	42.05	2	3
3. QBC NB LT Q	120	106	3.0	577	1600	42.05	2	3
4. QBC NB RT Q	120	20	0.0	465	1600	42.05	2	3
7. QBC SB Q	120	79	3.0	1456	1600	42.05	2	3
8. QBC SB LT Q1	120	103	3.0	308	1600	42.05	2	3
9. QBC SB LT Q2	120	103	3.0	308	1600	42.05	2	3
10. QBC SB RT Q	120	20	0.0	267	1600	42.05	2	3
13. CLR EB Q	120	88	3.0	1955	1600	43.86	2	3
14. CLR EB LT Q	120	112	3.0	140	1600	43.86	2	3
15. CLR EB RT Q	120	20	0.0	716	1600	43.86	2	3
18. CLR WB Q	120	69	3.0	1570	1600	43.86	2	3
19. CLR WB LT Q1	120	93	3.0	1141	1600	43.86	2	3
20. CLR WB LT Q2	120	93	3.0	1141	1600	43.86	2	3
21. CLR WB RT Q	120	20	0.0	256	1600	43.86	2	3
24. QBCS NB Q	120	55	3.0	1305	1600	42.05	2	3
25. QBCS NB LT Q1	120	108	3.0	434	1600	42.05	2	3
26. QBCS NB LT Q2	120	108	3.0	434	1600	42.05	2	3
29. QBCS SB Q	120	69	3.0	2311	1600	42.05	2	3

```
      30. QBCS SB RT Q1        *     120        10        0.0        1001
1600       42.05       2       3
      31. QBCS SB RT Q2        *     120        10        0.0        1001
1600       42.05       2       3
      34. 470 WB TRL Q         *     120        68        3.0           2
1600       42.26       2       3
      35. 470 WB LT Q          *     120        68        3.0        1672
1600       42.26       2       3
      36. 470 WB RT Q1         *     120        10        0.0         258
1600       42.26       2       3
      37. 470 WB RT Q2         *     120        10        0.0         258
1600       42.26       2       3

       RECEPTOR LOCATIONS
       ------------------
                               *          COORDINATES (FT)          *
        RECEPTOR               *      X           Y          Z      *
     --------------------------*------------------------------------*
      1. Rec 1                 *    216271.9   319803.6        6.0   *
      2. Rec 2                 *    216231.9   319803.2        6.0   *
      3. Rec 3                 *    216201.9   319802.8        6.0   *
      4. Rec 4                 *    216181.9   319806.8        6.0   *
      5. Rec 5                 *    216167.1   319820.2        6.0   *
      6. Rec 6                 *    216160.7   319840.2        6.0   *
      7. Rec 7                 *    216160.7   319870.2        6.0   *
      8. Rec 8                 *    216160.6   319910.2        6.0   *
      9. Rec 9                 *    216045.1   319906.2        6.0   *
     10. Rec 10                *    216044.8   319866.4        6.0   *
     11. Rec 11                *    216044.6   319836.3        6.0   *
     12. Rec 12                *    216040.9   319816.3        6.0   *
     13. Rec 13                *    216026.7   319802.2        6.0   *
     14. Rec 14                *    216006.7   319798.6        6.0   *
     15. Rec 15                *    215976.7   319798.9        6.0   *
     16. Rec 16                *    215936.7   319799.2        6.0   *
     17. Rec 17                *    215922.3   319677.1        6.0   *
     18. Rec 18                *    215962.3   319676.7        6.0   *
     19. Rec 19                *    215992.3   319676.3        6.0   *
     20. Rec 20                *    216012.3   319673.2        6.0   *
     21. Rec 21                *    216024.9   319657.6        6.0   *
```

PAGE 3
JOB: QBC/CLR INTERIM 2035 PR RUN:
INTERIM 2035 PR

DATE : 6/10/15
TIME : 9:12:53

RECEPTOR LOCATIONS

RECEPTOR	COORDINATES (FT) X	Y	Z
22. Rec 22	216028.9	319637.6	6.0
23. Rec 23	216028.9	319607.6	6.0
24. Rec 24	216028.8	319567.6	6.0
25. Rec 25	216175.6	319569.8	6.0
26. Rec 26	216174.2	319609.8	6.0
27. Rec 27	216173.3	319639.7	6.0
28. Rec 28	216178.3	319659.7	6.0
29. Rec 29	216192.4	319673.9	6.0
30. Rec 30	216212.4	319678.6	6.0
31. Rec 31	216242.4	319678.8	6.0
32. Rec 32	216282.4	319679.0	6.0
33. Rec 33	216337.2	319192.8	6.0
34. Rec 34	216280.7	319195.5	6.0
35. Rec 35	216254.6	319206.4	6.0
36. Rec 36	216229.8	319224.0	6.0
37. Rec 37	216215.9	319238.3	6.0
38. Rec 38	216204.0	319254.8	6.0
39. Rec 39	216190.7	319283.9	6.0
40. Rec 40	216184.8	319311.6	6.0
41. Rec 41	216182.6	319368.1	6.0
42. Rec 42	216027.8	319368.9	6.0
43. Rec 43	216026.8	319312.3	6.0
44. Rec 44	216021.6	319270.2	6.0
45. Rec 45	216010.6	319241.2	6.0
46. Rec 46	216000.6	319223.8	6.0
47. Rec 47	215988.5	319207.9	6.0
48. Rec 48	215965.8	319187.2	6.0
49. Rec 49	215926.7	319170.8	6.0
50. Rec 50	215982.8	319122.1	6.0
51. Rec 51	216010.8	319127.1	6.0
52. Rec 52	216039.0	319129.7	6.0
53. Rec 53	216042.0	319101.5	6.0
54. Rec 54	216042.2	319073.3	6.0
55. Rec 55	216173.2	319047.8	6.0
56. Rec 56	216173.2	319087.8	6.0
57. Rec 57	216173.2	319116.2	6.0
58. Rec 58	216176.0	319144.3	6.0
59. Rec 59	216204.3	319143.4	6.0
60. Rec 60	216232.4	319139.7	6.0

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PAGE  4
      JOB: QBC/CLR INTERIM 2035 PR                              RUN:
INTERIM 2035 PR

       MODEL RESULTS
       -------------

REMARKS : In search of the angle corresponding to
the maximum concentration, only the first
angle, of the angles with same maximum
concentrations, is indicated as maximum.

WIND ANGLE RANGE:  10.-360.

WIND   * CONCENTRATION
ANGLE *      (PPM)
(DEGR)* REC1  REC2  REC3  REC4  REC5  REC6  REC7  REC8  REC9  REC10 REC11
REC12 REC13 REC14 REC15 REC16 REC17 REC18 REC19 REC20
 ------*-------------------------------------------------------------------
-----------------------------------------------------
  10.  *   0.0   0.0   0.1   0.1   0.3   0.4   0.4   0.4   2.7   2.9   3.0
2.8   1.8   1.3   0.8   0.6   3.5   3.7   4.1   4.3
  20.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   3.0   3.2   3.3
3.1   2.2   1.5   1.2   0.8   3.8   4.0   4.3   4.4
  30.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.9   3.0   3.1
2.9   2.4   1.7   1.1   0.9   4.0   4.0   4.2   4.3
  40.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.6   2.8   2.9
2.7   2.1   1.7   1.3   0.9   3.9   4.3   4.3   4.2
  50.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5   2.6   2.7
2.5   2.1   1.6   1.2   0.9   4.2   4.3   3.9   4.1
  60.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.2   2.4   2.5
2.3   1.8   1.6   1.3   0.8   4.2   4.4   4.5   4.7
  70.  *   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0   2.1   2.4   2.4
2.3   1.9   1.8   1.2   1.0   4.5   4.5   4.9   5.0
  80.  *   0.9   0.9   0.9   0.7   0.5   0.3   0.1   0.0   2.2   2.6   2.8
2.7   2.5   2.4   2.1   1.8   4.4   4.5   4.8   5.2
  90.  *   2.1   2.2   2.2   2.1   1.6   1.1   0.7   0.5   2.8   3.2   3.7
3.9   4.1   4.0   3.6   3.4   3.7   3.9   4.1   4.4
 100.  *   3.3   3.4   3.5   3.2   2.6   2.0   1.4   1.1   3.5   3.9   4.4
4.7   4.8   4.8   4.6   4.4   2.5   2.6   3.1   3.5
 110.  *   3.8   3.8   3.7   3.5   2.8   2.5   1.9   1.4   3.7   4.1   4.6
4.6   5.0   4.9   4.7   4.6   1.8   2.3   2.5   2.9
 120.  *   3.7   3.7   3.7   3.5   2.8   2.3   1.8   1.5   3.8   4.2   4.2
4.5   4.8   4.7   4.8   4.6   1.8   2.1   2.5   2.9
 130.  *   3.2   3.2   3.3   3.1   2.7   2.1   1.8   1.5   3.9   4.2   4.1
4.3   4.7   4.8   4.8   4.7   1.7   2.1   2.4   3.0
 140.  *   3.0   3.0   3.0   2.9   2.5   2.1   1.8   1.4   4.2   4.2   4.3
4.7   5.0   5.0   4.9   4.8   1.7   2.0   2.6   2.9
 150.  *   2.9   2.9   2.9   2.8   2.3   2.0   1.6   1.3   4.5   4.7   5.0
5.3   5.5   5.3   4.9   4.9   1.6   2.1   2.6   3.2
 160.  *   2.8   2.8   2.8   2.7   2.4   1.9   1.6   1.4   5.0   5.4   5.8
6.1   6.0   5.4   5.3   4.6   1.5   2.0   2.5   3.2
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 170.  *   2.8    3.0    3.0    3.0    3.0    2.9    2.6    2.2    5.5    5.8    6.2
6.4   5.8    5.4    4.8    4.3    1.2    1.6    2.2    2.7
 180.  *   3.3    3.7    4.2    4.5    4.3    3.9    3.5    3.2    4.5    4.9    5.3
5.5   4.8    4.6    3.9    3.5    0.6    0.8    1.1    1.7
 190.  *   3.9    4.4    4.9    4.8    4.7    4.2    3.9    3.6    2.7    3.1    3.5
3.6   3.4    3.4    3.1    3.0    0.0    0.1    0.2    0.5
 200.  *   4.4    4.8    5.0    4.7    4.2    4.0    3.5    3.2    1.6    1.9    2.3
2.6   2.8    2.9    2.9    2.8    0.0    0.0    0.0    0.0
 210.  *   4.5    4.8    4.5    4.2    3.7    3.5    3.1    3.0    1.6    1.7    2.0
2.5   2.9    3.0    3.0    3.0    0.0    0.0    0.0    0.0
 220.  *   4.5    4.4    4.0    3.9    3.5    3.3    2.8    2.8    1.4    1.8    2.2
2.6   3.0    3.1    3.1    3.1    0.0    0.0    0.0    0.0
 230.  *   4.3    4.0    4.0    3.9    3.6    3.2    3.0    3.2    1.4    1.8    2.4
2.7   3.2    3.5    3.4    3.3    0.0    0.0    0.0    0.0
 240.  *   4.5    4.0    4.1    3.8    3.6    3.3    3.0    3.0    1.2    1.7    2.3
2.8   3.5    3.7    3.6    3.5    0.0    0.0    0.0    0.0
 250.  *   4.3    4.3    4.1    4.0    3.5    3.2    3.0    2.5    0.8    1.4    1.9
2.7   3.4    3.7    3.5    3.3    0.1    0.1    0.1    0.1
 260.  *   3.7    3.8    3.9    3.5    3.3    2.8    2.5    2.1    0.3    0.8    1.3
2.0   2.7    3.0    2.7    2.6    0.5    0.5    0.6    0.5
 270.  *   2.6    2.7    2.7    2.5    2.4    2.2    1.8    1.7    0.1    0.3    0.6
1.0   1.6    1.8    1.7    1.6    1.4    1.5    1.6    1.5
 280.  *   1.5    1.7    1.6    1.6    1.5    1.6    1.5    1.4    0.0    0.1    0.2
0.3   0.5    0.7    0.6    0.5    2.4    2.7    2.8    2.7
 290.  *   1.0    1.0    1.1    1.2    1.4    1.4    1.5    1.4    0.0    0.0    0.0
0.0   0.1    0.2    0.2    0.1    3.2    3.4    3.6    3.3
 300.  *   0.8    1.0    1.0    1.2    1.4    1.4    1.5    1.4    0.0    0.0    0.0
0.0   0.0    0.0    0.0    0.0    3.4    3.6    3.6    3.5
 310.  *   0.8    0.9    1.1    1.3    1.4    1.6    1.5    1.4    0.0    0.0    0.0
0.0   0.0    0.0    0.0    0.0    3.4    3.5    3.6    3.3
 320.  *   0.8    0.9    1.0    1.3    1.5    1.5    1.5    1.4    0.0    0.0    0.0
0.0   0.0    0.0    0.0    0.0    3.2    3.2    3.3    3.1
 330.  *   0.6    0.9    1.2    1.3    1.6    1.6    1.5    1.4    0.1    0.1    0.1
0.0   0.0    0.0    0.0    0.0    3.0    3.0    3.0    3.0
 340.  *   0.5    0.8    1.0    1.2    1.4    1.6    1.5    1.5    0.3    0.3    0.3
0.2   0.0    0.0    0.0    0.0    2.9    2.8    2.8    2.8
 350.  *   0.3    0.6    0.7    0.9    1.2    1.2    1.3    1.2    0.8    0.8    0.9
0.7   0.4    0.2    0.1    0.0    2.9    3.0    3.0    3.1
 360.  *   0.2    0.3    0.4    0.6    0.7    0.8    0.8    0.7    1.8    2.0    2.1
1.8   1.2    0.8    0.4    0.2    3.2    3.4    3.8    3.7
 ------*------------------------------------------------------------------------
------------------------------------------------------
 MAX   *   4.5    4.8    5.0    4.8    4.7    4.2    3.9    3.6    5.5    5.8    6.2
6.4   6.0    5.4    5.3    4.9    4.5    4.5    4.9    5.2
 DEGR. *  210    200    200    190    190    190    190    190    170    170    170
170   160    160    160    150     70     70     70     80
```

PAGE 5
JOB: QBC/CLR INTERIM 2035 PR RUN: INTERIM 2035 PR
MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 10.-360.

WIND ANGLE (DEGR) * CONCENTRATION (PPM)

WIND ANGLE (DEGR)	REC21	REC22	REC23	REC24	REC25	REC26	REC27	REC28	REC29	REC30	REC31	REC32	REC33	REC34	REC35	REC36	REC37	REC38	REC39	REC40
10.	4.2	4.4	4.0	3.9	1.5	1.7	1.8	2.1	2.4	2.7	2.6	2.6	0.5	0.5	0.5	0.6	0.6	0.6	0.7	1.0
20.	4.5	4.4	4.2	4.1	1.3	1.7	1.8	2.0	2.4	2.6	2.6	2.6	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.9
30.	4.5	4.2	3.9	3.9	1.2	1.6	1.8	2.2	2.6	2.7	2.7	2.7	0.4	0.4	0.6	0.6	0.6	0.6	0.6	0.8
40.	4.3	3.9	4.2	4.2	1.4	1.6	1.9	2.3	2.7	2.9	2.9	2.9	0.2	0.4	0.4	0.4	0.4	0.5	0.6	0.6
50.	4.4	4.3	4.2	4.4	1.4	1.6	2.1	2.5	2.9	3.0	3.0	3.0	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.4
60.	4.5	4.6	4.6	4.5	1.3	1.7	2.1	2.6	3.0	3.2	3.2	3.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
70.	4.8	4.9	4.5	4.3	1.0	1.6	2.2	2.6	3.3	3.5	3.4	3.3	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
80.	4.7	4.7	4.4	4.2	0.7	1.0	1.6	2.0	2.7	2.9	2.9	2.7	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.2
90.	4.3	4.5	4.1	3.8	0.6	0.7	1.0	1.4	1.8	2.0	2.0	1.9	0.5	0.5	0.5	0.4	0.3	0.3	0.2	0.2
100.	3.3	3.7	3.5	3.3	0.2	0.2	0.4	0.5	0.7	0.8	0.8	0.7	0.6	0.7	0.5	0.5	0.5	0.5	0.4	0.4
110.	3.2	3.4	3.3	3.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.6	0.7	0.6	0.6	0.5	0.5	0.5	0.4
120.	3.3	3.4	3.3	3.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.6	0.7	0.6	0.6	0.6	0.5	0.4	0.4
130.	3.4	3.4	3.4	3.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.4
140.	3.4	3.6	3.5	3.7	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4
150.	3.5	3.8	3.7	3.9	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.3
160.	3.9	4.2	4.1	4.0	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3
170.	3.3	3.6	3.7	3.7	0.9	0.9	1.0	0.8	0.7	0.3	0.1	0.1	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.6

```
 180.  *   2.3   2.4   2.4   2.3   2.2   2.3   2.5   2.1   1.4   1.2   0.9
0.4   0.7   0.8   0.8   1.0   1.0   1.0   1.3   1.4
 190.  *   0.8   1.0   1.0   0.9   3.1   3.5   3.6   3.2   2.5   1.9   1.3
1.0   0.8   1.1   1.0   1.4   1.3   1.5   2.0   2.4
 200.  *   0.1   0.2   0.2   0.2   3.5   3.7   3.9   3.7   2.9   2.4   1.9
1.4   1.0   1.1   1.4   1.6   1.6   1.8   2.5   2.8
 210.  *   0.0   0.0   0.0   0.0   3.3   3.7   4.0   3.7   3.1   2.6   2.0
1.6   1.2   1.4   1.5   1.6   1.7   2.0   2.5   2.6
 220.  *   0.0   0.0   0.0   0.0   3.1   3.6   3.7   3.6   3.0   2.4   2.0
1.6   1.3   1.4   1.5   1.5   1.7   2.0   2.3   2.6
 230.  *   0.0   0.0   0.0   0.0   3.0   3.4   3.6   3.2   2.8   2.4   1.9
1.7   1.1   1.4   1.4   1.6   1.6   2.2   2.3   2.5
 240.  *   0.0   0.0   0.0   0.0   3.0   3.3   3.3   3.0   2.6   2.3   2.0
1.7   1.1   1.3   1.3   1.6   1.8   2.0   2.3   2.5
 250.  *   0.0   0.0   0.0   0.0   2.8   3.1   3.1   3.0   2.6   2.5   2.1
1.7   1.3   1.3   1.5   1.5   1.7   1.9   2.2   2.2
 260.  *   0.2   0.2   0.1   0.0   2.9   3.2   3.4   3.2   3.4   3.0   2.8
2.4   1.2   1.3   1.4   1.8   1.8   1.9   2.2   2.3
 270.  *   1.1   0.6   0.3   0.2   3.4   3.7   4.1   4.0   4.0   3.9   3.6
3.4   1.1   1.5   1.6   1.6   1.7   1.9   2.3   2.4
 280.  *   1.9   1.3   0.8   0.3   3.6   4.2   4.5   4.7   4.7   4.9   4.4
3.9   1.1   1.4   1.4   1.8   1.9   2.0   2.4   2.5
 290.  *   2.5   1.8   1.2   0.7   4.2   4.6   5.0   5.0   4.8   4.5   4.1
4.1   1.1   1.4   1.6   1.8   1.9   2.1   2.4   2.5
 300.  *   2.8   2.2   1.6   1.2   4.8   5.0   5.0   4.6   4.2   3.9   3.7
3.6   1.3   1.5   1.7   1.8   2.0   2.1   2.4   2.7
 310.  *   2.6   2.3   1.8   1.4   4.7   4.8   4.5   4.1   3.5   3.3   3.5
3.7   1.5   1.8   1.9   2.2   2.4   2.5   2.8   3.2
 320.  *   2.6   2.2   1.7   1.5   4.6   4.5   4.0   3.8   3.6   3.4   3.5
3.4   1.8   2.1   2.3   2.6   2.7   3.0   3.3   3.4
 330.  *   2.5   2.0   1.7   1.5   4.2   4.3   3.9   3.7   3.4   3.4   3.3
3.4   1.8   2.1   2.3   2.6   2.7   3.0   3.3   3.7
 340.  *   2.4   1.9   1.8   1.5   3.9   3.6   3.7   3.3   3.3   3.5   3.2
3.1   1.4   1.8   2.1   2.6   2.7   3.0   3.4   3.7
 350.  *   2.8   2.6   2.3   2.0   3.5   3.3   3.3   3.1   3.3   3.2   3.2
3.0   0.8   1.3   1.8   1.7   2.0   2.4   2.8   3.0
 360.  *   3.7   3.4   3.2   3.0   2.4   2.6   2.7   2.7   2.9   3.0   2.9
2.8   0.6   0.8   0.9   1.0   1.1   1.4   1.8   2.1
 ------*----------------------------------------------------------------
------------------------------------------------------
 MAX   *   4.8   4.9   4.6   4.5   4.8   5.0   5.0   5.0   4.8   4.9   4.4
4.1   1.8   2.1   2.3   2.6   2.7   3.0   3.4   3.7
 DEGR. *   70    70    60    60   300   300   300   290   290   280   280
290   320   320   320   320   320   320   340   330
```

```
PAGE  6
      JOB: QBC/CLR INTERIM 2035 PR                              RUN:
INTERIM 2035 PR

       MODEL RESULTS
       -------------

       REMARKS : In search of the angle corresponding to
                 the maximum concentration, only the first
                 angle, of the angles with same maximum
                 concentrations, is indicated as maximum.

 WIND ANGLE RANGE:  10.-360.

 WIND  * CONCENTRATION
 ANGLE *      (PPM)
 (DEGR)* REC41 REC42 REC43 REC44 REC45 REC46 REC47 REC48 REC49 REC50 REC51
REC52 REC53 REC54 REC55 REC56 REC57 REC58 REC59 REC60
 ------*---------------------------------------------------------------------
-----------------------------------------------------
  10.  *   1.2   3.8   3.6   3.4   2.8   2.4   2.1   1.8   1.5   2.3   3.1
4.8   5.3   5.5   1.2   1.3   1.5   1.5   1.1   1.1
  20.  *   0.9   4.3   4.2   4.0   3.4   3.2   2.9   2.4   1.9   2.9   3.3
4.7   5.0   5.0   0.8   0.8   0.9   0.9   1.0   0.9
  30.  *   0.8   4.5   4.3   3.8   3.2   3.0   2.8   2.5   1.9   2.8   3.4
4.3   4.5   4.6   0.5   0.5   0.7   0.8   0.9   0.8
  40.  *   0.7   4.3   4.0   3.7   3.2   3.1   2.9   2.6   2.1   2.6   2.9
3.9   4.1   4.0   0.5   0.5   0.6   0.8   0.9   0.9
  50.  *   0.5   3.8   3.7   3.3   3.0   2.7   2.4   2.2   1.9   2.4   2.7
3.7   3.6   3.3   0.3   0.4   0.5   0.6   0.7   0.7
  60.  *   0.4   3.4   3.2   3.0   2.7   2.4   2.3   1.9   1.7   2.0   2.4
3.3   3.0   3.0   0.3   0.3   0.5   0.7   0.7   0.7
  70.  *   0.3   2.9   2.8   2.6   2.5   2.3   2.1   1.6   1.3   1.8   2.3
2.9   2.7   2.7   0.3   0.3   0.4   0.6   0.7   0.7
  80.  *   0.2   2.8   2.8   2.5   2.4   2.3   2.1   1.9   1.6   1.8   2.1
2.8   2.8   3.0   0.3   0.3   0.4   0.7   0.7   0.7
  90.  *   0.2   2.9   2.8   2.7   2.7   2.4   2.1   2.0   1.7   2.0   2.3
3.0   3.2   3.5   0.5   0.5   0.5   0.8   1.0   0.9
 100.  *   0.4   3.0   3.0   2.9   2.7   2.3   2.2   2.1   1.7   2.1   2.4
3.0   3.3   3.4   0.6   0.5   0.6   0.8   0.8   0.8
 110.  *   0.3   3.0   3.0   2.9   2.6   2.4   2.0   2.1   1.6   1.9   2.2
2.7   3.1   3.2   0.4   0.4   0.4   0.5   0.5   0.5
 120.  *   0.3   3.3   3.1   2.8   2.2   2.0   2.0   1.8   1.7   2.0   2.4
3.0   3.2   3.2   0.4   0.3   0.3   0.3   0.3   0.3
 130.  *   0.3   3.3   3.2   2.7   2.3   2.0   1.9   1.9   1.7   2.0   2.4
3.2   3.4   3.3   0.3   0.3   0.3   0.3   0.3   0.3
 140.  *   0.3   3.3   3.0   2.8   2.4   2.0   2.0   2.0   1.7   2.0   2.6
3.4   3.6   3.6   0.3   0.3   0.3   0.3   0.3   0.3
 150.  *   0.3   3.6   3.2   2.9   2.6   2.4   2.1   2.0   1.6   2.0   2.6
3.6   3.9   3.8   0.3   0.3   0.3   0.3   0.3   0.3
 160.  *   0.3   3.4   3.1   3.1   2.7   2.4   2.2   1.8   1.4   1.8   2.5
4.1   4.3   4.4   0.3   0.3   0.3   0.3   0.3   0.3
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 170.  *   0.8   3.1   3.0   2.7   2.3   2.0   1.7   1.4   0.9   1.3   2.1
4.0   4.3   4.5   0.6   0.6   0.6   0.5   0.4   0.3
 180.  *   1.6   2.0   1.9   1.8   1.4   1.1   0.9   0.8   0.5   0.7   1.2
3.0   3.5   3.6   1.2   1.3   1.3   1.2   0.8   0.6
 190.  *   2.6   0.9   0.7   0.6   0.4   0.3   0.2   0.3   0.2   0.1   0.3
1.6   2.1   2.2   1.7   1.9   2.0   1.9   1.1   0.8
 200.  *   2.6   0.3   0.2   0.2   0.2   0.1   0.1   0.2   0.2   0.0   0.1
0.6   0.8   1.0   2.0   2.1   2.3   2.1   1.5   1.3
 210.  *   2.9   0.1   0.1   0.1   0.1   0.1   0.1   0.2   0.2   0.0   0.0
0.2   0.4   0.5   2.2   2.4   2.4   2.3   1.8   1.4
 220.  *   2.8   0.1   0.1   0.1   0.1   0.1   0.1   0.2   0.2   0.0   0.0
0.2   0.3   0.3   2.4   2.4   2.4   2.1   1.8   1.4
 230.  *   2.8   0.0   0.1   0.1   0.1   0.1   0.2   0.2   0.3   0.0   0.0
0.1   0.2   0.3   2.3   2.3   2.2   1.9   1.6   1.4
 240.  *   2.5   0.0   0.0   0.1   0.1   0.1   0.1   0.2   0.3   0.0   0.0
0.1   0.2   0.2   2.1   2.2   2.0   1.5   1.5   1.4
 250.  *   2.5   0.0   0.0   0.0   0.1   0.1   0.1   0.2   0.2   0.0   0.0
0.0   0.1   0.1   2.0   2.0   1.8   1.3   1.2   1.1
 260.  *   2.5   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.2   0.1   0.1
0.1   0.0   0.0   2.1   2.0   1.7   1.4   1.2   1.3
 270.  *   2.6   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.1   0.2   0.2
0.2   0.1   0.0   2.1   2.0   1.6   1.3   1.4   1.2
 280.  *   2.5   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.3   0.3
0.3   0.2   0.2   2.3   2.1   1.6   1.6   1.6   1.4
 290.  *   2.5   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.3   0.3
0.3   0.2   0.3   2.3   2.0   1.4   1.7   2.1   1.9
 300.  *   2.8   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.3   0.3
0.3   0.3   0.4   2.3   1.9   1.6   2.1   2.1   1.9
 310.  *   3.4   0.3   0.2   0.1   0.1   0.1   0.1   0.1   0.1   0.3   0.3
0.3   0.4   0.4   2.4   2.1   1.9   2.6   2.4   2.2
 320.  *   3.7   0.6   0.4   0.3   0.3   0.2   0.1   0.1   0.1   0.3   0.3
0.3   0.4   0.5   2.6   2.3   2.4   3.0   3.0   2.7
 330.  *   4.0   0.8   0.6   0.6   0.5   0.4   0.4   0.3   0.2   0.5   0.5
0.5   0.7   0.7   2.8   2.8   3.1   3.8   3.5   3.0
 340.  *   3.8   0.9   0.9   0.6   0.6   0.6   0.6   0.6   0.4   0.6   0.8
1.2   1.4   1.5   3.2   3.4   3.7   4.0   3.3   2.8
 350.  *   3.1   1.6   1.6   1.3   1.1   0.9   0.8   0.8   0.6   1.0   1.1
2.2   2.5   2.6   3.3   3.3   3.6   3.6   2.8   2.2
 360.  *   2.0   2.9   2.5   2.3   1.8   1.5   1.5   1.2   1.0   1.5   2.1
3.6   4.1   4.3   2.4   2.3   2.6   2.8   1.9   1.6
 ------*------------------------------------------------------------------
------------------------------------------------------
 MAX   *   4.0   4.5   4.3   4.0   3.4   3.2   2.9   2.6   2.1   2.9   3.4
4.8   5.3   5.5   3.3   3.4   3.7   4.0   3.5   3.0
 DEGR. *  330    30    30    20    20    20    20    40    40    20    30
10    10    10    350   340   340   340   330   330

 THE HIGHEST CONCENTRATION OF    6.40 PPM OCCURRED AT RECEPTOR REC12.
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PAGE 7
JOB: QBC/CLR INTERIM 2035 PR RUN: INTERIM 2035 PR

DATE : 6/10/15
TIME : 9:12:53

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

* CO/LINK (PPM)
* ANGLE (DEGREES)

LINK #	REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15	REC16	REC17	REC18	REC19	REC20
	210	200	200	190	190	190	190	190	170	170	170	170	160	160	160	150	70	70	70	80
1	0.6	0.7	0.8	0.9	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.4	0.1	0.1	0.2	0.4
2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.2	0.0	0.0	0.0	0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.0	0.9	0.8	0.5	0.3	0.0	0.0	0.0	0.2	0.1	0.1	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.3	0.3	0.5	0.3	0.5	0.5	0.5	0.5	0.7	0.9	1.1	1.3	1.3	1.1	0.8	0.7	0.4	0.6	0.9	1.2
12	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.8	1.6	1.5	1.3	0.6
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.2	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.1	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.7	0.7	0.7	0.7	0.6	0.5	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.4	0.5	0.7	1.1
17	1.5	1.4	1.4	1.3	1.1	0.9	0.7	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.8	0.9	0.7

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         18  *   0.3   0.3   0.2   0.1   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.2   0.2
         19  *   0.3   0.3   0.2   0.1   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.2   0.2   0.3
         20  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1
         21  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         22  *   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.5   0.7
1.0   1.2   1.5   1.5   1.6   1.7   0.4   0.2   0.1   0.0
         23  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1
0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0
         24  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         25  *   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         26  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         27  *   0.0   0.1   0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1
0.1   0.1   0.1   0.1   0.1   0.1   0.0   0.0   0.0   0.0
         28  *   0.2   0.3   0.3   0.3   0.3   0.3   0.3   0.2   0.2   0.2
0.3   0.3   0.2   0.2   0.3   0.2   0.0   0.0   0.0   0.0
         29  *   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.3   1.1   1.0
1.0   0.9   0.6   0.4   0.3   0.2   0.2   0.2   0.3   0.4
         30  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         31  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         32  *   0.1   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.1   0.2
0.2   0.2   0.1   0.1   0.1   0.0   0.0   0.0   0.0   0.0
         33  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         34  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         35  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         36  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         37  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         38  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

PAGE 8
JOB: QBC/CLR INTERIM 2035 PR RUN: INTERIM 2035 PR

DATE : 6/10/15
TIME : 9:12:53

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

* CO/LINK (PPM)
* ANGLE (DEGREES)

LINK #	REC21	REC22	REC23	REC24	REC25	REC26	REC27	REC28	REC29	REC30	REC31	REC32	REC33	REC34	REC35	REC36	REC37	REC38	REC39	REC40
ANGLE	70	70	60	60	300	300	300	290	290	280	280	290	320	320	320	320	320	320	340	330
1	0.4	0.6	0.6	0.6	1.3	1.3	1.3	1.1	0.8	0.7	0.4	0.2	0.4	0.4	0.4	0.5	0.5	0.6	1.3	1.4
2	0.0	0.1	0.2	0.2	0.6	0.6	0.4	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
3	0.1	0.2	0.2	0.3	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	1.4	1.4	1.5	1.5	0.8	0.8	0.7	0.7	0.5	0.6	0.4	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.5	0.6
12	0.3	0.1	0.0	0.0	0.6	0.8	0.9	1.1	0.9	1.0	0.8	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
13	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.2	0.2	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
14	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	1.0	1.0	0.7	0.6	0.0	0.0	0.2	0.3	1.0	1.0	1.2	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
17	0.8	0.6	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0

```
      18  *   0.2   0.2   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      19  *   0.2   0.2   0.2   0.2   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      20  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      21  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      22  *   0.0   0.0   0.0   0.0   0.5   0.6   0.7   0.8   0.9   0.7
0.7   0.6   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.3
      23  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      24  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      25  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      26  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      27  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.2   0.3   0.4   0.4   0.5   0.1   0.0
      28  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.2   0.3   0.4   0.5   0.5   0.6   0.1   0.3
      29  *   0.4   0.5   0.5   0.5   0.3   0.3   0.3   0.2   0.2   0.2
0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.3   0.3
      30  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      31  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      32  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      33  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      34  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      35  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      36  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      37  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      38  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

PAGE 9
JOB: QBC/CLR INTERIM 2035 PR RUN: INTERIM 2035 PR

DATE : 6/10/15
TIME : 9:12:53

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

* CO/LINK (PPM)
* ANGLE (DEGREES)

*	REC41	REC42	REC43	REC44	REC45	REC46	REC47	REC48	REC49	REC50	REC51	REC52	REC53	REC54	REC55	REC56	REC57	REC58	REC59	REC60
LINK # *	330	30	30	20	20	20	20	40	40	20	30	10	10	10	350	340	340	340	330	330
1 *	1.5	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.3	0.3
2 *	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 *	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.5	0.4	0.4	0.3	0.2
4 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 *	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
7 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
8 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 *	0.8	0.7	0.3	0.5	0.4	0.4	0.4	0.1	0.1	0.3	0.1	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.2
12 *	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
13 *	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
14 *	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
15 *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16 *	0.0	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
17 *	0.0	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0

```
      18  *   0.0   0.1   0.1   0.0   0.0   0.0   0.0   0.1   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      19  *   0.0   0.1   0.1   0.0   0.0   0.0   0.0   0.1   0.1   0.0
0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      20  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      21  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      22  *   0.3   0.0   0.0   0.0   0.0   0.1   0.1   0.0   0.0   0.0
0.0   0.1   0.1   0.1   0.1   0.2   0.2   0.2   0.2   0.2
      23  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      24  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.2   0.1   0.0   0.0   0.0   0.0
      25  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      26  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      27  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.0
0.2   0.1   0.1   0.2   0.5   0.6   0.9   1.2   0.8   0.5
      28  *   0.1   1.3   1.6   1.4   1.1   0.9   0.7   0.9   0.6   0.9
1.3   1.8   1.5   1.2   0.5   0.7   0.7   0.6   0.6   0.5
      29  *   0.3   0.6   0.5   0.6   0.5   0.4   0.4   0.3   0.2   0.4
0.3   0.6   0.5   0.4   0.3   0.3   0.3   0.3   0.3   0.2
      30  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      31  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      32  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.1   0.6   1.5   2.0   0.0   0.0   0.0   0.0   0.0   0.0
      33  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.1   0.1   0.2   0.2   0.3   0.3
      34  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      35  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.2
      36  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      37  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      38  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.2
0.2   0.2   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0
```

Biological Resources Technical Report

For the C-470 Corridor
Revised Environmental Assessment

June 2015

Submitted To:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted By:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

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1.0 INTRODUCTION

This report identifies existing biological resources present within the Colorado State Highway 470 (C-470) Revised Environmental Assessment (EA) Study Area located in the southwestern part of the Denver metropolitan area. C-470 is located about 13 miles south of downtown Denver. The project study area is located Arapahoe, Douglas, and Jefferson counties. Figure 1 shows the study area.

Figure 1
C-470 EA Study Corridor

The Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) have initiated the Revised EA for the 13.75-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the Revised EA differs slightly from the Express Lanes alternative identified in the previous EA that was approved by CDOT and FHWA in 2006. No Decision Document was obtained for the 2006 EA, and therefore the EA is being revised in 2015 for the C-470 Express Lanes Project.

This report has been prepared to ensure impacts to biological resources are determined in accordance with the following federal and state regulations:

- Endangered Species Act (ESA) – The ESA is administered by the US Fish and Wildlife Service (USFWS) and protects plant and wildlife species threatened with extinction.
- Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act – The USFWS administers these acts that protect migratory bird nesting habitat and active migratory bird and eagle nests.
- Waters of the U.S. including wetlands – The U.S. Army Corps of Engineers regulates jurisdictional waters under Section 404 of the Clean Water Act.

- Colorado Non-game, Endangered, and Threatened Species Conservation Act - Colorado Parks and Wildlife (CPW) is responsible for listing species of concern, threatened, and endangered within the state. This act provides some protection for state listed wildlife.
- CDOT 2009 Impacted Black-tailed Prairie Dog Policy - Work within the CDOT right-of-way that will impact black-tailed prairie dog colonies must follow these guidelines.
- Colorado Senate Bill 40 (SB 40) – CDOT is required to obtain certification from CPW when the agency plans construction in any stream, tributary, or stream bank. The certification identifies mitigation measures for working in these areas.
- Noxious Weeds – The Colorado Department of Agriculture (CDOA) Noxious Weed Act of 2003 (CRS 35-5-101; CRS 35-5.5-101; and Executive order D-006-99) identifies state designated noxious weeds and provides recommendations for managing noxious weeds.

1.1 Project Description - General

The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged, but would receive maintenance as needed to maintain the safety and functionality of the existing four-lane freeway.

In the more heavily travelled, eastern half of the project, the Proposed Action would add <u>two tolled Express Lanes in each direction</u>, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, <u>auxiliary lanes</u> will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross-section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes.

In the less heavily travelled, western half of the project, the Proposed Action would add only <u>one tolled Express Lane in each direction</u>, but would be designed to accommodate an additional lane in the future. Westbound, the second toll lane would end at Lucent Boulevard, and the westbound single toll lane would end about one mile east of Kipling Boulevard. Eastbound, the first toll lane would begin east of Kipling. The second eastbound toll lane would begin in the vicinity of Broadway.

The Proposed Action includes <u>no new interchanges and no major interchange modifications, except for the addition of two “direct-connect” ramps</u> in the western half of the I-25/C-470 interchange. A new westbound ramp will enable exiting E-470 traffic to reach the rightmost westbound C-470 lane without having to merge across several lanes of through traffic. Then a new westbound lane will carry southbound and northbound I-25 traffic directly into the westbound C-470 express lane without having to merge across those same lanes. At the C-470/Santa Fe interchange, the westbound on-ramp would be modified.

1.2 Project Description – South Platte River Bridges Replacement

Various C-470 structures will be widened as part of the Proposed Action but the only bridges that will be completely replaced are the parallel C-470 eastbound and westbound bridges that cross the South Platte River. The C-470 crossing of the South Platte River is the most environmentally sensitive location along the project corridor as the bridges cross over riparian habitat connecting Chatfield State Park to the south with South Platte Park to the north. The river and its adjacent Mary Carter Greenway Trail provide an opportunity for wildlife and people to cross under C-470 at this location.

Figure 2
South Platte River Crossing Vicinity

C-470 at this location is located on an easement from the U.S. Army Corps of Engineers (USACE). For flood control purposes, USACE must have the ability to release large flows of water from the adjacent Chatfield Dam upstream (south of C-470). The design of the new bridges here must meet highway needs, USACE requirements, and other regulatory constraints pertaining to wetland and riparian areas, floodplains and water quality, while also considering trail and wildlife needs.

Following the discussion of various biological resources from a corridor-wide perspective in this Technical Memorandum, a focused discussion on this sensitive location is provided.

The C-470 crossing of the South Platte River is the most environmentally sensitive location along the project corridor, and also the location most constrained by various governmental regulations.

2.0 METHODS

The study area is defined as the area within the existing CDOT C-470 right-of-way between Kipling Boulevard and I-25. Study efforts included review of 2006 findings, an updated computer data search, and new field visits for the Revised EA. The desktop study and survey identified the following biological resources:

- Federal candidate, threatened, and endangered species, as identified by the USFWS Jefferson, Douglas, and Arapahoe Counties Species Lists and the online Information, Planning and Conservation (IPaC) System (USFWS 2015a).
- Colorado sensitive, threatened, and endangered species as identified on the CPW and Colorado Natural Heritage Program (CNHP) websites.
- Migratory bird habitat and nesting including raptors.
- Black-tailed prairie dog colonies.
- Wetlands and Waters of the United States, delineated in accordance with the *1987 U.S. Army Corps of Engineers Wetland Delineation Manual* and the *2010 Corps Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region* (Version 2.0) (USACE 2010).
- Noxious weeds occurring in the corridor were identified and locations of larger populations were presented in this document.
- SB 40 streams are identified.

This study used existing biological resource data collected for the 2006 C-470 EA. In addition, an initial desktop data collection process was initiated to review federal and state listed wildlife species and their habitats. The other biological resources addressed in this document were also reviewed in the desktop study using existing data from the 2006 C-470 EA and data from agencies. Subsequently, the Revised EA has been refined using newer data.

On July 12, 17, and 22, 2013, Robert Belford, Senior Biologist with Wilson & Company conducted a biological resources survey of the study corridor. All biological resource data collected in the field was recorded with a handheld GPS Unit that collects data to sub-meter accuracy. The weather during the field review was generally sunny with scattered afternoon clouds. Temperatures ranged from the upper 80s to middle 90s. No precipitation was present during the field review.

In December 2014, Mr. Belford made a follow-up visit to check for raptor nests while deciduous trees had no foliage.

3.0 BIOLOGICAL RESOURCES

This section identifies the results of the desktop and field survey for biological resources within the C-470 Study Area. A figure indicating the general location of identified biological resources along the corridor is provided in Figure 3.

The vegetation communities encountered in the study area included:

- The most common vegetation community was the roadside upland habitat that was dominated by crested wheatgrass (*Agropyron cristatum*), smooth brome (*Bromis inermis*), and cheat grass (*Bromis tectorum*).
- Short grass prairie was present in very isolated locations. The dominant plant species in these locations included yucca (*Yucca glauca*), blue grama (*Bouteloua gracilis*), and rabbitbrush (*Chrysothamnus spp*.).
- Scrub-shrub and emergent wetlands, and the riparian vegetation community are present along streams. Wetlands are dominated by sandbar willow (*Salix exigua*), cattail (*Typha spp*.), and various sedges and rushes. The riparian vegetation community is primarily comprised of plains cottonwood (*Populus deltoides*), narrow leaf cottonwood (*Populus angustifolia*), chokecherry (*Prunus virginiana*), and other herbaceous plants.

Impacts to the riparian and wetland communities along these streams are detailed in a separate Wetland Finding Report for the Revised EA. That report identified 41 wetland areas totaling 12.7 acres within the project area. The Proposed Action would have permanent impacts totaling 0.7 acre at 16 of these sites, and another 1.3 acres of temporary impacts at seven sites. CDOT will follow its policy of “no net loss” for wetlands, providing mitigation within the project area where appropriate, but may address some of these impacts using an offsite wetland mitigation bank. The report indicates that there would be no impacts to other waters of the United States.

3.1 Federal Candidate, Threatened, and Endangered Species

This section addresses the federal candidate, threatened, and endangered wildlife and plant species in Jefferson, Douglas, and Arapahoe counties. The USFWS online IPaC System was reviewed for each county to identify potential species that may occur in the study area. Species lists were reviewed to determine if suitable habitat was present within the study area to support federally listed species. Table 1 identifies the federal candidate, threatened, and endangered wildlife and plant species in Jefferson, Douglas, and Arapahoe counties. The table also provides narrative on the potential for each species to occur in the study area.

A total of 13 Federally listed species may occur in Jefferson County, 12 species in Douglas County, and 8 species in Arapahoe County (USFWS 2015b). Based on the review of habitat present within the C-470 Study Area, none of these species were determined to occur in the study area.

No Federal candidate, threatened or endangered species were found to occur in the C-470 study area.

Figure 3
General Location of Biological Resources along the C-470 Corridor

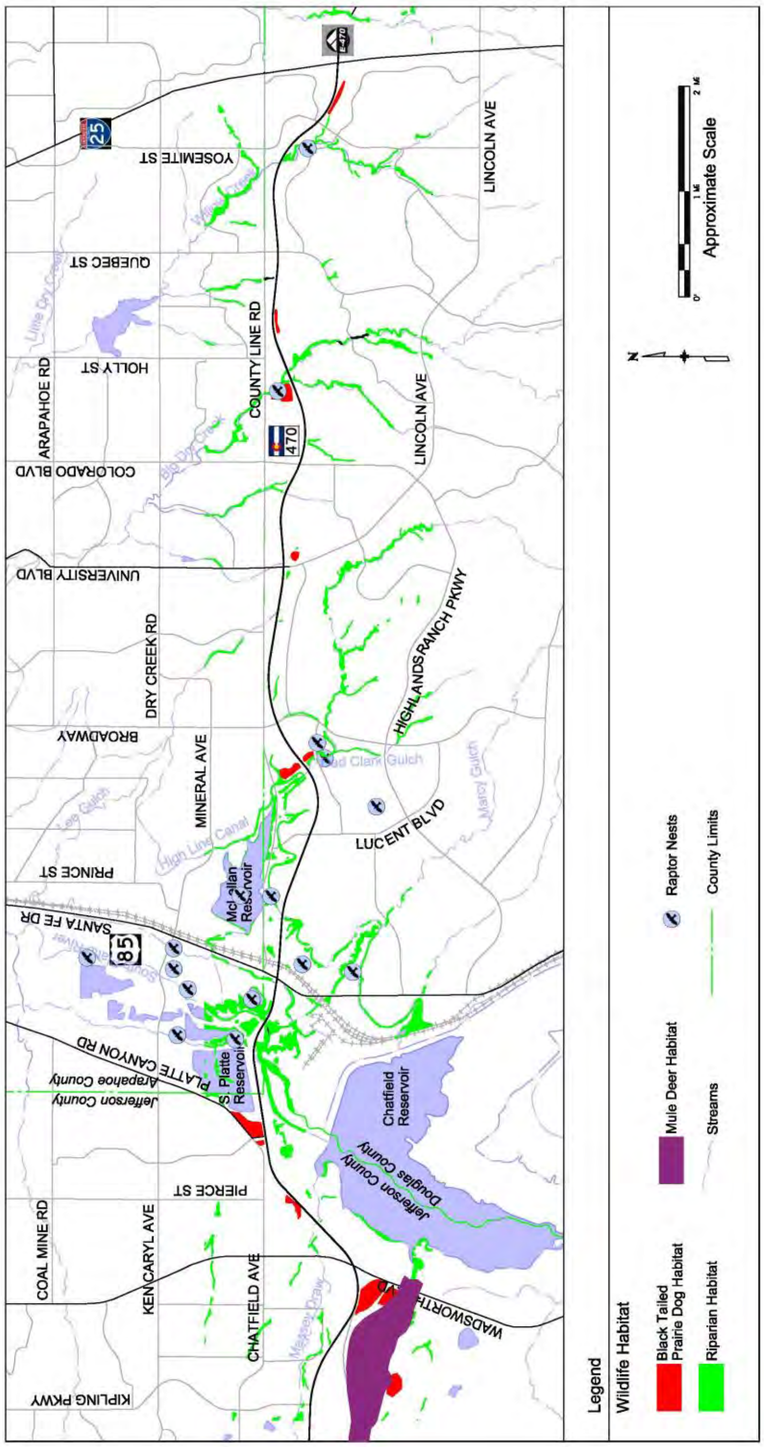


Table 1
Federal Listed Wildlife and Plant Species in Jefferson, Douglas, and Arapahoe Counties and their Potential to Occur in the C-470 Study Area

Species	Status	Counties	Habitat	Potential Occurrence in Study Area
Birds*				
Mexican Spotted Owl (*Strix occidentalis lucida*)	Threatened	Arapahoe, Douglas, Jefferson	Prefers mature conifer forests in the montane vegetation community.	No suitable habitat is present in the study area. The study area does not contain conifer forests with topography such as canyons for this avian species.
Least Tern (*Sternula antillarum*)	Endangered	Arapahoe, Douglas, Jefferson	Inhabits reservoirs, lakes, and rivers with sandy shorelines or islands.	No suitable habitat is present in the study area. This species is listed in the study area counties because it inhabits the middle Platte River and is included in the SPWRAP species recovery program.
Piping Plover (*Charadrius melodus*)	Endangered	Arapahoe, Douglas, Jefferson	Inhabits reservoirs, lakes, and river habitat with bare, non-vegetated shorelines.	No suitable habitat is present in the study area. This species is listed in the study area counties because it is included in the SPWRAP species recovery program.
Whooping Crane (*Grus americana*)	Endangered	Arapahoe, Jefferson, Douglas	Utilizes large wetlands, irrigated meadows, reservoirs, and river sandbars during the migration through the plains states.	No suitable habitat is present in the study area. This species is listed in the study area counties because it is included in the SPWRAP species recovery program.
Insects				
Pawnee montane skipper (*Hesperia leonardus montana*)	Threatened	Douglas, Jefferson	Occurs in the South Platte Canyon drainage systems. It prefers dry, open, ponderosa pine woodlands.	Suitable habitat for this species does not occur within the study area.
Fish				
Greenback cutthroat trout (*Oncorhynchus clarki ssp. stomias*)	Threatened	Douglas	Found in streams in the upper Arkansas and South Platte River drainages.	No suitable cold water stream habitat exists in study area.

Table 1, continued - Federal Listed Wildlife and Plant Species

Species	Status	Counties	Habitat	Potential Occurrence in Study Area
Fish (continued)				
Pallid sturgeon (*Scaphirhynchus albus*)	Endangered	Arapahoe, Douglas, Jefferson	Inhabits large river systems such as the Missouri River.	This fish species is not found in the study area. The closest documented occurrence of this species is the lower Platte River in Nebraska. This fish species is listed in the study area counties because it is included in the SPWRAP species recovery program.
Mammals				
Canada lynx (*Lynx canadensis*)	Threatened	Jefferson	Found in high elevation conifer forests.	No suitable habitat for the Canada lynx in the study area. The study area does not contain high-elevation conifer forests.
Preble's meadow jumping mouse (*Zapus hudsonius preblei*)	Threatened	Arapahoe, Douglas, Jefferson	Occurs along streams with adequate trees, shrubs, and herbaceous cover.	Unlikely to occur along the streams in the study area. All of the streams with the exception of a stretch of the South Platte River upstream from the C-470 Bridge are block-cleared. The short segment of the South Platte River in the vicinity of the C-470 Bridge has poor to marginal habitat for the mouse.
Plants				
Colorado butterfly plant (*Gaura neomexicana var. coloradensis*)	Threatened	Douglas, Jefferson	Stream channel sites that are occasionally disturbed, sub-irrigated alluvial soils along streams, and open floodplain meadows.	Unlikely to occur along study area streams due to dense vegetation present in riparian zones. The South Platte River downstream from the C-470 Bridge is block-cleared. The plant has never been documented in Douglas County and a small population exists at Chambers Preserve in Jefferson County. The population at Chambers Preserve was introduced from seed and transplants in the mid-1980s (USFWS 2010).
Ute ladies'-tresses orchid (*Spiranthes diluvialis*)	Threatened	Arapahoe, Douglas, Jefferson	This orchid prefers sub-irrigated alluvial soils along streams and open meadows in riparian corridors.	Unlikely to occur along study area streams due to dense vegetation present along riparian streams in study area. The South Platte River downstream from the C-470 Bridge has been block-cleared. The orchid is documented as occurring in Jefferson County. There are historic records of the orchid occurring in Douglas County and no records of the species occurring in Arapahoe County.
Western prairie fringed orchid (*Platanthera praeclara*)	Threatened	Arapahoe, Douglas, Jefferson	This orchid occurs in Nebraska and is addressed in this section because of the SPWRAP recovery program.	The SPWRAP discussion in Section 3.1.1 discusses the species recovery related to South Platte River depletions.

* The full common names of bird species are capitalized per American Ornithologists' Union standards.

3.1.1 South Platte River Depletions

Five species listed for each of the three study area counties were associated with the South Platte River Water Related Activities Program (SPWRAP). Actions undertaken in Colorado have the potential to affect these species many miles downstream, in Nebraska and other states. These species are:

- Interior Least Tern
- pallid sturgeon
- Piping Plover
- Whooping Crane
- western prairie fringed orchid

To address the effects that any depletion would have on federally-listed species downstream that depend on the river for their survival, CDOT, as a state agency, is participating in the South Platte Water Related Activities Program (SPWRAP). CDOT is cooperating with FHWA which provides a federal nexus for the project. In response to the need for formal consultation for water used from the South Platte basin, FHWA has prepared a Programmatic Biological Assessment (PBA) that will estimate total water usage from 2012 until 2019. The PBA addresses the five species noted above. Any water used for this project will be reported to the USFWS at the year's end after the completion of the project as per the aforementioned consultation. Effects to species not addressed in the PBA, or affected by causes other than water depletions to the South Platte, have been analyzed separately.

3.1.2 Changes to the Preble's Meadow Jumping Mouse, Ute ladies'-Tresses Orchid, and Colorado Butterfly Plant Block-Clearance Zone since the 2006 C-470 EA

Changes have occurred to the Preble's meadow jumping mouse, Ute ladies' tresses orchid, and Colorado butterfly plant block-clearance zones since the 2006 C-470 EA was completed. The 2005 C-470 T&E Technical Memorandum identified potential Preble's meadow jumping mouse habitat in the South Platte River below Chatfield Reservoir dam, Big Dry Creek, and Willow Creek. These stream segments were not block-cleared at the time the 2006 EA was published. While the technical memorandum had identified these stream segments as potential habitat, the2005 study did not include a presence/absence survey for the Preble's meadow jumping mouse. Therefore, this species was never confirmed as present along these streams.

In 2010, the USFWS designated Preble's meadow jumping mouse block-clearance for the South Platte River downstream from the C-470 Bridge, Big Dry Creek, and Willow Creek. This only leaves the South Platte River upstream from the C-470 Bridge as the study area stream segment not block-cleared.

The 2005 Technical Report and 2006 EA also addressed the habitat conditions for the Ute ladies' tresses orchid and Colorado butterfly plant within the study area. The Technical Report addressed habitat for these species along the South Platte River and stated the vegetation was dense and not appropriate for the presence of these species (ERO 2005). Other streams along the corridor were not addressed in the report. In

2006, the South Platte River was not block-cleared for these species. That status changed in 2008 when the USFWS designated block-clearance for these two plant species on the South Platte River downstream from the C-470 Bridge.

3.1.3 Current Status of Preble's Meadow Jumping Mouse, Ute ladies'-Tresses Orchid, and Colorado Butterfly Plant for Revised C-470 EA

The 2015 biological survey looked at habitat conditions for the Preble's meadow jumping mouse, Ute ladies'-tresses orchid, and Colorado butterfly plant on the upstream side of the C-470 parallel bridges over the South Platte and determined the habitat had not changed since the 2005 C-470 EA Biological Study had been completed. The riparian habitat in this location is impacted by the bridge, the recreational trail on the west side of the river, and bridge support materials on the east side of the river. Both sides of the river at the C-470 bridges have narrow strips of riparian vegetation consisting of willow and other herbaceous plants. Therefore, this site does not contain the habitat conducive to Preble's meadow jumping mouse, Ute ladies'- tresses orchid, and Colorado butterfly plant occupancy.

In 2005, the USFWS concurred that the C-470 Project was not likely to adversely affect these three species. Since the habitat has not changed since 2005, block-cleared areas for these species has been expanded, and the project preferred alternative has been proposed that will limit roadway improvements to an area within the CDOT right-of-way, the USFWS has again concurred the project was not likely to adversely affect the Preble's meadow jumping mouse, Ute ladies'-tresses orchid, and Colorado butterfly plant. The USFWS concurrence correspondence dated June 15, 2015 is found in Appendix A.

3.2 State-Listed Species

This section identifies state-listed species that have the potential to occur in Jefferson, Douglas, and Arapahoe counties. The CPW has listed 74 species of amphibians, birds, fish, mammals, reptiles, and mollusks as endangered, threatened, or of special concern. This section will only identify the 11 state listed threatened and endangered species potentially occurring within the study area counties. The CPW Natural Diversity Information System and CNHP data were reviewed to identify species ranges in the three study area counties, Arapahoe, Douglas and Jefferson.

The distribution and habitat preferences of each state-listed species were identified and the potential for each of these species to occur in the study area is identified in Table 2. The study area has 11 state listed birds, fish, and mammal species that potentially occur in the study area counties (CPW 2013).

Table 2
State-Listed Species Potentially Occurring in Jefferson, Douglas, and Arapahoe Counties and their Potential to Occur in the C-470 Study Area

Species	Status	Counties	Habitat	Potential Occurrence in Study Area
Birds				
Burrowing Owl (*Athene cunicularia*)	State Threatened	Arapahoe, Douglas, Jefferson	Prairie dog colonies are primarily used by the owl for nesting and hunting. The owl is a migrant that can arrive in March and is typically migrating south by October.	Potential to occur in study area because black-tailed prairie dog colonies are present.
Mexican Spotted Owl (*Strix occidentalis lucida*)	State Threatened	Arapahoe, Douglas, Jefferson	Described in Table 3-1 because it is also Federally listed.	No suitable nesting habitat in the study area. Was discussed in Table 1 because it is also Federally listed.
Plains Sharp-tailed Grouse (*Tympanuchus phasianellus jamesii*)	State Endangered	Douglas	Occurs in shrublands and will use croplands and riparian corridors during the winter months.	No suitable habitat present in the study area.
American Peregrine Falcon (*Falco peregrinus anatum*)	State Species of Concern	Arapahoe, Douglas, Jefferson	Requires rocky outcrops for nesting. Uses a variety of habitats during the spring and fall migration.	Could use the study area during migration. However, there is no suitable nesting habitat in the study area.
Mountain Plover (*Charadrius montanus*)	State Species of Concern	Arapahoe, Douglas, Jefferson	Requires open grassland for nesting. Will use other habitats during the migration in the spring and fall.	No suitable nesting habitat in the study area. Could use parts of the study area during migration.
Fish				
Common shiner (*Luxilus cornutus*)	State Threatened	Arapahoe, Douglas	Prefers warm water streams and rivers. Primarily found in the South Platte River and its tributaries in eastern Colorado.	Potential to occur in the study area. Has been documented as occurring in West Plum Creek in Douglas County (NDI 2013).
Northern redbelly dace (*Phoxinus eos*)	State Endangered	Arapahoe, Douglas	Native to the South Platte River Basin. The fish requires slow moving streams and cold water temperatures.	Potential to occur in the study area. Has recently been found in the Plum Creek drainage in Douglas County.
Mammals				
Canada lynx (*Lynx canadensis*)	State Endangered	Jefferson	Described in Table 3-1 because it is also Federally listed.	Discussed in Table 3-1 because it is also Federally listed.
Preble's meadow jumping mouse (*Zapus hudsonius preblei*)	State Threatened	Arapahoe, Douglas, Jefferson	Described in Table 3-1 because it is also Federally listed.	Discussed in Table 3-1 because it is also Federally listed.
Black-tailed prairie dog (*Cynomys leucurus*)	State Species of Concern	Arapahoe, Douglas, Jefferson	Grassland habitat.	Numerous black-tailed prairie dog colonies are present adjacent to C-470 within the study area.

Table 2 (continued)
State-Listed Species Potentially Occurring in Jefferson, Douglas, and Arapahoe Counties and their Potential to Occur in the C-470 Study Area

Species	Status	Counties	Habitat	Potential Occurrence in Study Area
Mammals (continued)				
Northern pocket gopher (*Thomomys talpoides macrotis*)	State Species of Concern	Douglas	Occupies many different habitats, including agricultural areas, grasslands, shrub-lands, and high-elevation meadows.	Potential habitat for the species is present in the study area.

The black-tailed prairie dog is present in the C-470 study area. Six other state-listed species may occur in the area: three bird species, two fish species and the northern pocket gopher.

A total of seven state-listed species potentially occur in the study area. Of the avian species identified as potentially occurring in the study area, the Burrowing Owl is the only species that could nest in study area prairie dog colonies. However, no Burrowing Owls were observed in the prairie dog colonies during the biological survey. Of note, a Burrowing Owl survey using the CPW Guidelines was not completed for this biological assessment. The mitigation section will address the requirement for additional Burrowing Owl surveys as the project progresses. The other two avian species, American Peregrine Falcon and Mountain Plover, may use the study area for short periods during the spring and fall migrations. The two fish species, the common shiner and northern redbelly dace, may occur in the South Platte River, Big Dry Creek, and Willow Creek. The black-tailed prairie dog is present in the study area. The northern pocket gopher could inhabit some of the open grasslands in the study area.

3.3 Migratory Birds, Including Raptors

Migratory birds as well as their eggs and nests are protected under the Migratory Bird Treaty Act (MBTA). With the exception of House Sparrow, Rock Dove (Common or Feral Pigeon), European Starling, and resident game birds such as Pheasant and Grouse, all wild birds commonly found in the U.S. are protected by the MBTA, even species such as Magpie and Great Horned Owl that tend to be present throughout the year. All active nests are protected, including cavity nests (e.g., Flicker), ground nests (e.g. Killdeer), and subterranean nests (e.g., Burrowing Owl).

The MBTA does not contain any prohibition that applies to the destruction of an inactive bird nest alone (without birds or eggs), provided that no possession occurs during the destruction. While destruction of an inactive nest by itself is not prohibited under the MBTA, nest destruction that results in the unpermitted take of migratory birds or their eggs is illegal and fully prosecutable under the MBTA (Migratory Bird Permit Memorandum, U.S. Fish and Wildlife April 15, 2003).

Migratory bird nesting habitat is available along riparian corridors and some remaining grassland along the entire length of the C-470 study area. The western end of the project as the corridor passes through the Chatfield Reservoir State Recreation Area contains the best habitat for nesting migratory birds along the South Platte River and the grasslands within the area. This portion of the corridor contains the highest quality habitat for grassland-dependent nesting migratory birds.

Swallow nests were observed during the field review at the Erickson Boulevard Bridge, C-470 Bridge over the South Platte River, and the C-470 Bridge over Willow Creek. Figure 4 shows the swallow nests at the Erickson Boulevard Bridge. The protocol for surveying bridges for swallow nesting sites will be addressed in the migratory bird mitigation commitments.

Figure 4
Swallow Nests on the C-470 Bridge over Erickson Boulevard

Note: Photo taken from north of C-470, facing southward. Bridge shown carries westbound C-470 traffic. (Wilson & Company, August 2013)

Birds of prey, also known as raptors, hunt vertebrates, including other birds, and invertebrates for food. Eagles and hawks are well known examples, but many other species are also considered raptors. Raptors have three distinguishing characteristics: a hooked beak, excellent long-range vision, and strong feet with sharp talons. An important conservation approach for these birds is to avoid disturbances to raptor nesting activities, which can mean restricting construction activity within proximity of an active nest during the nesting season.

An extensive field survey for raptor nests was conducted in August 2003, followed by limited spot checks in 2013 and 2014. The 2003 effort determined that raptor nests were present in the project area, specifically including four active Red-Tailed Hawk nests located within one-third of a mile from C-470. This is the buffer zone radius within which Colorado Parks and Wildlife recommends temporal restrictions on construction activities to minimize disruptions to active nests. The Red-Tailed Hawk is the most common raptor species in America, according to the U.S. Fish and Wildlife Service.

The four active Red-Tailed Hawk nest from the 2003 field survey were located along Big Dry Creek, Willow Creek, and (two) the southeastern corner of the C-470/Santa Fe Drive interchange. Since then, major development has occurred in the vicinity of this interchange, including construction of a major retirement community (Windcrest) complex and construction of the southbound Santa Fe Drive flyover ramp to eastbound C-470, as well as establishment of a former gravel pit as a small local park ("Johnny's Pond), attracting more human foot traffic to the area.

Other nests observed in the original field survey were inactive or were located beyond a half mile distant from C-470. Within a full mile from C-470, other raptors had been observed including one Prairie Falcon nest and another nest previously productive for the Great Horned Owl. The 2006 EA reported that the riparian canopy near the Highline Canal is known to be a winter perch site for the Bald Eagle. Additionally, an unconfirmed report from a citizen in 2006 noted the presence of a nesting pair of Kestrels in the Herrick Dale neighborhood of Littleton.

Numerous raptors are listed on the bird-watching checklists developed by Chatfield State Park and by the South Platte River Park which abut C-470 at its South Platte River crossing. Chatfield State Park includes Chatfield Reservoir and South Platte Park includes numerous lakes as well as riparian area. Additionally, the continued presence of prairie dog colonies along C-470 provides a source of prey between the riparian areas.

Spot checks performed in 2013 and 2014 confirmed continued presence of recently active raptor nests within the project area, likely to be occupied in spring for the start of the nesting season. The purpose of the visits was not to complete an updated inventory, but to confirm that conditions in the area remain conducive for raptor presence. Based on these observations, it should be assumed that active raptor nests will be present along the corridor, especially near riparian areas, consistent with past findings.

The mitigation commitments for migratory birds will outline the protocol for raptor nest surveys to be completed as the project progresses; including the commitment to conduct raptor nest surveys.

3.4 Black-tailed Prairie Dogs

Black-tailed prairie dog colonies are present throughout the study area. The 2005 C-470 Biological Technical Report mapped a total of 21 colonies that encompassed 90 acres (ERO 2005). The 2013 survey used the 2005 prairie dog mapping and visited all sites located within the CDOT right-of-way to verify the current status of the colonies. A total of 20 colonies were present in the CDOT right-of-way. All of the

20 active colonies of black-tailed prairie dogs are present along C-470 in the study area.

colonies identified in 2005 within the CDOT right-of-way were active, except for one near University Boulevard. Based on the 2005 mapping, most of the colonies appear to be approximately the same size. No appreciable increase or decrease in colony size was noted in the field review. In addition, no additional new colonies were observed during the 2013 biological survey. The mitigation section will address project adherence with the *CDOT 2009 Impacted Black-tailed Prairie Dog Policy* (CDOT 2009).

3.5 Common Wildlife

Wildlife habitat in the study area is generally located along the undeveloped stream corridors that cross C-470, and the open grasslands and shrublands that are found in the western portion of the study area. Most of the species likely to be found in the study are well-adapted to human modified habitat and human disturbance. Common mammals in these areas include mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), cottontail rabbit (*Sylvilagus audubonii*), deer mouse (*Peromyscus maniculatus*), and striped skunk (*Mephitis mephitis*).

Most of the stream crossings along C-470 also serve as wildlife corridors across the highway. The most significant wildlife corridors are along the South Platte River and Big Dry Creek, where highway bridges allow for wildlife passage underneath. Other wildlife crossings include Willow Creek, Dad Clark Gulch, and the Highline Canal, where box culverts allow for some wildlife movement. Any habitat impacts, especially riparian and wetland habitat impacts, would adversely affect the wildlife species that depend on them.

3.5.1 Mule Deer and Elk

Mule deer (*Odocoileus hemionus*) are common in shrublands on rough, broken terrain that provides abundant browse and cover. Mule deer are likely to occur in and near the western portions of the corridor, especially in the South Platte River floodplain and west of the river to the foothills beyond Kipling Parkway (outside of the C-470 study area).

American elk (*Cervus elaphus*) are commonly found in semi-open forest or along forest edges above 6,000 feet. Elk are known to migrate through the Chatfield Basin to the southwest of the corridor and along the Dakota hogback to the west of the study area, and may occasionally venture into the corridor, particularly in the winter.

The existing C-470 highway poses a substantial barrier to movement by both of these species. Mule deer are likely to use the South Platte River and Big Dry Creek bridges as movement corridors, while the likelihood of elk crossing C-470 to the north and east is very small due to the absence of suitable habitat in the urbanized areas. Although the South Platte River bridge is likely a major movement corridor, it provides little room for wildlife movement along the river banks due to the existing trail and riprap. Mule deer also may occasionally cross the C-470 roadway surface during low traffic periods.

The C-470 Proposed Action would cause the direct disturbance or loss of habitat areas for mule deer or elk because of the larger footprint of the proposed roadway and its associated facilities. Most impacts would be to relatively low quality habitat in the median and in mowed areas of existing highway right-of-way. Some higher quality habitat would be lost in areas where the right-of-way would be expanded into currently undeveloped areas. In addition to direct impacts to habitat, increased noise and traffic volumes would enlarge the area around the highway that mule deer and elk would likely avoid. This would effectively reduce the amount habitat used by deer and elk. A benefit of transportation improvements would be reconstruction of the existing bridge over the South Platte River. The reconstructed bridge would improve the movement corridor between Chatfield State Park and South Platte Park. Movement at other crossings would not be improved.

3.5.2 Vehicle-Wildlife Crashes

CDOT's Traffic Safety Branch provided a listing of 2,311 reported crashes along a 13-mile stretch of C-470 from Kipling to Interstate 25 for the five-year period of 2008 to 2012, inclusive. This equates to an average of 462 crashes per year for the corridor, or 1.27 crashes per day along this 13-mile segment. Only 29 (1.2%) of the reported 2,311 crashes involved a wild animal. About 70% of these crashes (21 of 29) involved deer.

Over the five-year period, the total of 29 vehicle-wildlife crashes reported along C-470 equates to an average of just under six crashes per year. As noted above other crashes went unreported. Undoubtedly there were also numerous near misses. Out of the 29 total crashes, 21 (nearly 70%) occurred in the western half of the 13-mile corridor. The western half is less densely developed, with large parcels of adjacent park lands, and it includes the South Platte River.

The 2006 C-470 Environmental Assessment identified five known wildlife crossing areas along C-470, in the vicinity of the following drainages, listed from west to east:

- Massey Draw (approximately C-470 milepost 14.1)
- South Platte River (MP 16.5)
- Highline Canal (MP 17.6)
- Big Dry Creek (MP23.0)
- Willow Creek (MP 25.1)

> Seven vehicle-wildlife crashes were reported along the 13-mile C-470 project area during 2012. There has been no clear trend in the number of such crashes between 2008 and 2012.

During the 2008-2012 reporting period, eight vehicle wildlife crashes (1.6 per year) occurred generally near the South Platte River (between Platte Canyon Drive and Santa Fe Drive), in an area bordered to the south by Chatfield State Park and to the north by South Platte Park.

Another three crashes occurred near Massey Draw, and two crashes occurred near Big Dry Creek. There were no vehicle-wildlife crashes near the Highline Canal or Willow Creek. Another 16 vehicle-wildlife crashes occurred elsewhere along the corridor, not at the five identified crossing areas.

The CDOT records include a wide range of data including the date, time, lighting conditions, and other data regarding each crash. A review of these records yielded the summary information provided in Table 3. The number and geographic concentration of the observed vehicle-wildlife crashes along C-470 during 2008 to 2012 are not indicative of localized roadway deficiencies that would need to be addressed in the design of the Proposed Action. Nevertheless, it is desirable to minimize the number of these incidents through design and operational features as practicable.

Table 3
Reported C-470 Vehicle-Wildlife Crashes Summary

Detail	Summary of 29 Total Crashes Over Five Years
Species	Deer - 21 crashes; elk - 3; coyote - 2; owl – 1; unknown - 2.
Yearly Trend	No trend is evident in the number of total crashes by year (most recently, 7 in 2012).
Season	Totals by calendar quarter show more crashes in the latter part of the year.
Time of Day	Two-thirds of the crashes (20 of 29) occurred overnight, between the hours of 7pm and 6am.
Lighting	19 of the 29 crashes happened during conditions of darkness, 16 of these in unlighted areas.
Vehicle Speed	24 crashes involved vehicles traveling at least 60 miles per hour (mph); 4 crashes at 50 to 55 mph; 1 crash reported at 20 mph.
Other Factors	Bad weather and driver impairment were not contributing factors. Only one crash out of 29 occurred during bad weather conditions.
Outcomes	All 29 crashes resulted in vehicle damage; 2 of the crashes resulted in human injury, with no fatalities. The records do not indicate injury or fatality outcomes for the animals involved.

3.6 Noxious Weeds

In summer 2013, the study area was surveyed for all noxious weeds listed on the Colorado Department of Agriculture (CDOA) Noxious Weed List, CDOT Maintenance Noxious Weed List, and the respective noxious weed lists maintained by Jefferson and Douglas counties (Jefferson and Douglas Counties 2013). Arapahoe County does not have its own county noxious weed list. Eight species of noxious weeds were observed in the study area, as listed in Table 4.

Table 4 identifies the noxious weed species observed in the corridor field survey and lists the CDOA, and county designation for each. CDOA designates noxious weed species in three categories (Lists A, B, and C), depending on their potential adverse impacts and their degree of spreading to date:

- List A species are targeted for eradication.
- List B species are managed to curtail spreading and expansion of local populations.
- List C species do not require management actions, but are listed because they can be a problem and local management actions may be required.

Table 4
Noxious Weeds Present in the Study Area

Common Name	Species Name	CDOA Noxious Weed Lists	Douglas County List	Jefferson County List
Canada thistle	*Cirsium arvens*	List B	x	x
Diffuse knapweed	*Centaurea diffusa*	List B	x	x
Field bindweed	*Convolvulus arvensis*	List C	--	--
Leafy spurge	*Euphorbia esula*	List B	x	x
Musk thistle	*Cardus nutans*	List B	x	x
Russian olive	*Elaeagnus angustifolia*	List B	x	x
Salt cedar	*Tamarix ramosissima*	List B	x	x
Scotch thistle	*Onopordum tauricum*	List B	x	x

x indicates that the species is included on the CDOT or county list.

Noxious weeds were generally observed and scattered throughout the study area. Moderate to larger populations of noxious weeds were observed at the following locations along the corridor:

- Along Massey Draw and the South Platte River, Russian Olive is present within and adjacent to riparian habitat.
- Upland areas in the Chatfield State Recreation Area have low populations of diffuse knapweed, Canada thistle, and musk thistle.
- On the south side of Big Dry Creek in the upland areas within the CDOT right-of-way, a mix of diffuse knapweed, leafy spurge, musk thistle, and Scotch thistle was observed.
- Within upland sites adjacent to Willow Creek, a mix of diffuse knapweed and scotch thistle was observed.
- Adjacent uplands near Massey Draw contained a mix of diffuse knapweed, leafy spurge, and Scotch thistle.
- Some isolated individual salt cedar is present along the South Platte River.
- Field bindweed was present throughout the corridor.

The noxious weed sites identified in the 2006 C-470 EA have not spread based on the findings of the 2013 field survey. Additionally, the 2013 findings are consistent with the results of the CDOT Statewide Noxious Weed Mapping results available online for 2011-2012.

Within the study corridor any additional “hot spots” or larger populations of noxious weeds will be identified prior to initiation of construction. These sites will be targeted for treatment and management action. Additional noxious weed mitigation strategies will be identified in the mitigation section.

3.7 Riparian Areas Protected by SB 40

SB 40 (33-5-101-107, CRS 1973 as amended) requires any agency of the state to obtain wildlife certification from the CPW when the agency plans construction in riparian areas. Although SB 40 emphasizes the protection of fishing waters, it acknowledges the need to protect and preserve all fish and wildlife resources associated with streams in Colorado. In July 2013, CDOT and CPW signed a new Memorandum of Agreement that identifies some changes to the SB 40 process(CDOT 2013). The C-470 Proposed Action will adhere to these new guidelines and will implement them into the SB 40 process as the project progresses to design and construction.

The C-470 project area contains several streams that meet the criteria for jurisdiction under SB 40. The criteria used to determine study area stream eligibility included the following:

- Perennial stream represented by a solid blue line on the U.S. Geological Survey 7.5' Quad.
- Segments of ephemeral and intermittent streams providing flowing water beneficial to fish and wildlife.
- Stream segments that have 25 percent or more of the vegetation comprised of riparian vegetation such as cottonwood, willow, alder, sedges, and other plants dependent on groundwater or overbank flooding. These stream segments will be within 300 feet upstream or downstream of the project. The 300-foot distance is measured by valley length as identified in the recently issued SB 40 Guidelines.

Based on these criteria, the following five study area streams are SB 40 jurisdictional:

- South Platte River
- Big Dry Creek
- Willow Creek
- Dad Clark Gulch
- Massey Draw

Based on the project's conceptual design, potential impacts to a total of 2.771 riparian acres are anticipated at seven locations along the corridor as indicated in Table 5.

Table 5
Location and Magnitude of Potential Impacts to Riparian Areas

#	Drainage	Location	Area (acres)
1	Massey Draw	Northwestern quadrant of C-470/Kipling interchange	0.285
2	Massey Draw	Northeastern quadrant of C-470/Kipling interchange	0.608
3	Massey Draw	Between Kipling interchange and Deer Creek Pool	0.320
4	Massey Draw	Trail crossing into western portion of Chatfield State Park	0.066
5	South Platte River	North (upstream), under, and mostly south of C-470 bridges	0.978
6	Big Dry Creek	North, under, and south of C-470	0.277
7	Willow Creek	Immediately south of C-470	0.159
8	Willow Creek	North of C-470 and north of Parkway Drive	0.079
		Total	2.771

4.0 CONCLUSIONS AND MITIGATION

This section summarizes the findings for biological resources and identifies mitigation for these resources. The biological resources findings and mitigation identified in this section will be included in the C-470 Revised EA.

4.1 Federal Candidate, Threatened, and Endangered Species

A total of 11 federal candidate, threatened, and endangered species - including birds, an insect, fish, and mammals - are listed within the study area counties. Of these listed species, none were identified as occurring within the proposed project area. In correspondence dated June 15, 2015, the USFWS concurred with the finding that the Proposed Action in the Revised C-470 EA was not likely to adversely affect the Preble's meadow jumping mouse, Ute ladies' tresses orchid, and Colorado butterfly plant.

Five of the listed species are in the SPWRAP. In response to the need for formal consultation for the water used from the South Platte basin, FHWA has prepared a PBA that will estimate total water usage from 2012 until 2019. The water used for this project will be reported to the USFWS at the year's end after the completion of the project as per the aforementioned consultation. As water depletion impacts to the five downstream species have already undergone consultation with the USFWS under the PBA, these five species are not discussed further in this report.

4.2 State-listed Species

A total of seven state-listed species may occur in the study area. One of these, the black-tailed prairie dog, is present in the study area and is discussed separately below. The other six species may use the study area in some capacity, either as a resident or briefly stopping in the study area during the bird migration. No mitigation is recommended for the state-listed species potentially occurring in the study area.

4.3 Black-tailed Prairie Dogs

A total of 20 black-tailed prairie dog colonies were identified in the study area. These sites and the entire corridor will be surveyed to finalize colony boundaries as the project progresses into later design and construction phases. Mitigation for impacts to black-tailed prairie dogs in the study area will follow the *2009 CDOT Impacted Black-tailed Prairie Dog Policy*.

4.4 Migratory Birds, Including Raptors

The Migratory Bird Treaty Act protects migratory birds and their nests. CDOT has developed specific guidelines to protect migratory birds during roadway construction and maintenance activities. As mitigation, CDOT will require compliance with its standard specifications, as follows:

- Standard Specifications – Section 240 Protection of Migratory Birds –Biological Work Performed by the Contractor's Biologist
- Standard Specifications – Section 240 Protection of Migratory Birds During Structure Work

No raptor nests were observed during the 2013 biological survey. The survey was conducted in July and the dense foliage on the trees prevented observation of nests. The biological survey for the 2006 C-470 EA identified the location of several raptor nests in the study corridor. Therefore, additional survey of the study area for raptor nests will be included in the C-470 Revised EA mitigation commitments.

In Colorado, migratory bird nesting generally occurs between April 1 and August 31. However, raptor nesting can be initiated as early as February 1 (Ferruginous Hawk) and restrictions to protect specific raptor species nesting starts on this date. The following migratory bird mitigation commitments are being recommended for the project:

- Pre-construction surveys for nesting birds will be completed prior to the start of construction. This includes a Burrowing Owl survey meeting the CPW Guidelines.
- When possible, vegetation shall be cleared outside of the active nesting period of April 1 through August 31. Trees and shrubs scheduled for clearing and grubbing during this period shall be surveyed for nesting birds. If active nests are located within the project area, they shall be protected.
- If a nest is identified within the project area during construction, a buffer of 50 feet will be established around the nest. This protective buffer will be a plastic fence installed around the nest. Work shall not proceed in this zone until the young have fledged or the nests are inactive.
- Ground nesting birds will be protected by conducting a survey at least seven days before ground disturbing activity is initiated. Within the work zone, the undisturbed ground cover to 50 feet beyond the planned disturbance, or to the right-of-way line, shall be maintained at a height of six inches or less beginning April 1 and continuing until August 31 or until the end of ground disturbance work.
- Raptor nest surveys will be required for the project if work is initiated between February 1 and August 31 and will be surveyed out to 0.5 mile from the construction site. If raptor nests are identified within the buffer, CPW recommended buffer zones and seasonal restriction dates will be established. As stated above, some raptors initiate nesting in February and seasonal restrictions are active starting on February 1. No work will be allowed within the buffer until the biologist has determined the young have fledged or the nest is unoccupied.
- A survey for swallows shall be completed for work being conducted on structures from April 1 through August 31. If swallow nests are present on the structure and work is planned for this time, nests should be removed before April 1. If swallows are trying to build nests between April 1 and August 31, the biologist should monitor the structure every three days. If the swallows are building a nest, they should be removed before the nest is complete.
- Installation of netting can be used to prevent nest building on structures. Netting shall consist of mesh with openings that are ¾ inch by ¾ inch or less.

4.5 Common Wildlife

Over the project reach, the amount of usable habitat would be reduced by the Proposed Action due to right-of-way acquisition (minimal), increased noise and light, and greater difficulty in crossing eight lanes of highway, compared to the four lanes that exist today.

At the South Platte River, the two existing C-470 bridges (separate bridges for eastbound and westbound traffic) would be demolished and replaced as part of the Proposed Action. The replacement bridges have been designed to improve wildlife crossing opportunities at this key location. The new opening under the highway will have more vertical and horizontal clearance, with space usable by wildlife better separated from the trail on the western bank of the river.

Existing chain-link right-of-way fences on each side of C-470 near the South Platte River help to direct wildlife to the river for crossing, especially for smaller species unable to jump the fences. The area is a known and signed wildlife crossing area with an annual average of two reported vehicle-wildlife collisions.

In addition, existing culverts in excess of 24 inches in diameter will remain to serve as small animal crossings along the C-470 corridor.

4.6 Noxious Weeds

Noxious weeds are present throughout the study area and are generally scattered in disturbed areas of the right-of-way. Some larger densities of weeds were identified in specific locations as described in Section 3.5. CDOT Standard Specifications addressing noxious weeds are identified in Sections 207, 212, and 217. These specifications require that during construction the spread of noxious weeds must be minimized through the implementation of best management practices.

For mitigation, a Noxious Weed Management Plan will be prepared prior to construction for implementation throughout the project duration. The following best management practices are designed to prevent the spread of noxious weeds:

- Weed management efforts will be coordinated with local agencies and adjacent landowners to the extent possible.
- Application of herbicides immediately adjacent to active prairie dog colonies will not be permitted.
- Herbicides specified for use near wetlands and water bodies are required when conducting noxious weed control in these areas.
- Soil disturbance will be minimized to the extent possible.
- Noxious weeds observed in and near the construction area will be treated with herbicides or mechanically removed prior to the start of construction to minimize spread of weeds during ground disturbing activities.
- All disturbed soil will be re-seeded with a certified weed-free seed mix within seven days of work during the growing season. If compost is used for soil amendment, it will be STA-certified as weed free.

- Fertilizer will not be used in wetland areas.
- Topsoil will not be imported due to the potential for spread of noxious weeds.
- During construction, all areas treated for noxious weeds during construction will be observed and noxious weeds will be treated again if they emerge.

4.7 Riparian Areas Protected by Senate Bill 40

As identified in Section 3.7, the C-470 Revised EA project area contains several SB 40 jurisdictional streams. Impacts to these areas will be avoided and minimized to the extent practicable, and mitigation measures will address any remaining impacts.

Section VI (General Conditions) of the April 2013 Guidelines agreed upon by CDOT and CPW include a list of 24 (letters A through X) Best Management Practices (BMPs) applicable in SB40 jurisdictional areas. This lengthy list is not repeated here but is incorporated by reference. For each SB40 jurisdictional area affected by the Proposed Action, CDOT will consider all of these mitigation measures and select those that are well-suited for the site, as necessary to achieve full SB 40 compliance. These specific measures will be proposed to CPW in the SB 40 application package when specific project impacts are determined in final design.

Some of the BMPs in the April 2013 Guidelines address water quality issues. In addition, the Proposed Action will include a number of BMPs developed for water quality throughout the corridor. These are likely to benefit riparian areas, SB 40 jurisdictional or not. Please see the *Water Quality Technical Report* for more information about these BMPs.

5.0 FOCUS AREA – SOUTH PLATTE RIVER BRIDGES

Section 1.2 of this Technical Memorandum noted that the Proposed Action would demolish and replace the C-470 bridges over the South Platte River, and that this location is the most environmentally sensitive and regulated locale along the project corridor. In developing the conceptual design for the new bridges, CDOT explored opportunities to minimize adverse effects and to enhance the river crossing under the bridges.

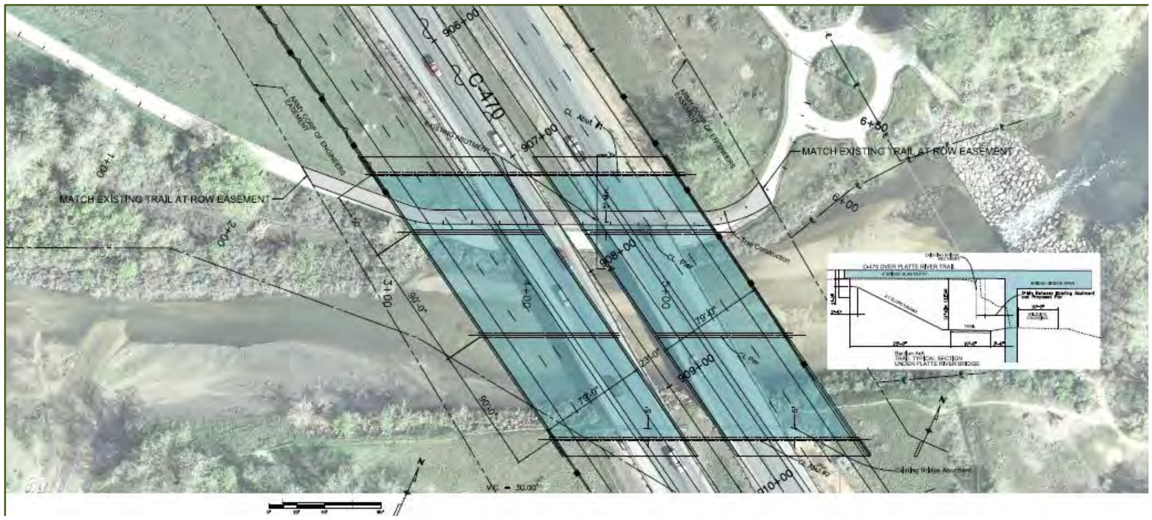
Figure 5 shows the C-470 existing bridges over the South Platte River. The eastbound bridge is in the foreground and the westbound bridge is visible behind it.
The Mary Carter Greenway Trail is visible on the left side (western bank) of this view from the southern (upstream) side of the bridges.

Figure 5
Photo of C-470 Bridges Crossing the South Platte River

Figure 5 provides an aerial view of these bridges, with the conceptual planned new bridge design superimposed. For orientation purposes, the photo in Figure 4 was shot from the left edge of Figure 6. Some notable observations about the planned bridges are:

- Each new bridge 77 feet wide would be much wider than the existing 36-feet wide bridge it replaces.
- The inside edges of the existing and new bridges are similar locations, which means that the newly bridged area will extend upstream and downstream from the current roadway.

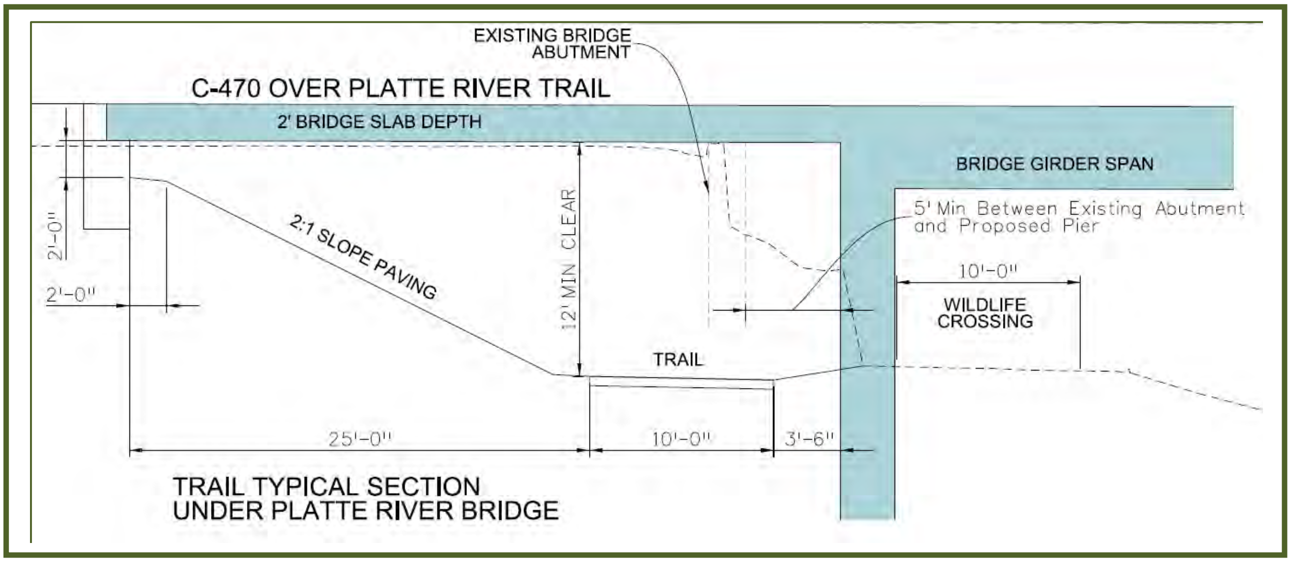
Figure 6
Aerial View of Planned New Bridge Design



With regard to the design of the new bridges, CDOT met on several occasions with representatives of the South Suburban Parks and Recreation District (SSPRD), which owns and maintains the Mary Carter Greenway Trail. SSPRD noted that the existing trail under the C-470 bridges has substandard vertical clearance and inadequate horizontal site distance. They indicated that the highway crossing would be safer for trail users and wildlife alike if there were more space under the bridge.

In response, CDOT developed a bridge design that moves the western bridge abutments farther to the west. The new design reduces the curvature of the trail under the bridge, increases the vertical clearance for bicyclists and pedestrians, and provides a wider buffer space between the trail and the river for use by wildlife. This wildlife use area will have a natural substrate and is expected to offer approximately 8 feet of vertical clearance. The typical section design for the western side of the new bridges is provided in Figure 7. This drawing is a side view, somewhat similar to the photo provided in Figure 4.

Figure 7
Typical Design Section for Trail and Wildlife Crossing under C-470 South Platte River Bridges



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APPENDIX

United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE/LAKEWOOD
P.O. BOX 25486, DENVER FEDERAL CENTER
DENVER, COLORADO 80225-0486

IN REPLY REFER TO
ES/CO: CDOT
TAILS: 06E24000-2015-I-0741

JUN 16 2015

Francesca Tordonato
Colorado Department of Transportation
425A Corporate Circle
Golden, Colorado 80401

Dear Ms. Tordonato:

On August 15, 2013, the U.S. Fish and Wildlife Service (Service) concurred with your determination that the impacts resulting from reconstructing C-470 between I-25 and Kipling Parkway in Arapahoe, Douglas, and Jefferson Counties, Colorado, are not likely to adversely affect the Preble's meadow jumping mouse (*Zapus hudsonius preblei*), the Ute ladies'-tresses orchid (*Spiranthes diluvialis*), or the Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*) (2013-I-0687). We based this determination on the project's location within areas that have been block-cleared for these species or on the lack of suitable habitat in areas outside the block-cleared areas. Our review was performed consistent with our authority under the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*). No critical habitats have been designated in the project area; therefore, none will be affected.

On June 5, 2015, we received your request to extend the above clearance because the project has not yet commenced. There have been no changes to the project description, the site conditions, or listed species or designated critical habitats; therefore, we expect the impacts from the project to be discountable and insignificant.

Given that the project description and habitat conditions have not changed, the Service continues to find your determination acceptable and agrees that the project will not likely adversely affect the Preble's meadow jumping mouse, the Ute ladies'-tresses orchid, or the Colorado butterfly plant.

Please note that reinitiation of consultation will be required if:

1. New information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;
2. The action is subsequently modified in a manner that causes an adverse effect to the listed species or critical habitat that was not considered in this opinion; or
3. A new species is listed or critical habitat designated that may be affected by the action.

If the proposed project has not commenced within one year, please contact the Colorado Field Office to request an extension.

We appreciate your submitting this report to our office for review and comment. If the Service can be of further assistance, please contact Alison Deans Michael of my staff at (303) 236-4758.

Sincerely,

for Drue L. DeBerry
Acting Colorado Field Supervisor

cc: CDOT, HQ (Jeff Peterson)
CDOT, R1 (Jon Chesser)
Wilson and Company (Doug Eberhart)
Michael

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Environmental Justice Technical Report

For the C-470 Corridor
Revised Environmental Assessment

July 2015

Submitted To:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted By:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

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1.0 INTRODUCTION

This Environmental Justice Technical Report examines potential impacts to minority and low-income populations as the result of proposed improvements to Colorado State Highway 470 (C-470) in the southwestern part of the Denver metropolitan area.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in Figure 1. In 2013, the Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) initiated a Revised Environmental Assessment (EA) for the 13-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the Revised EA differs slightly from the Express Lanes (EL) alternative identified in the previous EA that was approved by CDOT and FHWA in 2006.

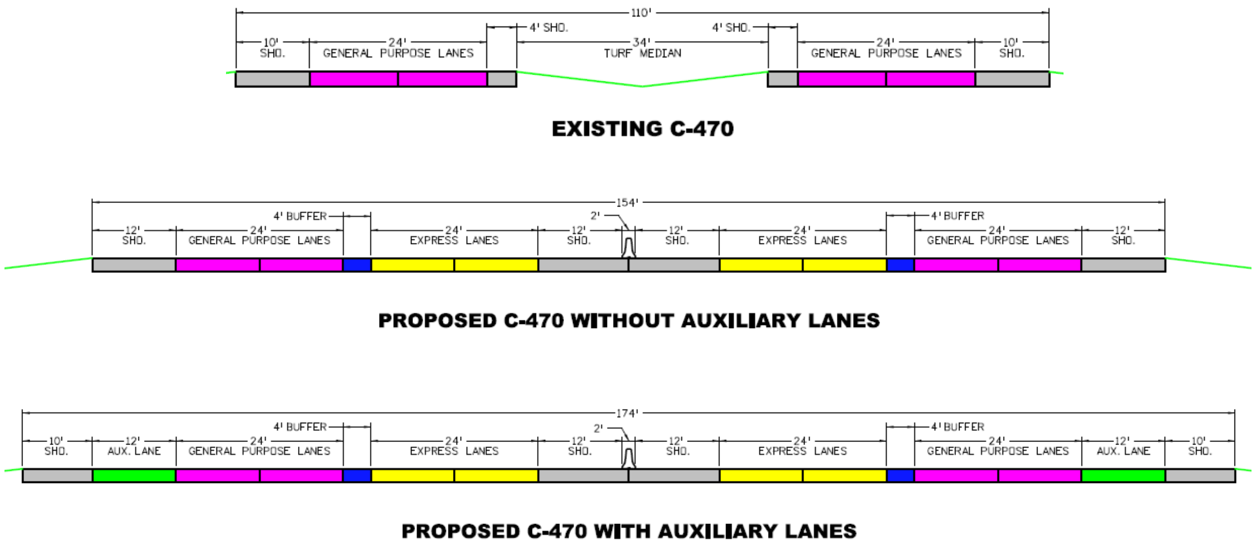
Figure 1. C-470 Corridor and Surrounding Vicinity

1.1 Project Description

The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged, but would receive maintenance as needed to maintain the safety and functionality of the existing four-lane freeway.

The Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications. The existing and proposed typical cross sections are shown below in Figure 2.

Figure 2. Existing and Proposed C-470 Typical Cross Sections



1.2 Environmental Justice Executive Order

As a part of the Revised EA, the project corridor was evaluated to determine the presence of minority and/or low-income populations and whether these populations might incur disproportionate high and adverse environmental impacts as a result of this project. This evaluation is called the environmental justice analysis.

In February 1994, President Clinton issued Executive Order 12898 requiring federal agencies to incorporate consideration of environmental justice into the National Environmental Policy Act (NEPA) evaluation process. The purpose of the order is to ensure that minority and low-income communities do not suffer a disproportionate share of high and adverse environmental impacts and are not excluded from the benefits resulting from federal actions. The order also requires that these parties have adequate access and opportunity for participation in project planning. As a federally sponsored project requiring FHWA approval, the C-470 proposed improvements are subject to the environmental justice requirements.

Various federal agencies subsequently issued their own guidance to detail how they would carry out Executive Order 12898. Guidance applicable to FHWA highway projects includes the following:

- Council on Environmental Quality (CEQ) Environmental Justice Guidance under NEPA (1997)
- U.S. Department of Transportation (DOT) Order 5610.2 on Environmental Justice (1997), updated in 2012
- FHWA Guidance on Environmental Justice and NEPA (2011)

Six years after issuing the order on environmental justice, President Clinton issued Executive Order 13166, directing federal agencies to make their programs reasonably accessible for persons who have difficulty understanding the English language. This is summarized as follows by FHWA's website on Limited English proficiency:

> Executive Order 13166 challenges federal agencies to "implement a system by which [limited English-proficient or "LEP"] persons can meaningfully access… services consistent with, and without unduly burdening, the fundamental mission of the agency." When read in its entirety, and interpreted consistently with Title VI of the Civil Rights Act of 1964 and Section 504 of the Rehabilitation Act of 1972, the Executive Order applies to all programs and activities of a federal agency, which is, essentially, everything the agency does.

Accordingly, the CDOT NEPA Manual calls for an examination of limited English-proficient populations as part of a NEPA evaluation (CDOT, 2014).

1.3 Comparison of the 2006 Analysis and the 2014 Analysis

An environmental justice analysis was prepared for the C-470 EA that was approved by CDOT and FHWA in 2006. That analysis relied on data from the 2000 Census. That comprehensive analysis examined the entire study area but focused largely on impacts to a low-income area called the Wolhurst Community, located immediately northwest of the I-25/Santa Fe Drive interchange. As described on their website, this neighborhood is a mobile home community of more than 300 residences for persons age 55 or older (Wolhurst Community, 2013). It is not a minority population but is considered low-income due to its many retirees.

Since 2006, a planned flyover ramp for southbound to eastbound traffic has been constructed at the C-470/Santa Fe interchange as a separate safety project with its own environmental clearance process. For the Revised EA, that flyover ramp and its impacts are part of the existing condition. Thus, ramp-construction impacts would not constitute direct or indirect effects of the Revised EA Proposed Action.

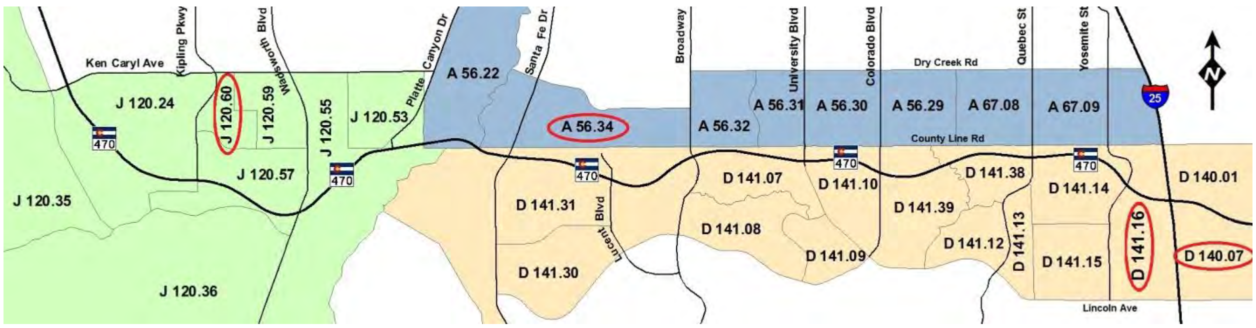
Notable changes making the Revised EA different from the 2006 EA include the following:

- 2010 Census data are now available, whereas the previous EA relied on year 2000 Census data.
- New FHWA Guidance on Environmental Justice and NEPA was issued on December 16, 2011, and US DOT Order 5610.2 was updated in 2012.
- CDOT's NEPA Manual was revised in October 2014, providing detailed instructions for addressing a wide range of social and environmental impacts, including environmental justice.
- A national recession officially occurred between December 2007 and June 2009, with adverse economic impacts that continue today. The Revised EA may reflect more household financial distress than the 2006 EA, as the currently available data may not fully reflect any economic recovery underway at this time.

2.0 AFFECTED ENVIRONMENT

The study area for this environmental justice evaluation extends approximately one mile on each side of the existing highway, as it did in the approved 2006 EA. This area comprises 30 Census tracts, as depicted in Figure 3. Existing land use in this area is generally suburban residential, mixed with commercial development and dedicated open space. The 2010 U.S. Census data indicates that the population along the C-470 Corridor study area was 114,465 residents and 45,954 households (Census, 2010a).

Figure 3
Census Tracts Included in the Analysis



Note: Letters and colors denote Arapahoe (A), Douglas (D) and Jefferson (J) counties. Tracts highlighted with an oval had the highest percentages of minority or low-income individuals, as detailed in this report.

The study area encompasses portions of three Colorado counties – Douglas, Jefferson and Arapahoe, which have a combined population of 1.4 million, as indicated in Table 1. However, the study area population is only a small portion (8%) of the three-county total, and nearly half of the study area population lives in Douglas County. Thus, study area population characteristics are more reflective of Douglas County than of the two other counties or the three-county total. Approximately 75% of the length of the Proposed Action is located within Douglas County.

Table 1
Relationship of Population in the C-470 Study Area and Surrounding Counties

Area Characteristic	Arapahoe County	Douglas County	Jefferson County	3-County Total
Total population, 2010	572,003	285,465	534,543	1,392,011
C-470 study area population by county	28,641	54,136	33,775	114,465
Study area portion of total county population	5%	19%	6%	8%
County portion of study area population	25%	46%	29%	100%

(Census, 2010)

Of the 30 Census tracts in the study area, 13 abut or include the highway, and the remaining 17 are the next closest tracts north or south of the highway, as summarized in Table 2.

Table 2
Census Tracts Examined, by Location

Census Tract Characteristic	Arapahoe County	Douglas County	Jefferson County	Totals
Number of Census tracts that include or abut C-470	2	7	4	13
Other nearby Census tracts included in the analysis	6	7	4	17
Total Census tracts examined	8	14	8	30

Each Census tract is further divided into smaller areas called block groups (i.e. groups of individual Census blocks). The 30 Census tracts in the study area contain a total of 73 block groups. Race, ethnicity, income and other demographic data were initially examined at the tract level, and tracts of particular interest were then examined at the block group level, if appropriate.

2.1 MINORITY POPULATIONS

The U.S. DOT Order 5610.2 defines the term minority as a person who is Black/African American, Asian or Pacific Islander (including Native Hawaiian), American Indian or Alaskan Native, or from Hispanic/Latino culture or origin, regardless of race. A minority population includes any readily identifiable group of minority persons who live in geographic proximity who will be affected by a proposed program, policy, or activity. The CEQ has a similar definition, but goes on to say that minority populations exist where the minority population of an affected area is greater than 50 percent, or is meaningfully greater than the minority population percentage of the surrounding geographic area. The 50% minority threshold is not met anywhere in the C-470 corridor.

The US DOT definition for minorities combines racial origin and ethnic origin that are asked as two separate questions on the Census form. The U.S. Census form choices for race include White, Black/African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, two or more races, and some other race. Hispanic is not available as an answer to this question of race. A separate Census question asks whether or not the respondent is Hispanic or Latino.

2.1.1 Race

According to the 2010 Decennial Census, approximately 91.1% of the residents within the study area reportedly were of white race alone, while 8.9% were of other races or of multiple races.

The data presented in Table 3 indicate that the study area has lower percentages of racial minorities than its three surrounding counties. Racial minorities accounted for 11.8% of the population in Arapahoe and Jefferson counties, and 22.3% in Arapahoe County. The percentage of racial minorities for the entire State of Colorado, not shown in the table, was 18.3%.

In 2010, the population in the study area was 91.1% white alone. The 8.9% racial minorities here were less than half the Colorado statewide percentage.

Table 3
Race in the C-470 Study Area and Surrounding Counties

Reported Race	Study Area		Arapahoe County		Douglas County		Jefferson County	
	Persons	% of Total	Persons	% of Total	Persons	% of Total	Persons	% of Total
White	104,309	91.1%	415,910	72.7%	257,598	88.2%	472,694	88.2%
Asian	3,937	3.4%	29,077	5.1%	10,716	3.8%	14,037	2.6%
African-American	1,346	1.2%	58,107	10.2%	3,476	1.2%	5,667	1.1%
Other Race, or Combined Races	4,873	4.3%	68,909	12.0%	13,675	6.8%	42,145	8.1%
Total	114,465	100.0%	572,003	100.0%	285,465	100.0%	534,543	100.0%

The largest percentages of racial minorities shown in Table 3 (e.g., 4.3% for the study area) are for Other Race, or Combined Races, which encompass several responses from the Census form. Additionally, Native Americans (ranging from 0.1% to 0.8% in the 30 Census tracts) and Hawaiian/Pacific Islanders (typically 0.1%) were so few in the study area that they have also been reported in this category. The next most prevalent racial minority group in the C-470 area was Asian, at 3.4%. African-Americans accounted for 1.2%. More detail is available in Appendix A to this Technical Report.

The percentages reported in Table 3 are aggregated for the entire study area of approximately 26 square miles (e.g., 13 miles long and two miles wide), which includes 30 separate Census tracts. Upon further examination, racial minority populations were slightly higher (9.5%) for the 13 tracts that are adjacent to C-470 as compared to the 17 tracts that are not immediately adjacent to the highway (8.4%).

Two Census tracts in Douglas County exhibited racial minority percentages that were notably higher than the study area averages, as detailed in Table 4. Both of these Census tracts are located at the extreme eastern end of the study area.

Table 4
Racial Composition in Selected Census Tracts

Reported Race	Study Area		Douglas County		Douglas County Census Tract 140.07		Douglas County Census Tract 141.16	
	Persons	% of Total	Persons	% of Total	Persons	% of Total	Persons	% of Total
White	104,309	91.1%	257,598	88.2%	1,964	81.5%	3,703	83.4%
Asian	3,937	3.4%	10,716	3.8%	191	7.9%	426	9.6%
African-American	1,346	1.2%	3,476	1.2%	90	3.7%	108	2.4%
Other Race, or Combined Races	4,873	4.3%	13,675	6.8%	165	6.9%	203	4.6%
Total	114,465	100.0%	285,465	100.0%	2,410	100.0%	4,440	100.0%

(Census, 2010)

Douglas County Census Tract 140.07 is located south of C-470 and east of Interstate 25, just beyond the eastern limit of construction for proposed C-470 improvements. This is the easternmost tract that is highlighted in a red oval in Figure 1, presented previously. Of the 30 Census tracts examined, this one had the highest total racial minority percentage (18.5%), a level that is comparable to the statewide average of 18.3% (in a corridor otherwise at 8.9%, or about half the statewide average). This tract also had the highest percentages for the categories of African-American (3.7%) and the "two or more races" (3.8%) Census response, and the second highest percentage for Asian races (7.9%).

Immediately west of the tract discussed above, Douglas County Census Tract 141.16 extends both north and south of C-470 between Yosemite Avenue and Interstate 25, and from County Line Road to Lincoln Avenue. Out of all 30 Census tracts examined, this one had the highest percentage (9.6%) for persons of Asian races. This number is well above the percentages for the State of Colorado (2.8%), Douglas County (3.8%), and the C-470 study area (3.4%) overall. According to the Census Bureau, about 250 people from the country of India account for more than half of the Asian population in Census Tract 141.16. Upon closer examination at the block group level, the Asian population is concentrated in Block Group 3, which abuts Interstate 25.

2.1.2 Hispanic Ethnicity

Only 6.9% of the study area's residents characterized themselves as Hispanic or Latino in the 2010 Census. This was a smaller percentage than for the three surrounding counties (Douglas County 7.5%, Jefferson County 14.3%, Arapahoe County 18.4%). The numbers for the study area and surrounding counties are provided in Table 5.

In 2010, 6.9% of the population in the C-470 study area was Hispanic. This was about one third of the 20.4% Hispanic for the State of Colorado.

Table 5
Hispanic Ethnicity in the C-470 Study Area and Surrounding Counties

Ethnic Characteristic	Study Area		Arapahoe County		Douglas County		Jefferson County	
	Persons	% of Total	Persons	% of Total	Persons	% of Total	Persons	% of Total
Not Hispanic or Latino	106,622	93.1%	466,481	81.6%	264,073	92.5%	458,098	85.7%
Hispanic or Latino	7,843	6.9%	105,522	18.4%	21,392	7.5%	76,445	14.3%
Total	114,465	100.0%	572,003	100.0%	285,465	100.0%	534,543	100.0%

(Census, 2010)

Examination of the 30 Census tracts comprising the study area found percentages of Hispanic residents ranging from 3.3% to 11.1%. The highest percentage was found in Jefferson County Census Tract 120.60, at the western end of the study area. It is located immediately east of Kipling Parkway and north of Chatfield Avenue, beginning about a half mile north of C-470.

The second-highest Hispanic ethnicity percentage, 10.7%, was reported in Douglas County Census Tract 140.7 (described earlier), east of Interstate 25, which was the tract with the highest percentage of racial minorities.

2.1.3 Minority Population

To determine the total minority population under the US DOT definition, the number of white persons of Hispanic origin is added to the number of non-white persons of any ethnicity. This avoids double-counting persons who are both Latino and non-white as being minorities. Table 5 below presents the percentages of non-minority and minority populations in the C-470 study area and its surrounding counties.

In 2010, the minority population in the C-470 study area was 13.3%. This is well below the 50% threshold that is one of CEQ's definitions for a minority area.

The data in Table 6 indicate that the 13.3% minority population in the C-470 study area is lower than the percentage for Douglas County (14.8%), which in turn is significantly lower than that of Arapahoe and Jefferson counties.

Table 6
Minority Population in the C-470 Study Area and Surrounding Counties

Characteristic	Study Area		Arapahoe County		Douglas County		Jefferson County	
	Persons	% of Total	Persons	% of Total	Persons	% of Total	Persons	% of Total
Non-Minorities	99,190	86.7%	450,423	78.7%	243,297	85.2%	427,160	79.9%
Minorities	15,275	13.3%	121,580	21.3%	42,168	14.8%	107,383	20.1%
Total	114,465	100.0%	572,003	100.0%	285,465	100.0%	534,543	100.0%

(Census, 2010)

Among the 30 Census tracts in the C-470 study area, the minority population percentages range from a low of 7.4% to a high of 25.4%.The 25.4% figure corresponds to Douglas County Census Tract 140.07, which was previously identified as the tract with the highest racial minority percentage. As previously stated, Census Tract 140.07 is located south of C-470 and east of Interstate 25, beyond the eastern limit of construction for proposed C-470 improvements.

2.1.4 Households with Limited English Proficiency

Another population group examined in a NEPA analysis is persons with limited English proficiency (i.e., the inability of some residents to speak English very well). Inability to speak English well can hinder one's ability to participate effectively in public decision-making processes involving transportation projects or other proposed government actions.

Consideration of households with limited English proficiency is examined here in accordance with FHWA guidance and the CDOT NEPA Manual. Note that this topic focuses on households, rather than individuals, since an English-speaking adult in a household would have the ability to translate and communicate to the other residents. The lack of a capable English speaker in the household effectively isolates all persons living there.

A Census Bureau question addressing this issue asks whether or not the household includes anyone aged 14 or over who speaks English well. The latest available Census data for the C-470 study area, presented in Table 7, indicate that an estimated 668 households (1.5%) out of 45,954 have no adult who speaks English well. Of these 668, only about one third (0.5%) speak Spanish at home, and the remaining two-thirds include all other (non-English) languages combined. Spanish is the predominant language spoken in the households where there is a language barrier.

Table 7
Households Where "No One 14 and Over Speaks English Well"

Household Characteristic	Study Area		Arapahoe County		Douglas County		Jefferson County	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Total Households	45,954	100.0%	221,136	100.0%	100,795	100.0%	217,763	100.0%
Households with a language barrier	668	1.5%	12,647	5.7%	1,296	1.3%	3,478	1.6%
Of these, number where the spoken language is:								
• Spanish	217	0.5%	7,420	3.4%	415	0.4%	1,703	0.8%
• Other	451	1.0%	5,227	2.4%	881	0.9%	1,775	0.8%

(Census, 2010)

The C-470 study area's 1.5% of households with a language barrier is comparable to the percentages for Douglas County (1.3%) and Jefferson County (1.6%), but much lower than the 5.7% found in Arapahoe County.

Examining the study area in greater detail, the language barrier percentages for the 30 Census tracts ranges from zero to 3.6% for all tracts, except for a 5.8% value (all of them Spanish-speaking households) found in Jefferson County Census Tract 120.60. The Census Bureau estimates that 82 out of 1,415 households in this tract have a language barrier. This equates to one out of every 17 households in the area. As noted previously, this is the Census tract with the highest percentage of Hispanic population along the C-470 corridor, and is located a half mile north of C-470 at the western end of the study area.

The two block groups that comprise Jefferson County Census Tract 120.60 were examined and it was determined that this Spanish-speaking population is located primarily in Block Group 1, a neighborhood called Dakota Station. This block group is bounded by Kipling Parkway on the west, Garrison Street to the east, Chatfield Avenue on the south, and Ken Caryl Avenue.

2.2 LOW-INCOME POPULATIONS

As with minority populations, low-income populations can be spread throughout the community study area, but there may be a concentrated area that has a significantly higher percentage of low-income population than the county or metro area average. Thus, the approach is identifying low-income populations is a two-stage process beginning with Census data review and continuing with more detailed examination where appropriate.

2.2.1 Census Income Data

Low-income populations were determined in accordance with the CDOT NEPA Manual. County Census data and county-specific income data from the U.S. Department of Housing and Urban Development (HUD) are used to determine the areas for low-income populations. Specifically, the HUD data identify the income level that is 30 percent of median income for the county (HUD, 2013).

Douglas County is the 7th wealthiest county in the United States, with a median household income of about $100,000 per year. (Forbes, 2013)

Following the procedures in the CDOT NEPA Manual, the annual household incomes for the average household size in the three counties were determined as follows:

- Arapahoe County $19,946, based on average household size of 2.53 persons
- Douglas County $20,557, based on average household size of 2.79 persons
- Jefferson County $19, 687, based on average household size of 2.42 persons

Household income data are available from the Census Bureau for income thresholds in increments of $5,000. The dataset used was the American Community Survey 5-year estimates for 2007-2011 (Census, 2011). Using the data for households with $20,000 income thus closely and conservatively approximates the low-income household percentages for Arapahoe County and Jefferson County, “erring” on the side of including a small number of households above the target threshold. For Douglas County, however, using the $20,000 threshold would slightly underestimate the number of low-income households while using the $25,000 would result in a substantial overestimate. The Douglas County issue affects the project corridor percentage because 14 (almost half) of the 30 Census tracts in the analysis are in that county.

Table 8 presents the result of the calculations for percentages of low-income households. Somewhere in the range of 5.9% to 6.9% of households in the study area are low-income; the number is probably 6.0 or 6.1%. This compares with about 5 percent for Douglas County, 11.2% for Jefferson County, and 14.2% for Arapahoe County.

Table 8
Low-Income Households in the Study Area and Surrounding Counties

Household Characteristics	Study Area	Arapahoe County	Douglas County	Jefferson County
Total Households	45,954	221,136	100,795	217,763
Low-Income Households*	2,700 to 3,152	30,965	4,713 to 6,363	24,371
Low Income Households as a Percentage of Total Households	5.9% to 6.9%	14.2%	4.7% to 6.3%	11.2%

* Douglas County range covers annual household incomes of $20,000 (slight underestimate of low-income households) and $25,000 (major overestimate of low-income households), as the county's threshold figure is $20,557. This results in a range for the study area total also.
(Census, 2010; HUD, 2013)

Examination of the 30 individual Census tracts that comprise the C-470 study area determined that three census tracts had low-income household percentages of 12 percent or more (i.e., about twice the average for the C-470 corridor). These are:

- 14.8% in Arapahoe County Census Tract 56.34
- 13.4% in Jefferson County Census Tract 120.60
- 12.7% in Douglas County Census Tract 140.07

Arapahoe County Census Tract 56.34 is the locale of the Wolhurst mobile home community, with its more than 300 residences for persons age 55 or older. This community is located at the northwestern quadrant of the interchange of C-470 and Santa Fe Drive. Wolhurst was identified as a key low-income community of concern in the 2006 C-470 EA, based on detailed analysis and extensive community outreach. The 2006 C-470 EA included provision of a southbound-to-eastbound flyover ramp at the interchange, with a wide range of impacts to the Wolhurst Community. That interchange improvement subsequently underwent a separate environmental clearance process and has been constructed, and appropriate mitigation was implemented. Extensive details regarding Wolhurst were provided in the approved 2006 C-470 EA but are not necessary in this Revised EA because the Proposed Action in this revised EA does not include major improvements at the C-470/Santa Fe interchange.

Jefferson County Census Tract 120.60 was mentioned above as the location of the study area's highest percentage of Hispanic persons, located immediately east of Kipling Parkway and north of Chatfield Avenue, a mile north of C-470.

Douglas County Census Tract 140.07 was identified above as the tract with the highest concentration of racial minorities and total minorities, located south of C-470 and east of Interstate 25, beyond the eastern limit of construction for proposed C-470 improvements.

2.2.2 School Lunch Subsidy Data

As additional analysis of low-income indicators, the 2006 C-470 EA reviewed Internet-available statistics on the number of students eligible to receive a government-subsidized free or reduced-price lunch at schools within the C-470 study area. Each year, parents fill out an eligibility form to qualify for federal reduced or free lunch programs. To qualify for subsidized school lunch, a household must make 185 percent or less of the Federal Poverty Guideline. To qualify for free lunch, a household must make 130 percent or less of the Federal Poverty Guideline. Subsidy eligibility data are found on the National Center for Education Statistics website (NCES, 2013) and were reviewed to obtain information for the most recently available school year, which was 2010-2011.

Notwithstanding the income threshold noted above, the current application form for school lunch subsidies states that children from households receiving benefits from the Supplemental Nutrition Assistance Program (SNAP) are automatically eligible for free lunches "regardless of your income" (USDA, 2013a). The number of households receiving SNAP (formerly called Food Stamps) nationwide more than doubled between Fiscal Year (FY) 2003 and FY 2011 (USDA, 2013b), while the number in Colorado nearly doubled between FY 2008 and FY 2011 alone (USDA, 2013c).

The previous analysis reported statistics for the 2002-2003 school year for 13 area schools. The free lunch threshold was an income of $22,945, and the threshold for a reduced price lunch was $32,650. The corresponding levels for the most recent available data (2010-2011 school year) are $29,055 and $41,348. These eligibility levels are far higher than the AMI30 income data used above in Section 2.2.1 to define and discuss low-income households.

Comparing the results of the two analysis years, the total enrollment at the same 13 schools was virtually unchanged. The previous total of 11,232 students had grown only to 11,259, a difference of only one-fourth of one percent. Over the same eight-year period, however, the number of students meeting the free lunch eligibility criterion went from 1.8% to 10.0%, and the number in the reduced-price category increased from 2.0% to 3.0%. Adding the two categories together, the percentage of students eligible for either subsidy previously ranged from 0.70% to 10.2% for the 13 schools, while the new range is 6.5% to 31.8%. For the 13 schools combined, total eligibility jumped from 427 students to 1,459 students.

The noticeable jump in lunch subsidy eligibility occurred at all 13 schools. The national eligibility criteria remained at 130% and 185% of the Federal Poverty Guideline, although that guideline did increase from $17,650 to $23,350, an increase of nearly 27%. Total eligibility nationwide increased by 28.7% for the same eight-year period, from 16.4 million to 21.1 million students, according to the U.S. Department of Agriculture. This nationwide increase is far smaller than the 250% free lunch eligibility increase reflected in the 13 study area schools.

For each analysis year, the same school had by far the highest eligibility percentage. This was the Columbine Hills Elementary School at 6005 West Canyon Avenue in Littleton. The increase in school lunch eligibility at Columbine Elementary School from 52 out of 512 students in FY 2003 to 138 out of 433 students in FY2011 is due to program eligibility changes (i.e., pertaining to increased use of SNAP/Food Stamps), rather than being indicative of a major change in neighborhood demographics.

Columbine Elementary School in Littleton is located within Jefferson County Census Tract 120.55, and specifically within Block Group 1. This Census tract reportedly has a percentage of low-income households (6.5%) that exceeds the average for its county (6.2%), but only by a small margin. This area was not identified as a low-income area in the 2006 EA, and the newer data do not appear to warrant calling it that in 2014 either.

2.2.3 Other Income Indicators

The 2006 C-470 EA examined each Census block group that had a higher percentage of AMI30 households than its surrounding county. In addition to the block group containing the Wolhurst community, a total of nine block groups were investigated, including only one that has been discussed above (Douglas County Census Tract 141.07, specifically Block Group 1), five in the Highlands Ranch subdivision of Douglas County, and three in Jefferson County. None of these correspond with any subarea specifically discussed above in this 2014 environmental justice analysis. Site inspections were made in each of these block groups to see if there was visually apparent evidence of low-income households.

The 2006 EA also included telephone calls to local public housing administrators to inquire about localized availability of federally-subsidized Section 8 housing. It was determined that there was minimal subsidized housing in the area. Three apartment complexes near C-470 reported offering tax credits for low-income residents, but further examination led to the conclusion that these apartment complexes are not considered low-income populations.

The 2006 EA concluded that no subarea along the corridor merited further consideration as a low-income or minority area of concern except for the Wolhurst Community. As noted earlier, the C-470 Preferred Alternative in the 2006 EA included flyover ramp construction at the C-470/Santa Fe interchange, directly impacting the Wolhurst mobile home community. That construction project has since been completed and the Revised EA includes no similar component directly affecting that community.

Based on the outcome that additional indicators and site inspection revealed no other low-income populations in the previous analysis, additional indicators were not researched further for this Revised EA.

2.3 CONCLUSIONS REGARDING ENVIRONMENTAL JUSTICE POPULATIONS

It is concluded in this Revised EA, as in the 2006 C-470 EA, that the Wolhurst mobile home community on South Santa Fe Drive at C-470 is a low-income population for purposes of assessing environmental justice impacts. This neighborhood has the highest percentage of low-income households of any along the C-470 corridor, at more than double the corridor average and also higher than its surrounding county.

For the 2014 Revised EA, a second subarea is being deemed suitable for consideration of environmental justice impacts. Section 2.2.1 above cited the alternative threshold for a minority area where the minority population of an affected area is “meaningfully greater than the minority population percentage of the surrounding geographic area.” Douglas County Census Tract 140.07 was mentioned repeatedly in the various sections of the environmental justice analysis, and is circled as a focus area in Figure 3. It appears to meet the CEQ criterion for “meaningfully greater than” because it has:

- The study area’s highest total minority population (25.4%), nearly double the study area average of 13.3%.
- The study area’s highest percentage of racial minorities (18.1%), nearly double the study average of 8.9%.
- The study area’s highest percentage of African-Americans (3.7%) and persons of two or more races, and second-highest percentage of Asians (7.9%).
- The study area’s second highest percentage of persons of Hispanic ethnicity (10.9%), about 50 percent higher than the study area average of 8.9%.
- The study area’s third-highest percentage of low-income households (12.7%), more than double the study area average (approximately 6%).

The same area was carefully considered in the 2006 EA and determined not to be an area of concern. The 2006 C-470 EA described Block Group 1, which it referred to as ID #34, as follows:

> This census block group, located immediately east of I-25 and south of C-470/ E-470 is generally made up of office and commercial uses as part of the Meridian development, and one luxury apartment complex along Lincoln Avenue. Further east on Lincoln Avenue, the landscape becomes suburban, with large lot single-family residential development known as Grandview Estates. Many of these homes have horses on property. CDOT, 2005)

Racial and ethnic composition, rather than household income, is the reason for making a different judgment call in 2014. For the 2014 Revised EA, it appears reasonable to consider Census Tract 140.07 a minority population area.

Finally, considered but <u>not</u> selected as an area of potential environmental justice impacts was Jefferson County Census Tract 120.60. While it had the highest percentage of Hispanics (11.1%), this is little more than half the Colorado statewide average of 20.4%. More importantly, the total percentage of racial and ethnic minorities in this area was only 15.9%, not meaningfully higher than the study area (13.3%) and well below the percentage for its surrounding county (20.1%). The 82 Spanish-speaking households with a language barrier in this Census tract are not an environmental justice issue under Executive Order 12898, but rather a factor to be taken into account in the further public outreach activities for the Proposed Action under Executive Order 13166.

Jefferson County Census Tract 120.60 had the second highest percentage of low-income households (13.4%), a number twice the study area average, but not meaningfully above the Jefferson County average (11.2%). It should be kept in mind that the study area average is dominated by Douglas County, the seventh richest county in the United States. Finally, unlike the two other census tracts discussed above, this tract beginning a half mile north of the freeway does not include or abut C-470, so would not be directly affected by the Proposed Action. It is concluded that this Census tract is not a low-income area for the purposes of environmental justice analysis.

3.0 ENVIRONMENTAL CONSEQUENCES

Environmental consequences or impacts, as they pertain to the populations subject to the Environmental Justice guidelines, were evaluated as part of the C-470 EA. The impacts were considered with regard to their context and intensity.

3.1 NO-ACTION ALTERNATIVE

The only improvements included in this alternative are those projects with dedicated funding, included as municipal Capital Improvement Plans or DRCOG's MetroVision 2035 Regional Transportation Plan (RTP). As such, the Wolhurst Community and Douglas County Census Tract 141.07 east of I-25 would not receive any impacts other than those that will occur over time as a result of increased congestion on C-470, and the resulting increased noise and air quality effects of that congestion.

3.2 PROPOSED ACTION

The Proposed Action would widen C-470 to add two tolled lanes in each direction, and to add auxiliary lanes where needed, associated with minimal on-ramp and off-ramp modifications. It would not provide any new access to C-470 as was previously proposed in the 2006 EA. Also, advance signage would be needed at either end of the project (including on the north-south I-25 freeway) to alert approaching motorists that they need to decide whether to get into the free lanes or the toll lanes.

3.2.1 Land Acquisition

A small amount of land will need to be acquired from land abutting the existing C-470 right-of-way. Over the entire 13-mile corridor (with 26 miles of adjacent property lines), the 2006 EA estimated that only 20.25 acres of additional land would need to be acquired. Some of this land was needed for the C-470/Santa Fe flyover ramp that has already been constructed. The Proposed Action for the Revised EA will require an estimated 40 acres, most of it necessary to accommodate roadside water quality detention basins. All land needed is vacant with no buildings to be acquired. Thus, there would be no need to relocate any business or residence.

3.2.2 Traffic Flow and Toll Costs

The Proposed Action is being undertaken specifically to improve C-470 traffic flow, compared with a worsening of current congestion as expected with the No-Action Alternative. The addition of four tolled lanes on C-470 will increase the highway's traffic-carrying capacity. Improved traffic flow on C-470 would benefit all users of the highway, whether they choose to use the express lanes or not. Those paying the toll would receive the benefit of higher travel speeds and improved travel time reliability. They would not choose to pay the toll unless they received improved traffic flow in return.

Those choosing to use the free lanes would face more congested conditions and slower travel speeds, but these conditions would be better than the extreme congestion of the No-Action Alternative.

Low-income populations such as the Wolhurst Community or the residents of Douglas County southeast of the C-470/I-25 interchange would have the choice of using the free lanes or the toll lanes, just like any other C-470 motorist. Based on their economic limitations, they are likely to choose to use the free lanes, along with a large number of middle-income and high-income motorists. Theoretically, the free lanes will always carry more vehicles than the express lanes, due to the toll. This means that over 50% of C-470's motorists will be in the free lanes. Since low-income households account for just 6% of the study area population, low-income motorists will always be sharing the free lanes with a much larger number of middle-income and high-income motorists. All users of the free lanes will benefit from improved traffic flow as noted above.

I-25 and Santa Fe Drive (US Highway 85) are major north-south routes that intersect C-470. Ingress and egress for the managed express lanes will definitely be located in a manner that maximizes convenience for I-25 motorists and Santa Fe motorists. Thus, express lane access will be conveniently available to residents of both identified areas of low-income populations, although they may choose not to take advantage of this convenient access.

Work trips during congested peak period conditions are considered to be a key element of the overall demand for express lane use. The Wolhurst Community is home to adults aged 55 or older, many of whom are retired and would not normally use C-470 for peak-period commuter trips. According to the 2010 Census, the percentage of the population in Arapahoe County Census Tract 56.34 that is over age 55 was 54.2%. This is more than twice the study area average of 24.4%, and is much higher than the Census tract with the next highest percentage (34.3%).

The environmental justice analysis for another toll lane project in the Denver area (the U.S. 36 Environmental Impact Statement) included the following information about toll lane use by various income groups, as follows:

> "Various studies of tolled express lane projects (I-15 in San Diego County, California; State Route 91 in Orange County, California; and the Quick Ride Program on I-10 in Houston, Texas) have focused on the use of express lanes by low-income populations. The evaluations found that low-income drivers use the express lanes and approve of these lanes as much as higher-income drivers. The majority of SOV [single occupant vehicle] commuters, even those from higher-income households, do not use the tolled lanes for every trip." (CDOT, 2009).

An important consideration for low-income users of a tolled facility is any requirement to prepay for the use, or the need for the user to have a credit card. Toll collection based on license plate recognition and billing allows users to pay after using the toll road, rather than paying in advance. Typically, however, toll road authorities charge additional costs (e.g. 25% higher) for license plate billing, as compared with prepayment and the use of electronic transponders.

The U.S. 36 EIS stated the following regarding this transponder issue:

> "Transponders are free, but an account must be set up with a reserve balance to pay for each use. Studies show that methods for electronic toll collection should be considered and arrangements should be provided for individuals who may not have a credit card. Tolling programs should consider not excluding low-income drivers because of requiring upfront expenditures or requiring computers or credit cards for enrollment. For example, access to transponders could be a problem for some individuals if one needs either a credit card or lump sum deposit to open an account. In the future, technology changes, such as License Plate Tolling, currently being implemented on E-470, would provide options for low-income drivers that would not require setting up an account."

As of 2015, specific toll costs and toll collection policies for the C-470 managed express lanes have not been finalized, but it is expected that both transponders and license plate photo billing options will both be in use as part of the C-470 Proposed Action.

3.2.3 Air Quality

The Air Quality Technical Report for the Revised EA examines predicted future conditions for the Proposed Action and concludes that the project would not cause nor contribute to a violation of any national ambient air quality standard. The 2006 EA included microscale-level carbon monoxide concentration modeling for Santa Fe Drive at County Line Road, at the entrance to the Wolhurst Community, and concluded that no air quality problems were foreseen there. Traffic flow has improved at that location with the opening of a southbound to eastbound flyover ramp in 2011.

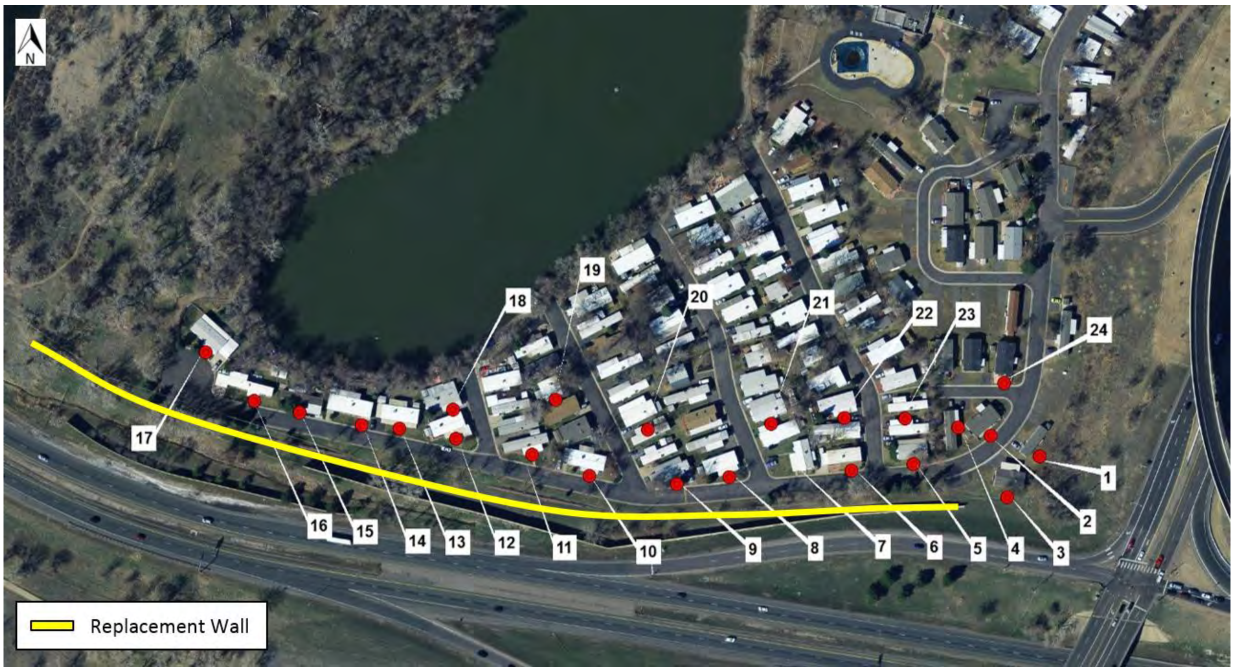
C-470 carries minimal heavy truck traffic, compared with all other freeways in the Denver Region (CDOT, 2013). Adding toll lanes would not be likely to attract additional heavy truck traffic to the corridor, as the proposed pricing plans would attempt to discourage use of these lanes by heavy trucks. Diesel trucks produce more of some emission types (particulate matter, mobile source air toxics) than do passenger cars and pickup trucks.

3.2.4 Highway Noise

As a result of the proposed highway widening, highway noise levels on C-470 are expected to increase. The number of traffic lanes would increase, the number of vehicles on the highway would increase, and the highway widening would expand the traveled roadway surface outward, closer to adjacent land uses.

In the case of the Wolhurst Community, there already is an existing noise wall along the westbound on-ramp to C-470. In this particular location, the 2006 EA did not predict a new noise impact needing to be addressed, but the roadway design would necessitate removing and replacing the existing noise wall. The replacement wall is expected to be slightly higher and longer than the existing wall. The 2006 EA estimated its dimensions to be 1,550 feet long and 20 feet high for the Express Lanes Alternative, which is similar to the 2015 Proposed Action. When the engineering designs are developed, the appropriate length and height of the replacement wall will be finalized, along with decisions regarding its aesthetic details. The dimensions will be adjusted as appropriate in response to the latest available noise modeling for this location. Figure 4 below, excerpted and adapted from the 2006 EA Noise Technical Report (Figure 4-7), depicts the conceptual dimensions and location for the replacement wall.

Figure 4
Conceptual Size and Location for Wolhurst Community Replacement Noise Wall



The numbered boxes on this graphic indicate residences or other specific land uses where predicted noise levels were predicted, referred to as modeled noise receptors. The yellow line depicts a recommended single, continuous noise barrier approximately 1,500 feet long and 15.5 feet tall, to replace the existing noise barriers at this location.

The 2006 C-470 EA did not identify any noise impacts affecting Douglas County Census Tract 141.07, southeast of the I-25/C-470 interchange.

4.0 MITIGATION

The 2015 Proposed Action would not have any impacts to the Wolhurst low-income population or the Douglas County Census Tract 141.07 minority population, and therefore no mitigation is planned. The replacement of the existing Wolhurst noise wall would occur due to construction constraints, rather than in response to any new foreseen noise impact. Replacing the existing wall with a longer higher wall that addresses foreseeable C-470 noise levels would be done regardless of whether or not the Wolhurst Community was considered a low-income area. CDOT will coordinate closely with the Wolhurst Community in the design of the replacement noise wall, continuing its outreach that has been ongoing now for approximately nine years.

In recognition of the identified cluster of households with limited English proficiency in the Dakota Station neighborhood a half mile north of C-470 and east of Kipling, CDOT will prepare outreach materials in Spanish to distribute or post in that neighborhood in advance of the Public Hearing for the Revised EA. CDOT routinely publicizes the availability of resources to accommodate Spanish speakers at public hearings.

5.0 PUBLIC OUTREACH

CDOT undertook an extensive public involvement program for the 2006 C-470 EA, which is the basis for much of the content in the Revised EA. The previous effort identified no minority populations meeting FHWA and CEQ minority thresholds in the study area, and determined that the Wolhurst Community was the only distinct low-income population along the corridor. Two major efforts at public outreach have been undertaken since 2006 – the process for developing the Santa Fe/C-470 flyover ramp and the C-470 Coalition's multi-year campaign to refine the preferred alternative (Express Lanes) from the 2006 EA into the 2015 Proposed Action which now has unanimous support from all of the affected county and local governments in the corridor.

Development of the Santa Fe/C-470 flyover ramp involved continuing close coordination with the Wolhurst Community, throughout project design and construction. This level of outreach would have been undertaken regardless of whether or not Wolhurst was a low-income area.

In the most recent public outreach effort, CDOT has participated as a member of the C-470 Corridor Coalition. This organization was formed in 2011 to provide a forum for local governments, business organizations and citizens to consider funding options and ultimately reach consensus on a plan to pay for improving the corridor from I-25 to I-70. The Proposed Action between I-25 and Kipling Parkway is considered the first implementable portion of the Coalition's long-term vision.

An innovative outreach technique used by the C-470 Corridor Coalition in summer 2012 a series of Telephone Town Hall meetings. Over 200,000 telephone calls were made to invite residents in the C-470 area to participate in the telephone meetings with elected officials.

Additionally, the C-470 Corridor Coalition conducted four Public Open House Meetings in August and September 2012, at locations along the corridor, and made outreach presentations to meetings of the Highlands Ranch Community Association (an organization of delegates from 95 different homeowners' associations in the area) and the Roxborough Park Home Owners Association. These were publicized meetings intended to obtain public input on various funding options. One of these options was to implement Managed Express Lanes. Under this option, users of the facility would pay for it rather than the cost being shared by the local public as a whole.

Further public outreach will occur in the form of a Public Hearing regarding the Revised EA, as noted above. If this process eventually leads to implementation of the Proposed Action, CDOT and/or its contractor will again closely coordinate with the Wolhurst Community regarding the planned replacement of the existing C-470 noise wall along the southern side of that neighborhood.

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APPENDIX A – DETAILED DATA TABLES

The following pages contain detailed data tables as follows:

Table A-1. Racial Populations from 2010 Census

Table A-2. Hispanic Ethnicity from 2010 Census

Table A-3. Total Minorities from 2010 Census

Table A-4. Linguistically Isolated Households from American Community Survey

Table A-5. Low-Income Households

Table A-6. Subsidized Lunch Eligibility for 13 Area Schools, FY 2003 and FY 2011 From U.S. Department of Education, National Center for Education Statistics (NCES)

Table A-1
Racial Populations from 2010 Census (continued on next page)

County	Tracts that Abut or Include C-470	Popu-lation	White	Per-cent	Asian	Per-cent	African Amer.	Per-cent	Other or Combi-nations	Per-cent
Arap-ahoe	56.22	2,326	2,169	93.3%	54	2.3%	26	1.1%	77	3.3%
	56.34	2,959	2,818	95.2%	34	1.1%	30	1.0%	77	2.6%
Douglas	141.07	3,718	3,380	90.9%	118	3.2%	38	1.0%	182	4.9%
	141.10	5,233	4,626	88.4%	230	4.4%	123	2.4%	254	4.9%
	141.14	3,678	3,415	92.8%	77	2.1%	38	1.0%	148	4.0%
	141.16	4,440	3,703	83.4%	426	9.6%	108	2.4%	203	4.6%
	141.31	3,283	3,000	91.4%	137	4.2%	39	1.2%	107	3.3%
	141.38	2,902	2,484	85.6%	196	6.8%	69	2.4%	153	5.3%
	141.39	4,052	3,516	86.8%	318	7.8%	70	1.7%	148	3.7%
Jeffer-son	120.36	3,707	3,476	93.8%	93	2.5%	14	0.4%	124	3.3%
	120.53	3,794	3,555	93.7%	46	1.2%	22	0.6%	171	4.5%
	120.55	3,706	3,399	91.7%	73	2.0%	26	0.7%	208	5.6%
	120.57	5,705	5,256	92.1%	122	2.1%	37	0.6%	290	5.1%
Subtotals	13 Tracts	49,503	44,797	90.5%	1,924	3.9%	640	1.3%	2,142	4.3%

County	Tracts Farther from C-470	Popu-lation	White	Per-cent	Asian	Per-cent	African Amer.	Per-Cent	Other or Combi-nations	Per-Cent
Arapahoe	56.25	2,899	2,675	92.3%	65	2.2%	37	1.3%	122	4.2%
	56.30	5,322	4,941	92.8%	128	2.4%	52	1.0%	201	3.8%
	56.31	3,028	2,837	93.7%	61	2.0%	27	0.9%	103	3.4%
	56.32	3,189	2,977	93.4%	74	2.3%	29	0.9%	109	3.4%
	67.05	4,979	4,540	91.2%	179	3.6%	39	0.8%	221	4.4%
	67.08	1,748	1,670	95.5%	20	1.1%	17	1.0%	41	2.3%
Douglas	141.01	6,242	5,526	88.5%	182	2.9%	96	1.5%	438	7.0%
	141.07	2,410	1,964	81.5%	191	7.9%	90	3.7%	165	6.8%
	141.08	4,894	4,559	93.2%	105	2.1%	32	0.7%	198	4.0%
	141.09	2,259	2,119	93.8%	66	2.9%	13	0.6%	61	2.7%
	141.12	3,834	3,469	90.5%	157	4.15	60	1.6%	148	3.9%
	141.13	3,046	2,663	87.4%	208	6.8%	53	1.7%	122	4.0%
	141.15	4,249	3,750	88.3%	282	6.6%	47	1.1%	170	4.0%
Jeffer-son	120.24	4,988	4,727	94.8%	82	1.6%	27	0.5%	152	3.0%
	120.35	5,294	5,058	95.5%	81	1.5%	22	0.4%	133	2.5%
	120.59	3,245	2,961	91.2%	79	2.4%	36	1.1%	169	5.2%
	120. 60	3,336	3,076	92.2%	53	1.6%	29	0.9%	178	5.3%
Subtotals	17 Tracts	45,545	59,512	91.6%	2,013	3.1%	706	1.1%	2,731	4.2%
	Arapahoe County Tracts (8)	26,450	24,627	93.1%	615	2.3%	257	1.0%	951	3.6%
	Douglas County Tracts (14)	54,240	48,174	88.8%	2,693	5.0%	876	1.6%	2,497	4.6%
	Jefferson County Tracts (8)	33,775	31,508	93.3%	629	1.9%	213	0.6%	1,425	4.2%
	Study Area Total (30 Tracts)	114,465	104,309	91.1%	3,927	3.4%	1,346	1.2%	4,873	4.3%
	All of Arapahoe County	572,003	415,910	72.7%	29,077	5.15	58,107	10.2%	68,909	12.0%
	All of Douglas County	285,465	257,598	90.2%	10,716	3.8%	3,476	1.2%	13,675	4.8%
	All of Jefferson County	534,543	472,694	88.4%	14,037	2.6%	5,667	1.1%	42,145	7.9%
	Three-County Total	1,392,011	1,146,202	82.3%	53,830	3.9%	67,250	4.8%	124,729	9.0%
	State of Colorado	5,029,196	4,089,202	81.3%	139,028	2.8%	201,737	4.0%	599,229	11.9%

Table A-1 (continued)
Racial Populations from 2010 Census (Detail for "Other or Combinations")

County	Tracts that Abut or Include C-470	Popu-lation	Native Amer-ican	Per-Cent	Pacific Island-er	Per-cent	Some Other Race	Per-cent	Two or More Races	Per-cent
Arap-ahoe	56.22	2,326	7	0.3%	0	0.0%	30	1.3%	40	1.7%
	56.34	2,959	14	0.5%	2	0.1%	25	0.8%	36	1.2%
Douglas	141.07	3,718	14	0.4%	0	0.0%	38	1.0%	130	3.5%
	141.10	5,233	14	0.3%	4	0.1%	107	2.0%	129	2.5%
	141.14	3,678	18	0.5%	0	0.0%	58	1.6%	72	2.0%
	141.16	4,440	8	0.2%	2	0.0%	82	1.8%	111	2.5%
	141.31	3,283	13	0.4%	1	0.0%	28	0.9%	65	2.0%
	141.38	2,902	14	0.5%	0	0.0%	54	1.9%	85	2.9%
	141.39	4,052	26	0.6%	0	0.0%	53	1.3%	69	1.7%
Jeffer-son	120.36	3,707	6	0.2%	1	0.0%	48	1.3%	69	1.9%
	120.53	3,794	25	0.7%	2	0.1%	58	1.5%	86	2.3%
	120.55	3,706	23	0.6%	2	0.1%	88	2.4%	95	2.6%
	120.57	5,705	24	0.4%	4	0.1%	98	1.7%	164	2.9%
Subtotals	13 Tracts	49,503	206	0.4%	18	0.0%	767	1.5%	1,151	2.3%

County	Tracts Farther from C-470	Popu-lation	Native Amer-ican	Per-Cent	Pacific Island-er	Per-cent	Some Other Race.	Per-Cent	Two or More Races	Per-cent
Arapahoe	56.25	2,899	10	0.3%	3	0.1%	28	1.0%	81	2.8%
	56.30	5,322	31	0.6%	3	0.1%	55	1.0%	112	2.1%
	56.31	3,028	10	0.3%	0	0.0%	35	1.2%	58	1.9%
	56.32	3,189	13	0.4%	1	0.0%	35	1.1%	60	1.9%
	67.05	4,979	6	0.1%	1	0.0%	55	1.1%	159	3.2%
	67.08	1,748	2	0.1%	0	0.0%	2	0.1%	37	2.1%
Douglas	141.01	6,242	49	0.8%	1	0.0%	164	2.6%	224	3.6%
	141.07	2,410	6	0.2%	3	0.1%	65	2.7%	91	3.8%
	141.08	4,894	6	0.1%	0	0.0%	75	1.5%	117	2.4%
	141.09	2,259	10	0.4%	0	0.0%	22	1.0%	29	1.3%
	141.12	3,834	9	0.2%	0	0.0%	46	1.2%	93	2.4%
	141.13	3,046	12	0.4%	2	0.1%	50	1.6%	58	1.9%
	141.15	4,249	15	0.4%	3	0.1%	57	1.3%	95	2.2%
Jefferson	120.24	4,988	17	0.3%	3	0.1%	29	0.6%	103	2.1%
	120.35	5,294	9	0.2%	3	0.1%	27	0.5%	94	1.8%
	120.59	3,245	19	0.6%	2	0.1%	77	2.4%	71	2.2%
	120. 60	3,336	14	0.4%	0	0.0%	63	1.9%	101	3.0%
Subtotals	17 Tracts	45,545	238	0.4%	25	0.0%	885	1.4%	1,583	2.4%
Arapahoe County Tracts (8)		26,450	93	0.4%	10	0.0%	265	1.0%	583	2.2%
Douglas County Tracts (14)		54,240	214	0.4%	16	0.0%	899	1.7%	1,368	2.5%
Jefferson County Tracts (8)		33,775	137	0.4%	17	0.1%	488	1.4%	783	2.3%
Study Area Total (30 Tracts)		114,465	444	0.4%	43	0.0%	1,652	1.4%	2,744	2.4%
All of Arapahoe County		572,003	4,963	0.9%	1,140	0.2%	39,048	1.0%	24,357	4.3%
All of Douglas County		285,465	1,183	0.4%	192	0.1%	4,894	1.7%	7,406	2.6%
All of Jefferson County		534,543	4,717	0.9%	457	0.1%	22,245	4.2%	14,546	2.7%
Three-County Total		1,392,011	10,863	0.8%	1,789	0.1%	66,187	4.8%	46,309	3.3%
State of Colorado		5,029,196	56,010	1.1%	6,623	0.1%	364,140	7.2%	172,456	3.4%

Table A-2
Hispanic Ethnicity from 2010 Census SF-1, Table P2

County	Tracts that Abut or Include C-470	Population	Hispanic or Latino	% Hispanic or Latino
Arapahoe	56.22	2,326	111	4.8%
	56.34	2,959	119	4.0%
Douglas	141.07	3,718	217	5.8%
	141.10	5,233	299	5.7%
	141.14	3,678	197	5.4%
	141.16	4,440	334	7.5%
	141.31	3,283	147	4.5%
	141.38	2,902	239	8.2%
	141.39	4,052	271	6.7%
Jefferson	120.36	3,707	231	6.2%
	120.53	3,794	359	9.5%
	120.55	3,706	357	9.6%
	120.57	5,705	493	8.6%
Subtotals	13 Tracts	49,503	3,374	6.8%

County	Tracts Farther from C-470	Population	Hispanic or Latino	% Hispanic or Latino
Arapahoe	56.25	2,899	229	7.9%
	56.30	5,322	315	5.9%
	56.31	3,028	192	6.3%
	56.32	3,189	207	6.5%
	67.05	4,979	284	5.7%
	67.08	1,748	58	3.3%
Douglas	141.01	6,242	661	10.6%
	141.07	2,410	259	10.7%
	141.08	4,894	338	6.9%
	141.09	2,259	115	5.1%
	141.12	3,834	261	6.8%
	141.13	3,046	135	4.4%
	141.15	4,249	201	4.7%
Jefferson	120.24	4,988	322	6.5%
	120.35	5,294	199	3.8%
	120.59	3,245	324	10.0%
	120. 60	3,336	369	11.1%
Subtotals	17 Tracts	45,545	3,242	7.1%
	Arapahoe County Tracts (8)	26,450	1,515	5.7%
	Douglas County Tracts (14)	54,240	3,674	6.8%
	Jefferson County Tracts (8)	33,775	2,654	7.9%
	Study Area Total (30 Tracts)	114,465	7,843	6.9%
	All of Arapahoe County	572,003	105,522	18.4%
	All of Douglas County	285,465	21,392	7.5%
	All of Jefferson County	534,543	76,445	14.3%
	Three-County Total	1,392,011	203,359	14.6%
	State of Colorado	5,029,196	1,038,687	20.7%

Table A-3
Total Minorities from 2010 Census SF-1, Table P2

County	Tracts that Abut or Include C-470	Population	White Alone Not Hispanic	All Others (Minority)	% Non-Minority	% Minority
Arapahoe	56.22	2,326	2,101	225	90.3%	9.7%
	56.34	2,959	2,741	218	92.6%	7.4%
Douglas	141.07	3,718	3,237	481	87.1%	12.9%
	141.10	5,233	4,464	769	85.3%	14.7%
	141.14	3,678	3,297	381	89.6%	10.4%
	141.16	4,440	3,478	962	78.3%	21.7%
	141.31	3,283	2,899	384	88.3%	11.7%
	141.38	2,902	2,316	586	79.8%	20.2%
	141.39	4,052	3,317	735	81.9%	18.1%
Jefferson	120.36	3,707	3,304	403	89.1%	10.9%
	120.53	3,794	3,296	498	86.9%	13.1%
	120.55	3,706	3,177	529	85.7%	14.3%
	120.57	5,705	4,926	779	86.3%	13.7%
Subtotals	17 Tracts	49,503	42,553	6,950	86.0%	14.0%

County	Tracts Farther from C-470	Population	White Alone Not Hispanic	All Others (Minority)	% Non-Minority	% Minority
Arapahoe	56.25	2,899	2,505	394	86.4%	13.6%
	56.30	5,322	4,727	595	88.8%	11.2%
	56.31	3,028	2,693	335	88.9%	11.1%
	56.32	3,189	2,819	370	88.4%	11.6%
	67.05	4,979	4,350	629	87.4%	12.6%
	67.08	1,748	1,622	126	92.8%	7.2%
Douglas	141.01	6,242	5,097	1,145	81.7%	18.3%
	141.07	2,410	1,799	611	74.6%	23.4%
	141.08	4,894	4,321	573	88.3%	11.7%
	141.09	2,259	2,044	215	90.5%	9.5%
	141.12	3,834	3,279	555	85.5%	14.5%
	141.13	3,046	2,584	462	84.8%	15.2%
	141.15	4,249	3,880	369	91.3%	
Jefferson	120.24	4,988	4,464	524	89.5%	10.5%
	120.35	5,294	4,903	391	92.6%	7.4%
	120.59	3,245	2,743	502	84.5%	15.5%
	120. 60	3,336	2,807	529	84.1%	15.9%
Subtotals	17 Tracts	45,545	56,637	8,325	87.2%	12.8%
	Arapahoe County Tracts (8)	26,450	23,558	2,892	89.1%	10.9%
	Douglas County Tracts (14)	54,240	46,012	8,228	84.8%	15.2%
	Jefferson County Tracts (8)	33,775	29,260	4,155	87.7%	12.3%
	Study Area Total (30 Tracts)	114,465	99,190	15,275	86.7%	13.3%
	All of Arapahoe County	572,003	450,423	121,580	78.7%	21.3%
	All of Douglas County	285,465	243,465	42,168	85.2%	14.8%
	All of Jefferson County	534,543	427,160	107,383	79.9%	20.1%
	Three-County Total	1,392,011	1,120,880	271,131	80.5%	19.5%
	State of Colorado	5,029,196	3,520,793	1,508,403	70.0%	30.0%

Table A-4
Linguistically Isolated Households from American Community Survey

County	Tracts that Abut or Include C-470	House-holds	Language Spoken at Home Spanish	Other	Total	Percentage of Households Spanish	Other	Total
Arapahoe	Tract 56.22	1,086	0	0	0	0.0%	0.0%	0.0%
	Tract 56.34	1,448	0	21	21	0.0%	1.5%	1.5%
Douglas	Tract 141.07	1,327	0	0	0	0.0%	0.0%	0.0%
	Tract 141.10	2,257	13	51	64	0.6%	2.3%	2.8%
	Tract 141.14	1,397	19	0	19	1.4%	0.0%	1.4%
	Tract 141.16	1,932	0	0	0	0.0%	0.0%	0.0%
	Tract 141.31	1,571	0	11	11	0.0%	0.7%	0.7%
	Tract 141.38	1,849	0	33	33	0.0%	1.8%	1.8%
	Tract 141.39	1,527	0	53	53	0.0%	3.5%	3.5%
Jefferson	Tract 120.36	1,374	0	0	0	0.0%	0.0%	0.0%
	Tract 120.53	1,439	8	0	8	0.6%	0.0%	0.6%
	Tract 120.55	1,578	0	0	0	0.0%	0.0%	0.0%
	Tract 120.57	2,562	11	77	88	0.4%	3.0%	3.4%
Subtotals	13 Tracts	20,261	51	246	297	0.2%	1.2%	1.4%

County	Tracts Farther from C-470	House-holds	Language Spoken at Home Spanish	Other	Total	Percentage of Households Spanish	Other	Total
Arapahoe	Tract 56.25	1,083	0	15	15	0.0%	1.4%	1.4%
	Tract 56.30	2,260	0	22	22	0.0%	1.0%	1.0%
	Tract 56.31	1,186	0	11	11	0.0%	0.9%	0.9%
	Tract 56.32	1,148	0	10	10	0.0%	0.9%	0.9%
	Tract 67.05	545	0	0	0	0.0%	0.0%	0.0%
	Tract 67.08	1,838	8	8	16	0.4%	0.4%	0.8%
Douglas	Tract 140.01	2,521	21	13	24	0.8%	0.5%	1.3%
	Tract 140.07	923	24	9	33	2.6%	1.0%	3.6%
	Tract 141.08	1,834	0	31	31	0.0%	1.7%	1.7%
	Tract 141.09	808	0	0	0	0.0%	0.0%	0.0%
	Tract 141.12	1,466	31	0	31	2.1%	0.0%	2.1%
	Tract 141.13	1,035	0	16	16	0.0%	1.5%	1.5%
	Tract 141.15	1,599	0	57	57	0.0%	3.6%	3.6%
Jefferson	Tract 120.24	1,932	0	13	13	0.0%	0.7%	0.7%
	Tract 120.35	1,839	0	0	0	0.0%	0.0%	0.0%
	Tract 120.59	1,175	0	0	0	0.0%	0.0%	0.0%
	Tract 120.60	1,415	82	0	82	5.8%	0.0%	5.8%
Subtotals	17 Tracts	18,385	166	205	371	0.7%	0.8%	1.5%
Arapahoe County Tracts (8)		10,594	8	87	95	0.1%	0.8%	0.9%
Douglas County Tracts (14)		22,046	108	274	382	0.5%	1.2%	1.7%
Jefferson County Tracts (8)		13,314	101	90	191	0.8%	0.7%	1.4%
Study Area (30 Tracts)		45,954	217	383	600	0.5%	0.8%	1.3%
All of Arapahoe County		221,136	7,420	5,227	12,647	3.4%	2.4%	5.7%
All of Douglas County		100,795	4,713	6,363	11,076	4.7%	6.3%	11.0%
All of Jefferson County		217,763	1,703	1,775	3,478	0.8%	0.8%	1.6%
Three-County Total		539,694	13,836	15,485	27,101	2.6%	2.9%	5.4%

Table A-5
Low-Income Households

County Threshold	Tracts that Abut or Include C-470	House-holds	Low-Income Households < $20,000	Low-Income Households < $25,000	% of Households < $20,000	% of Households < $25,000
Arapahoe	56.22	1,086	53	N/A	4.9%	N/A
$19,946	56.34	1,448	214	N/A	14.8%	N/A
Douglas	141.07	1,327	50	64	3.8%	4.8%
$20,557	141.10	2,257	91	203	4.0%	9.0%
	141.14	1,397	143	157	10.2%	11.2%
	141.16	1,932	143	196	7.4%	10.1%
	141.31	1,571	30	86	1.9%	5.5%
	141.38	1,849	147	188	8.0%	10.2%
	141.39	1,527	67	67	4.4%	4.4%
Jefferson	120.36	1,374	50	N/A	3.6%	N/A
$19,687	120.53	1,439	76	N/A	5.3%	N/A
	120.55	1,578	102	N/A	6.5%	N/A
	120.57	2,562	230	N/A	9.0%	N/A
Subtotals	13 Tracts	20,261	1,343	961	6.6%	4.7%

County Threshold	Tracts Farther from C-470	House-holds	Number with Income < $20,000	Number with Income < $25,000	% of Households < $20,000	% of Households < $25,000
Arapahoe	56.25	1,083	94	N/A	8.7%	N/A
$19,946	56.30	2,260	212	N/A	9.4%	N/A
	56.31	1,186	70	N/A	5.9%	N/A
	56.32	1,148	15	N/A	1.3%	N/A
	67.05	545	13	N/A	2.4%	N/A
	67.08	1,838	97	N/A	5.3%	N/A
Douglas	140.01	2,521	138	214	5.5%	8.5%
$20,557	140.07	923	117	141	12.7%	15.3%
	141.08	1,834	29	29	1.6%	1.6%
	141.09	808	57	57	7.1%	7.1%
	141.12	1,466	11	40	0.8%	2.7%
	141.13	1,035	34	34	3.3%	3.3%
	141.15	1,599	43	76	2.7%	4.8%
Jefferson	120.24	1,932	84	N/A	4.3%	N/A
$19,687	120.35	1,839	55	N/A	3.0%	N/A
	120.59	1,175	45	N/A	3.8%	N/A
	120.60	1,415	190	N/A	13.4%	N/A
Subtotals	17 Tracts	24,607	900	591	3.4%	2.4%
	Arapahoe County Tracts (8)	10,594	768	N/A	7.2%	N/A
	Douglas County Tracts (14)	22,046	1,100	1,552	5.0%	7.0%
	Jefferson County Tracts (8)	13,314	832	N/A	6.2%	N/A
	Study Area Total (30 Tracts)	45,954	2,700	3,152	5.9%	6.9%
	All of Arapahoe County	221,136	1,615	N/A	5.5%	N/A
	All of Douglas County (range)	100,795	4,713	6,363	4.7%	6.3%
	All of Jefferson County	217,763	24,371	N/A	11.2%	N/A
	Three-County Total (range)	539,694	30,699	32,349	8.8%	9.3%

Note: For Douglas County only, low-income households include those under $20,000 income plus a fraction of those in the next higher category (under $25,000).

Table A-6
Subsidized Lunch Eligibility for 13 Area Schools in the C-470 Study Area, FY 2003 and FY 2011

Source: U.S. Department of Education, National Center for Education Statistics

County	School	Enrolled Students	Students Eligible for Subsidy			% of Enrolled Students		
			Free	Reduced	Total	Free	Reduced	Total
Arapahoe	Powell Middle School	980	10	14	24	1.0%	1.4%	2.4%
Douglas	Acres Green Elementary	612	13	14	27	2.1%	2.3%	4.4%
	Chaparral High School	1,564	14	12	26	0.9%	0.8%	1.7%
	Cougar Run Elementary	643	10	8	18	1.6%	1.2%	2.8%
	Highlands Ranch H.S.	1,834	3	10	13	0.2%	0.5%	0.7%
	Northridge Elementary	623	16	13	29	2.6%	2.1%	4.7%
	Roxborough Elementary	692	13	10	23	1.9%	1.4%	3.3%
	Sand Creek Elementary	500	11	9	20	2.2%	1.8%	4.0%
Jefferson	Collegiate Charter Acad.	532	19	21	40	3.6%	2.9%	7.5%
	Columbine High School	1,795	36	49	75	2.0%	2.7%	4.7%
	Columbine Hills Elem.	512	23	29	52	4.5%	5.7%	10.2%
	Coronado Elementary	557	20	18	38	3.6%	3.2%	6.8%
	Mortensen Elementary	388	14	18	32	3.6%	4.6%	8.2%
	Totals for 2002-2003	11,232	202	225	417	1.8%	2.0%	3.7%

County	School	Enrolled Students	Students Eligible for Subsidy			% of Enrolled Students		
			Free	Reduced	Total	Free	Reduced	Total
Arapahoe	Powell Middle School	860	70	22	92	8.1%	2.6%	10.7%
Douglas	Acres Green Elementary	689	91	30	121	13.2%	4.4%	16.6%
	Chaparral High School	568	38	17	55	6.7%	3.0%	9.7%
	Cougar Run Elementary	2,077	132	46	178	6.4%	2.2%	8.6%
	Highlands Ranch H.S.	1,742	99	41	140	5.7%	2.3%	8.0%
	Northridge Elementary	713	62	17	79	8.7%	2.4%	11.1%
	Roxborough Elementary	448	22	7	29	4.9%	1.6%	6.5%
	Sand Creek Elementary	599	51	16	67	8.5%	2.7%	11.2%
Jefferson	Collegiate Charter Acad.	499	46	32	78	9.2%	6.4%	15.6%
	Columbine High School	1,622	240	50	290	14.8%	3.1%	17.9%
	Columbine Hills Elem.	433	117	21	138	27.0%	4.8%	31.8%
	Coronado Elementary	563	82	11	93	14.6%	2.0%	16.6%
	Mortensen Elementary	446	74	25	99	16.6%	5.6%	22.2%
	Totals for 2010-2011	11,259	1,124	335	1,459	10.0%	3.0%	13.0%
	Change, FY 2003 to FY 2011	27	922	110	1,042			
	% Change, FY 2003 to FY 2011	0.2%	456%	49%	250%			

Note: The 456% increase in free school lunch eligibility over an eight-year period may be due to structural changes in program eligibility, rather than reflecting rapid short-term demographic change in the study area. Eligibility increased at all 13 schools, not just in isolated locations. Also, the FY 2003 data reflect a relatively prosperous economic time, while the FY 2011 data reflect a time of slow recovery from a major national recession.

Geology Technical Report

For the C-470 Corridor Revised Environmental Assessment

January 2015

Submitted To:
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2015 UPDATE TO 2005 REPORT

> Following this introductory page, the entire contents of the report were prepared by Yeh & Associates in 2005.

This C-470 Revised Environmental Assessment (EA) Geology Technical Report examines geologic conditions, geologic hazards, and geological conditions that may limit or otherwise affect alignment choices for proposed improvements to Colorado State Highway C-470, between Kipling Parkway and Interstate 25, in the southwestern portion of the Denver metropolitan area. In 2013, CDOT and FHWA began evaluating impacts of a slightly revised Proposed Action in the same location as the alternative that was studied previously in the C-470 Environmental Assessment that was approved by these same agencies in 2006.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in Figure 1. CDOT and FHWA prepared the Revised EA for the 13.75-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users.

Figure 1. C-470 Corridor and Surrounding Vicinity

The Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications, although there would be minor ramp modification at C-470/Santa Fe Drive.

The conclusion by Yeh & Associates in their 2005 report, assumed to remain valid for this Revised EA, was that:

> *"The results of this analysis indicate the proposed alternatives will not significantly impact the construction along the C470 Corridor from Kipling Parkway to I-25."*

1.0 INTRODUCTION TO ANALYSIS

Information was gathered on geologic conditions, geologic hazards, and geologic factors that could potentially limit the proposed transportation alignment. While several geologic constraints have been identified along the corridor, no significant impacts to the geology, soils, or mineral resources are expected due to the proposed alternatives. Conditions that have been identified along the corridor that may require standard mitigation during construction include: expansive soils and bedrock, steeply dipping bedrock, corrosive soils, collapsible soils, and potentially unstable slopes.

Geology, soil, and mineral resources-related impacts that could be considered significant include the following:

- Topographic changes that lead to other adverse impacts (e.g., visual impacts or impacts on slope stability)
- Adverse affects on unique geologic or topographic features
- Exposing people or structures to major geologic hazards
- Causing substantial erosion or siltation
- Prevention of the recovery of significant mineral resources

The results of this analysis indicate the proposed alternatives will not significantly impact the construction along the C-470 Corridor from Kipling Parkway to I-25.

2.0 AFFECTED ENVIRONMENT

2.1 EXISTING CONDITIONS

The general geology, soils, and mineral resources encountered along the corridor are introduced in the following paragraphs. Then, specific conditions for the C-470 Corridor between Kipling Parkway and Interstate 25 are detailed in the next sections.

2.2 GEOLOGY

The geologic setting along the corridor includes bedrock and variable thicknesses of surficial deposits overlying bedrock (See Figures 2 through 7, Geology Map, at the end of this report). The study area lies within the Colorado Piedmont, along the southwestern flank of the Denver Basin. Sedimentary rock layers dip steeply from the flank of the Front Range eastward into the Denver Basin, then rise much more gradually up the eastern flank of the basin in eastern Colorado. The regional structure of the bedrock along the corridor predominantly strikes north-northwest and is slightly dipping to the northeast. The bedrock typically is hard and indurated while the surficial deposits are unconsolidated and in a looser condition. The bedrock within the corridor is all of sedimentary origin. These sedimentary rocks represent former environments and conditions that existed along the Front Range during the Cretaceous and early Tertiary geologic times. These environments include shallow inland seaways, near shore and terrestrial stream bed conditions. Overlying the bedrock formations are deposits of surficial material. These surficial deposits are the result of geomorphic activity that has shaped the present landforms and vary considerably in depth. This activity is primarily related to processes involving wind and water including former and modern streams and rivers. The surficial deposits are younger than the bedrock and are unconsolidated and loose by comparison. They are composed predominantly of boulders, cobbles, gravel, sand, silt, and clay deposited primarily by gravity (colluvium), streams (alluvium), wind (eolian sand and loess), or humans.

2.2.1 Surficial Units

Surficial geologic units along the corridor include artificial fill, colluvium, eolian sand, loess, and alluvium.

Artificial fill can be composed of various amounts of naturally occurring materials mixed with undocumented man-made materials such as concrete, brick, and trash. This unit includes highway and road fills, canal embankments, or trash dumps of various thicknesses. For construction, it is assumed that artificial fill is not suitable for use as backfill materials unless there are records of its content and placement. It will probably need to be removed and re-compacted to specified standards. At various locations along the corridor, the fill material ranges from the surface to approximately 10-15 feet deep.

Colluvial deposits typically consist of poorly sorted sandy gravel to silty clay on slopes adjacent to exposed alluvium and bedrock. Colluvial deposits may have low permeability and expansive clays, depending on site-specific soils. Generally, colluvium is less than 5 feet thick.

Eolian sands are wind-deposited materials that are generally very permeable with rapid surface drainage. Foundation stability is good under moderate static loads, but settling is common with heavy loads or vibrations. Eolian sand deposits have low swell potential and resistance to erosion is low on steep slopes and in cuts but moderate to high in flat areas because of high permeability.

Loess is wind-deposited material typically consisting of non-stratified fine sand and silt forming a mantle over bedrock and older alluvial surfaces. These materials are susceptible to hydro-compaction and to differential settlement. This unit can be found at many locations along the corridor and is generally 10 feet thick.

Alluvial stream-deposited materials within or adjacent to the corridor include the Post-Piney Creek Alluvium, Piney Creek Alluvium, Broadway Alluvium, Louviers Alluvium, and Slocum Alluvium. The oldest alluvial deposits lie several hundred feet above modern stream floodplains, while subsequent younger alluvial surfaces were cut at sequentially lower elevations, until modern floodplain levels were reached. Descriptions of the alluvial units from youngest to oldest follow. The Post-Piney Creek Alluvium is predominantly sand, silt, and clay with lenses of gravel that occurs in modern stream channels, floodplains, and alluvial fills. Generally it is 5 to 10 feet thick. The Piney Creek

Alluvium typically consists of interbedded sand, silt, and clay, with organic material near the surface and with gravel in lower portion. It is generally up to 20 feet thick. The Broadway Alluvium generally consists of fine sand and sandy silt forming terraces generally up to 25 feet thick. The Louviers Alluvium consists of gravelly sand with scattered boulders and gravelly channels. This deposit usually forms terraces approximately 25 feet thick. The Slocum Alluvium generally consists of sandy gravel, pebbly sand, pebbly clay, and silty gravel with scattered cobbles and boulders. This unit can be 15 to 20 feet thick (Lindvall 1980).

2.2.2 Bedrock Units

Four major bedrock geology units are encountered in the area of the corridor. The Dawson/Denver Formation consists of interbedded lenticular sandstone, claystone, siltstone, shale, and conglomerate that are brown to yellow-brown and gray to blue-gray. These units may up to 1000 feet thick and contain fossil leaves, dinosaur and mammal bones, and petrified wood. The Laramie Formation consists of interbedded gray to brown shale, siltstone, lignitic claystone, coal, and light gray to light brown sandstone. This formation can be up to 600 feet thick. The Fox Hills Sandstone contains greenish buff crossbedded sandstone in lower part grading upward to light yellow and white sandstone. This bedrock unit can be up to 300 feet thick. The Pierre Shale is primarily dark gray to brown clayey shale with some siltstone, silty sandstone, and limestone beds. The upper part of unit contains highly expansive claystone and siltstone as well as bentonite. It is generally up to 8,000 feet thick.

2.2.2 Geologic Units

A geologic hazard, as defined by Colorado House Bill 1041 (1974), is “a geologic phenomenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property.” Physical and/or chemical properties associated with the natural deposits, both bedrock and surficial, may impose risk or constraints to the corridor and the proposed improvements. Geologic hazards and engineering constraints along the corridor include expansive soil and bedrock, steeply dipping bedrock, corrosive soils, collapsing soil, and potentially unstable slopes.

Expansive soils and bedrock are widespread throughout the study area. The altered volcanic ash layers that are common in most bedrock units underlying the study area are composed primarily of swelling clay minerals. Soils that develop from and upon them tend to have elevated swell potential as well. Expansive soils and bedrock can repeatedly swell when wet and contract when dry, damaging man-made structures.

Steeply dipping bedrock units that contain layers with different swell potential occur west of the Wadsworth Interchange (See 21, Geology Map: Kl, Kfh, and Kp). This geologic hazard is distinguished from relatively flat-lying expansive bedrock hazards due to the differential movement that can occur associated with steeply dipping bedrock. Heaving bedrock and surficial deposits that have significant swell potential but are relatively flat-lying generally expand in fairly uniform directions.

On the other hand, steeply dipping bedrock that contains layers with different swell potential can cause extreme structural damage by either heaving or rebounding along individual bedrock layers and/or by asymmetrical thrust-like heaving along bedding planes or fractures (Noe 1997).

Corrosive soils underlay areas of the corridor. Most of the soils in the Denver Basin area potentially produce high concentrations of sulfate salts and therefore can corrode metals and concrete in moist conditions. The degree of the corrosion can be determined in the future geotechnical exploration and laboratory tests. Parts of the Dawson Arkose, Laramie Formation, Fox Hills Sandstone, and Pierre Shale are units near the surface that are prone to corrosive behavior (See Figures 2 to 6, Geology Map: TKda, Kl, Kfh, Kp).

Collapsing soils occur along the corridor in several surficial deposits. Upon inundation with water, these deposits undergo sudden changes in structural configuration with an accompanying decrease in volume that is expressed as settlement at the surface. Eolian sands, loess, and loose sands and silts are deposits near the surface that are prone to collapse (See Figures 2 to 6, Geology Map: Qes, Qol, and Qyl).

Potentially unstable slopes are defined as those slopes that in their current configuration are stable, but any modification to the slope through site grading, increase in water content, or erosion may cause the slope to become unstable and may initiate a slope failure. Identification of these slopes and their engineering characterization can be difficult. Grading cuts in the Laramie Formation and Pierre Shale, especially where overlain by alluvial terraces, should be individually analyzed for stability (See Figures 2to 6, Geology Map: Kl, Kp).

The site is considered to be in a seismically inactive area. There are no known active faults either on, or adjacent to the project site, so the potential for surface fault rupture is considered to be low. Faults within the corridor are believed to have been inactive for at least the last 45 million years. Seismic hazards at this site are, therefore, a consequence of ground shaking caused by events on distant, active faults. Based on a review of seismic data available from the United States Geological Survey (2003), the peak ground acceleration (PGA) with a 10% probability of exceedance in 50 years is approximately 0.02g at the site.

2.2.4 Mineral Resources

Mineral resources along the corridor are primarily aggregate resources near the Santa Fe Interchange. This includes aggregate recovery of sand and gravel from the Dawson/Denver Formation. In addition to the aggregate resources from the sedimentary units, sands and gravels have been produced from the current stream channels and older alluvial deposits near the corridor.

2.3 C-470 CORRIDOR

2.3.1 Existing Pavement Condition

The condition of the pavement along the C-470 between Kipling Parkway and I-25 was observed [in 2005]. The highway is constructed of concrete pavement over embankment cut or fill.

Due to the presence of expansive soils and rock in this area, we understand the upper 8 to 12 inches of subgrade beneath the pavement has been treated by sub-excavating, reconditioning the soil, and adding lime. Recently [in 2005], a two-inch asphalt overlay has been completed from Santa Fe to the Kipling.

Slab replacement, crack sealing, and area patches have been observed along the C-470 mainline area. The cracks appear to have resulted from a combination of localized consolidation and expensive soils or rock. We understand major repairs were conducted between Broadway and I-25 several years ago. Currently, three pavement distress areas were observed between Santa Fe Drive and Broadway, at University, and between Quebec and I-25. The conditions are summarized below.

2.3.1.1 Santa Fe Drive to Broadway

Pavement distress including heaving and cracking was found in a few isolated areas. It appeared that it was caused by expensive soils or rock.

2.3.1.2 University Interchange

Settlement and cracks were found on the westbound pavement near the east end of the bridge approach. This type of settlement could be a result of excessive wetting of the subgrade soils and improper compaction during construction.

2.3.1.3 Quebec to I-25 Interchange

Several transverse cracks and a depression were observed on the eastbound off-ramp at the Quebec Interchange. The cracks have been properly sealed and the depressed area has been patched. It does not appear that further pavement movement has occurred. We [Yeh & Associates] believe that most of the distressed pavement and subgrade soils have been stabilized. However, poor surface drainage around the distressed areas can cause severe roadway failure in the future. Extensive drainage improvement and major roadway repair are required.

2.3.2 Existing Geology and Geologic Hazards

2.3.2.1 Segment 1: Kipling Parkway to Santa Fe Drive

This segment is underlain by bedrock of the Laramie Formation, Fox Hills Sandstone and the Pierre Shale. These formations are overlain in places by alluvium, windblown sand, and loess. The alluvium is deposit from present day and former, higher river levels. There are several hazards and constraints associated with these geologic deposits, including expansive bedrock and soil, steeply dipping bedrock, corrosive soils, collapsing soils, and unstable slopes (See Figures 2 and 3).

2.3.2.2 Segment 2: Santa Fe Drive to Broadway
This segment is underlain by bedrock of the Dawson/Denver Formation. This formation is overlain in places by alluvium deposited from former, higher river levels and wind-deposited sand and loess. Geologic hazards and constraints associated with these soils (See Figure 4).

2.3.2.3 Segment 3: Broadway to I-25.
This segment is underlain by bedrock of the Dawson/Denver Formation. This formation is overlain in places by colluvium, wind-blown sand, loess, and alluvium. Geologic hazards and constraints associated with these geologic deposits include expansive bedrock and soils, corrosive soils and collapsing soils. Specific areas of high to very high swell potential (Hart 1974) along the alignment include the Highlands Ranch residential area (See Figures 5 and 6).

3.0 ENVIRONMENTAL CONSEQUENCES

3.1 METHODOLOGY FOR IMPACT EVALUATION

Geologic conditions present along the corridor were identified using information from geologic maps, topographic maps, United States Geological Survey reports, Colorado Geological Survey publications, United States Department of Agriculture soil survey reports, and geotechnical consulting reports. This information was supplemented with field reconnaissance, communications with local engineering and planning personnel. Evaluation of existing geologic conditions was based on proximity to the corridor, history of occurrence, and impact of occurrence on transportation and mobility.

3.2 FINDINGS

There is no clear distinction between direct impacts to geology, geologic hazards, soils, or mineral resources associated with the C470 Corridor under any of the proposed build alternatives. Any alternative except the No-Action Alternative will require crossing surficial and bedrock geology units that may require standard mitigation during construction. There are no indirect effects associated with the geology, geologic hazards, soil or mineral resources identified within the project area.

3.3 IMPACT EVALUATION

3.3.1 No-Action Alternative

The No-Action Alternative would not have any direct or indirect effects associated with the geology, geologic hazards, or mineral resources identified within the project area.

3.3.2 Build Alternative(s)

Both alternatives [from the 2006 C-470 Environmental assessment] were evaluated and considered to have the same impacts as follow. [2015 Note: The Proposed Action in the Revised EA is a managed express lanes configuration also adding four new lanes.]

Direct Impacts—Geologic conditions that have been identified along the corridor that may be directly impacted by the alternatives include: expansive soils and bedrock, corrosive soils, steeply dipping bedrock, collapsible soils, and potentially unstable slopes. None of these geologic conditions and aggregate resources along the corridor constitutes a significant impact that should alter the location of any of the proposed build alternatives.

Expansive soils and bedrock as well as corrosive soils may cause increasing damage to transportation system components over a period of years. Steeply dipping bedrock has locally demonstrated severe damage to pavement and transportation structures from differential movement. Collapsible soils can damage the system infrastructure by either large settlement areas or differential settlement. Unstable slopes can also cause failure at the cuts and fills area.

Indirect Impacts—There are no indirect effects associated with the geology, geologic hazards, soil or mineral resources identified within the project area.

Cumulative Impacts—There are no cumulative effects associated with the geology, geologic hazards, soil or mineral resources identified within the project area.

4.0 MITIGATION MEASURES

Conditions that have been identified along the corridor that may require standard mitigation during construction include: expansive soils and bedrock, corrosive soils, steeply dipping bedrock, collapsible soils, and potentially unstable slopes. Mitigation of the direct impacts can be mitigated through several standard techniques and should conform to the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction.

Expansive soils and bedrock as well as collapsible soils can be mitigated at structure locations by designing deep foundation systems, such as driven H-piles or drilled piers, rather than on shallow foundations. Foundation pads could also be designed to form a raft across any swelling or collapsing materials. Additionally, floating floor slabs can be designed instead of slab-on-grade construction. Structural Retaining walls, such as soil nail walls, ground anchors, mechanically stabilized earth (MSE) walls, cantilever walls, or reinforced soil slopes can be built to stabilize slopes when cut or fill slopes require steep gradients (3 horizontal: 1 vertical) or where potential slope failures may occur due to the presence of water and loose material.

Expansive subgrade soils under pavement sections can be stabilized with chemicals (lime), removed and re-compacted, or removed and replaced with imported structural fill of better quality. For planning purposes, preliminary evaluations indicate the corridor will require up to 4 feet of over-excavation, moisture treatment and re-compaction with up to 12-inch lime stabilization.

Collapsible subgrade materials under pavement sections can be mitigated by flooding, deep dynamic compaction, over-excavation prior to embankment placement, or additional loading with a thicker section of embankment material.

Steeply dipping bedrock areas require alternative practices such as over-excavation with re-fill and compaction to remove the conditions that perpetuate heaving. A barrier between the subgrade material and the pavement section could be constructed out of imported structural fill materials that range in thickness of 3 to 5 feet. Under structures, this depth of sub-excavation and replacement could be as much as 10 feet under the base of the shallow foundation footer.

The collection and diversion of surface drainage away from paved areas is critical to the satisfactory performance of pavement. Proper design of drainage should prevent ponding of water on or immediately adjacent to pavement areas. All landscape sprinkler heads and lines adjacent to pavement areas should be frequently checked for leaks and maintained in good working order. It is also imperative that surface and subsurface water conditions be addressed in the design of any retaining wall systems. Any design should consider diverting and controlling surface water around or away from the wall areas and the wall designs should incorporate an internal drainage system. Horizontal drains may increase slope stability by reducing the seepage and freezing pressure acting within fractures in rock and within zones of weakness in the soil. Slopes and other stripped areas should be protected against erosion by re-vegetation or other methods.

Stormwater Management Plans should be prepared and implemented. These plans prescribe best management practices (BMPs) to minimize potential soil erosion, and include prescriptions for monitoring of conditions before and after the completion of work (and for immediate post-restoration site stabilization). Measures that will be required are typical of erosion control procedures used in highway construction projects. The methods for controlling erosion will be as described in the Colorado Department of Transportation, Standard Specifications of Road and Bridge Construction, Section 208, Erosion Control.

The proposed mitigation measures are summarized in Table 1. In addition to designing the appropriate mitigation measures, proper maintenance of the new roadway segments is very important. Surface and underground drainages must be properly maintained to keep water flowing away from the roadway and not ponding.

Table 1
Proposed Mitigation Measures

Impact	Impact Type, Responsible Parties	Mitigation
Expansive Soils	Construction, Designer and/or Contractor	Installation of deep foundations systems, raft foundations, floating floor slabs.
Unstable Slopes		Design retaining walls, such as soil nail walls, ground anchor walls, MSE walls.
Expansive Subgrade Soils		Stabilize with lime treatment, remove and recompact, or remove and replace with imported fill material.
Collapsible Subgrade Soils		Stabilize by flooding, deep dynamic compaction, over-excavation, additional loading prior to construction.
Steeply Dipping Bedrock		Stabilize by over-excavation and replacement with imported fill materials.

5.0 SUMMARY/CONCLUSION

Based on the impact evaluation, the geologic resources will not be significantly impacted by the proposed alternatives along the C-470 Corridor from Kipling Parkway to I-25. However, geologic conditions that have been identified along the corridor that may be directly impacted by [C-470 widening alternatives] include: expansive soils and bedrock, corrosive soils, steeply dipping bedrock, collapsible soils, and unstable slopes. Specific mitigation measures have been proposed to alleviate the identified impacts along the C-470 Corridor.

6.0 REFERENCES

Bryant, B., Miller, R.D., Scott, G.R. 1973. Geologic Map of the Indian Hills Quadrangle, Jefferson County, Colorado: U.S. Geological Survey, GQ-1073, Scale 1:24,000.

Colorado Division of Water Resources, Well Permit Locator. http://165.127.86.125/website/lttools/index.asp?iw=450&ih=350

Hart, S.S. 1974. Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado: Colorado Geological Survey, Environmental Geology 7, Scale 1:100,000.

Lindvall, R.M. and Maberry, J.O. 1972. Geologic Map of the Parker Quadrangle, Douglas and Arapahoe Counties, Colorado: U.S. Geological Survey, I-770-A, Scale 1:24,000.

Lindvall, R.M. and Maberry, J.O. 1977. Geologic Map of the Highlands Ranch Quadrangle, Douglas and Arapahoe Counties, Colorado: U.S. Geological Survey, GQ-1413, Scale 1:24,000.

Scott, G. R.. 1962. Geologic Map of the Littleton Quadrangle, Jefferson, Douglas, and Arapahoe Counties, Colorado: U.S. Geological Survey, B1121-L, Scale 1:24,000.

Tweto, Ogden. 1979. Geologic Map of Colorado: United States Geological Survey and Colorado Geological Survey: Scale: 1:500,000.

Figure 2
Geology Map 1: Kipling Parkway to Wadsworth Boulevard

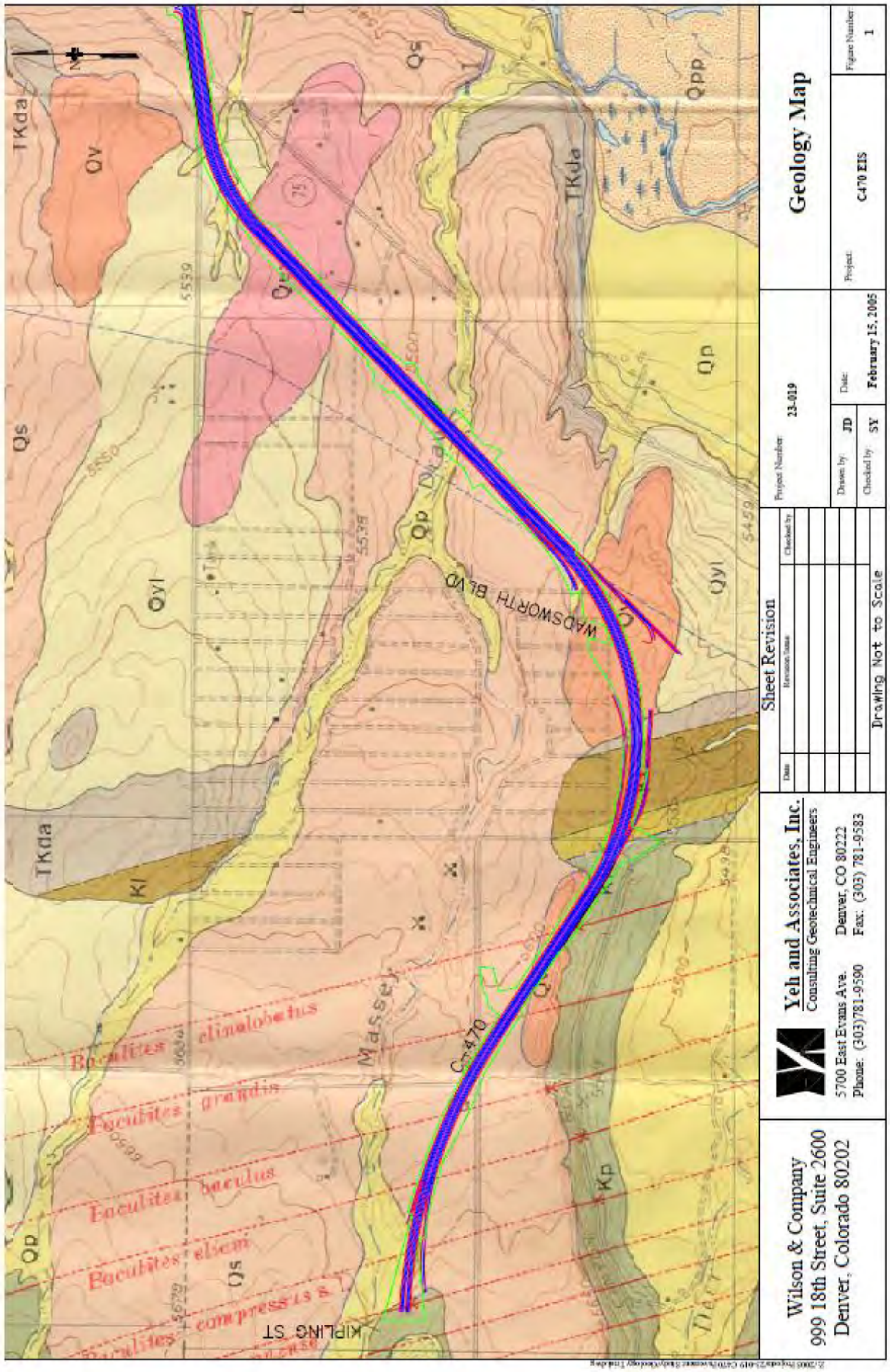


Figure 3
Geology Map 2: Wadsworth Boulevard to Santa Fe Drive

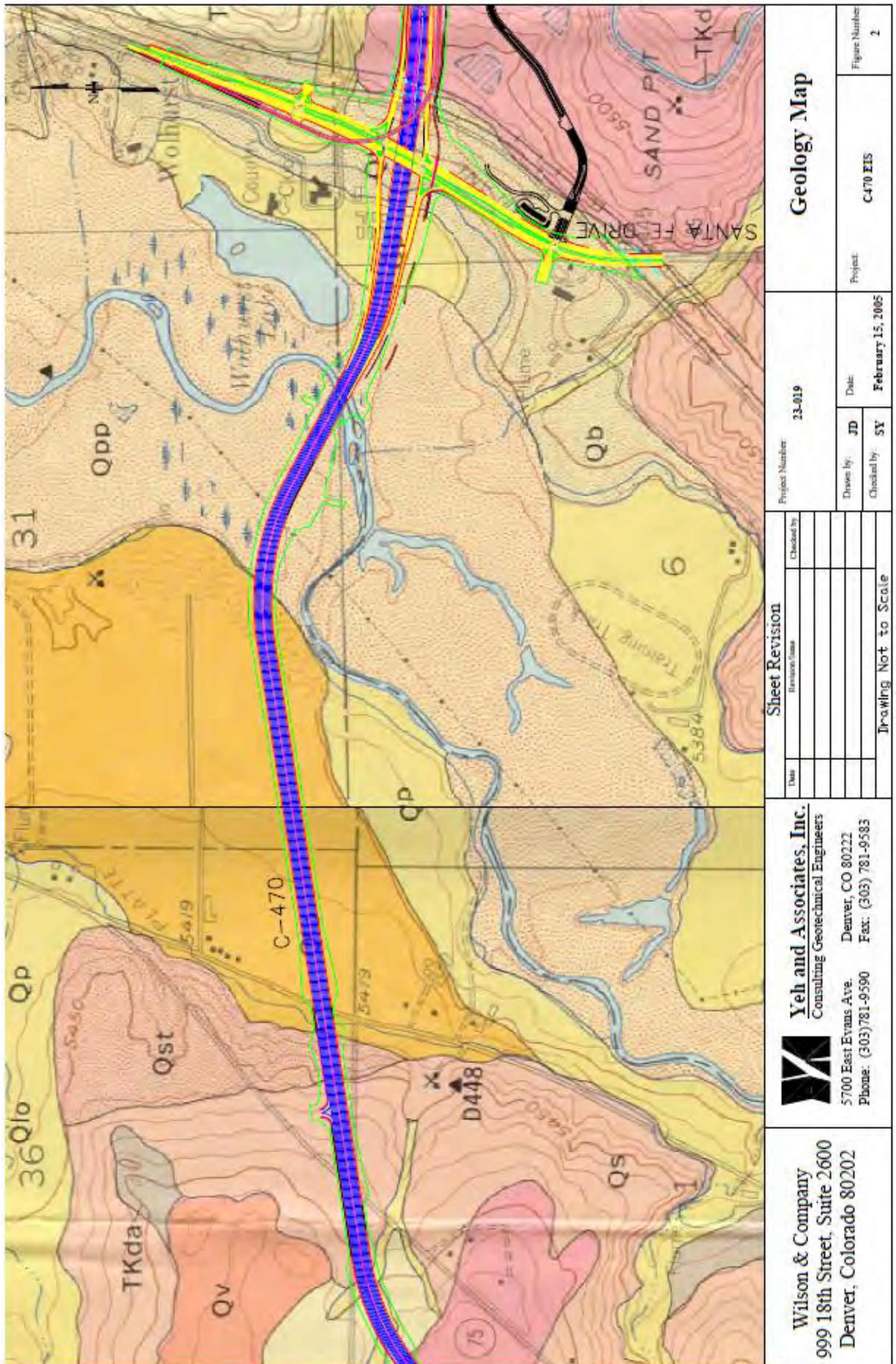


Figure 4
Geology Map 3: Santa Fe Drive to Broadway

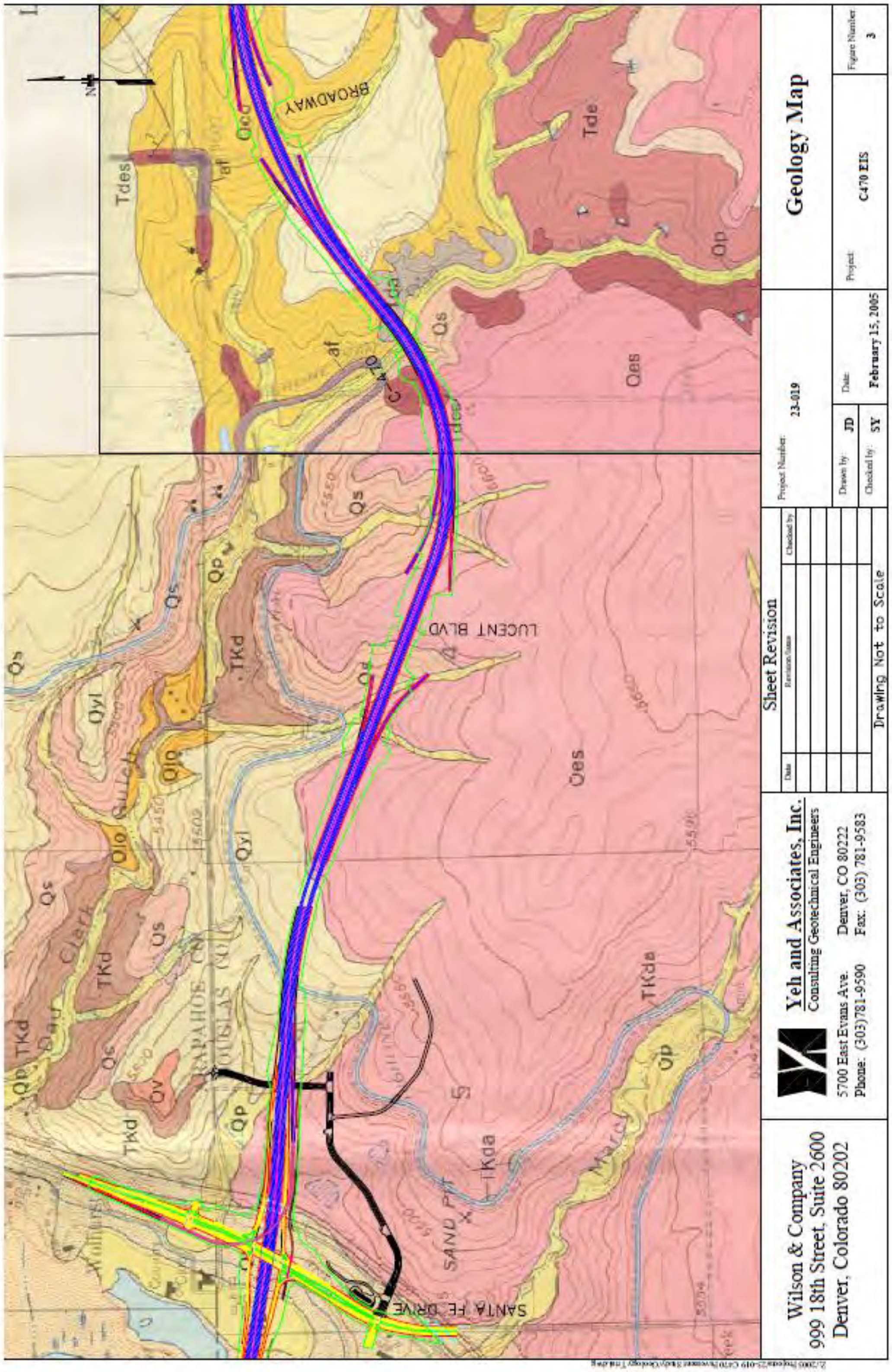


Figure 5
Geology Map 4: Broadway to East of Holly Street

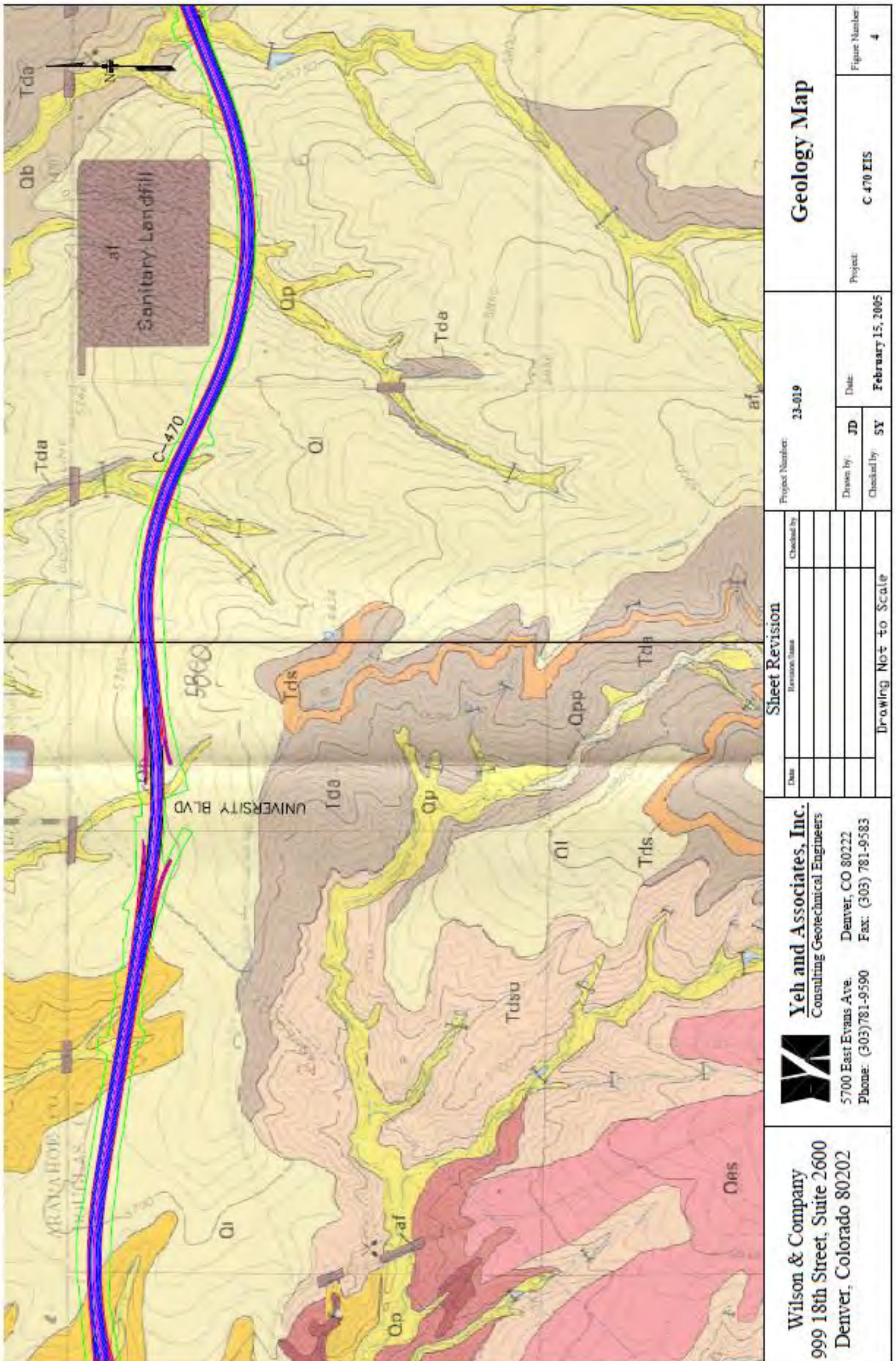


Figure 6
Geology Map 5: East of Holly Street to Interstate 25

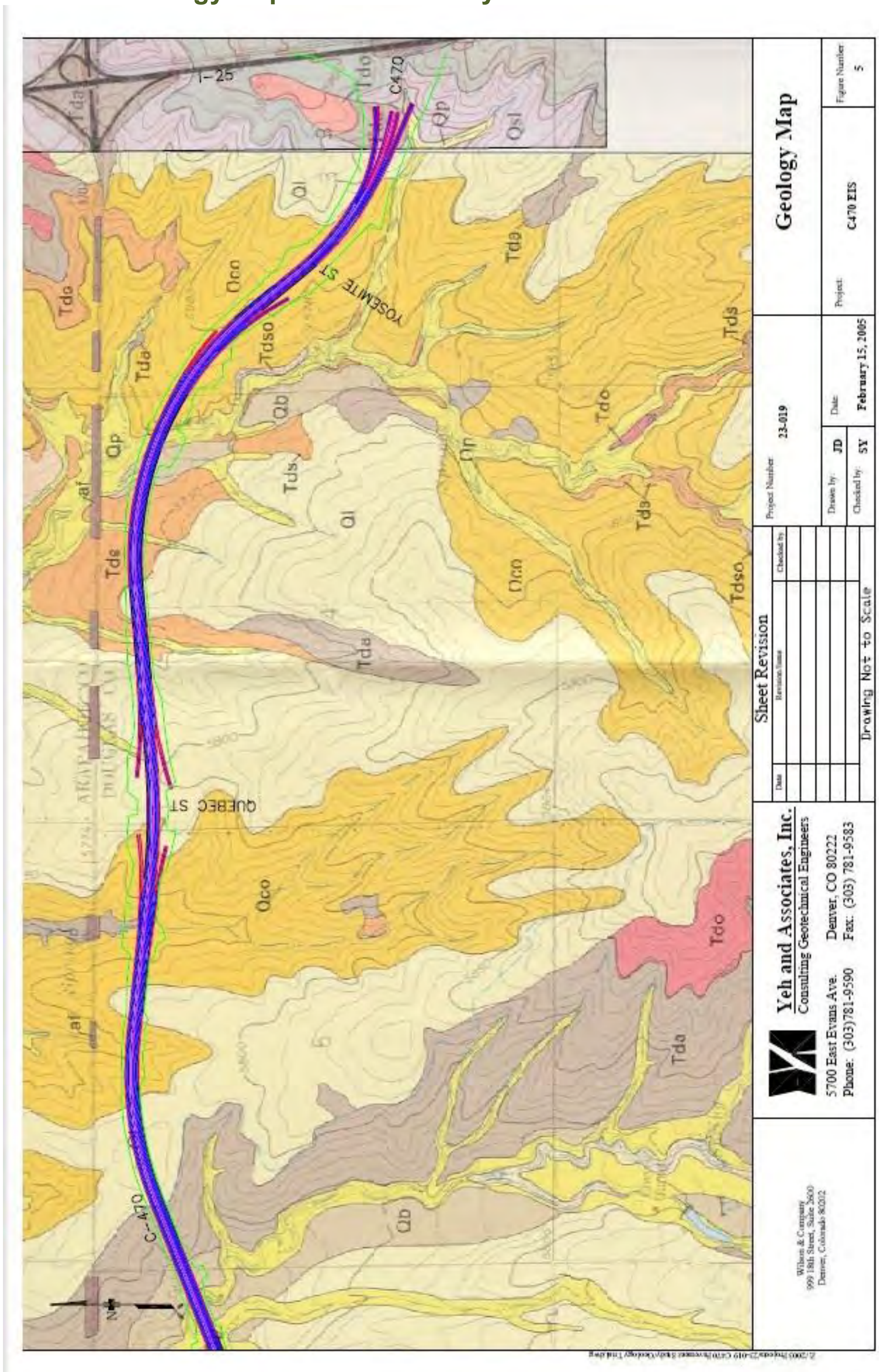
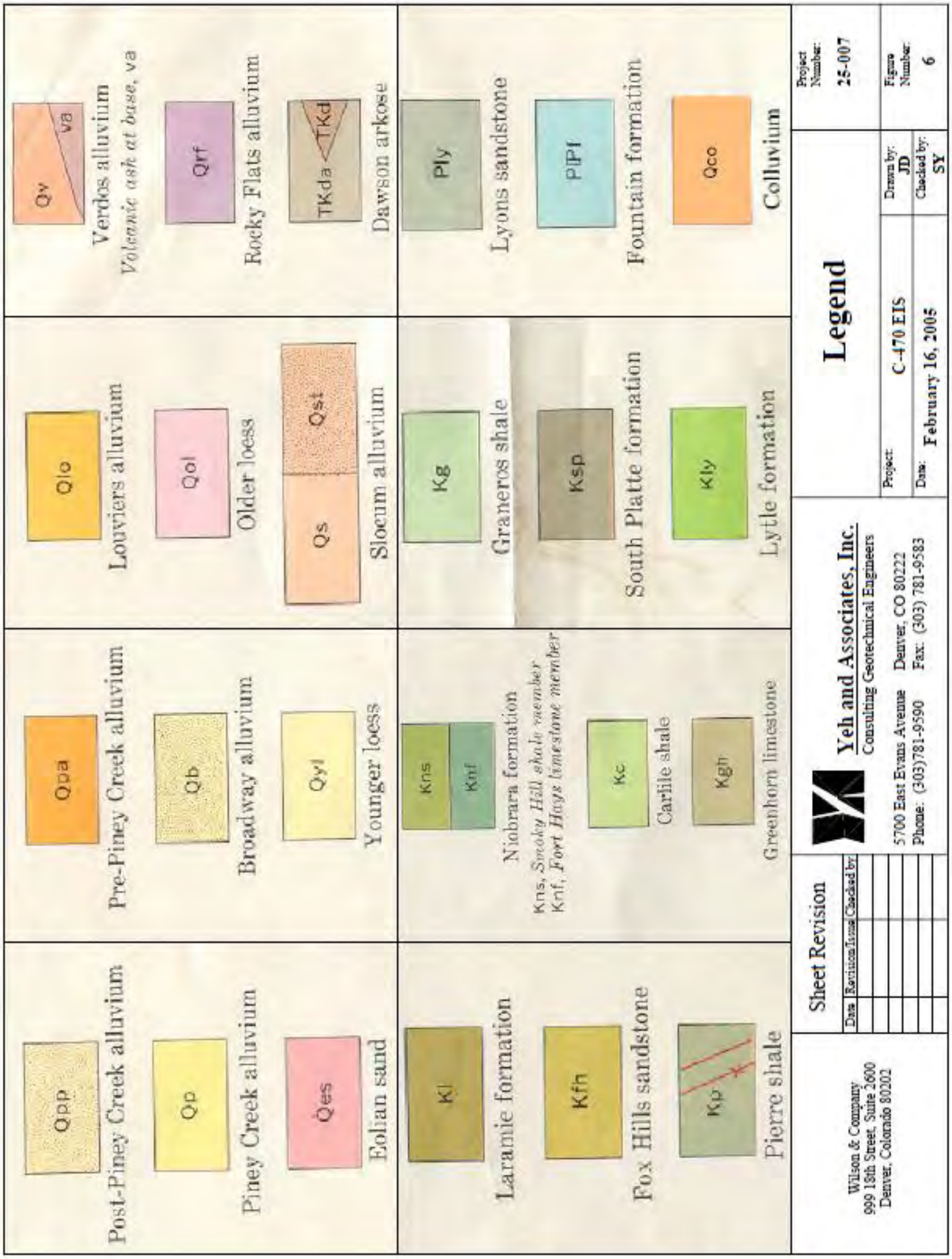


Figure 7
Geology Map Legend



Hazardous Materials Technical Report

For the C-470 Corridor
Revised Environmental Assessment

July 2015

Submitted To:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted By:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

INTRODUCTION

Following this introductory page, the entire contents of the report were prepared by Summit Technology in 2013.

This C-470 Revised Environmental Assessment (EA) Hazardous Materials Technical Report examines hazardous material conditions that may be encountered during construction of proposed improvements to Colorado State Highway C-470, between Kipling Parkway and Interstate 25, in the southwestern portion of the Denver metropolitan area.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in **Figure 1**. CDOT and FHWA prepared the Revised EA for the 13.75-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users.

Figure 1. C-470 Corridor and Surrounding Vicinity

Completion of the C-470 Revised EA was delayed beyond original expectations, resulting in the passage of more than one year from the completion of the hazardous materials ESA. Therefore, per standard CDOT practice, an updated data base search was performed in 2015. CDOT provided the data to Wilson & Company, preparer of the EA. Wilson & Company reviewed the updated database, compared it to the 2013 ESA findings, and found no new hazardous material sites reported.

Including six appendices that are listed in its table of contents, the 2013 ESA prepared by for Wilson & Company totaled 2,291 pages. The six appendices are part of the administrative record for this Revised EA, but are not included in this Hazardous Materials Technical Report. The 53 pages which follow this introductory page comprise the main portion of the Summit Technical Resources 2013 ESA for the C-470 Corridor.

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Draft
Phase I Environmental Site Assessment
Environmental Re-Evaluation of C-470
South Kipling Parkway to Interstate 25
Jefferson and Douglas Counties, Colorado

Project Information
WCI Job No. 11-100-31702

Prepared For:
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July 29, 2013

EXECUTIVE SUMMARY

Summit Technical Resources, Inc. (SUMMIT), conducted a Phase I Environmental Site Assessment (ESA) for the Colorado Department of Transportation (CDOT), Region 6, Environmental Re-Evaluation of C-470 project, from South Kipling Parkway to Interstate 25 (I-25), in Jefferson, Arapahoe, and Douglas Counties, Colorado (Site). The site visit was performed on June 10, 2013 by Mr. Andy Sagen and Ms. Darcy Schradeya (SUMMIT).

The purpose of the inspection was to visually obtain information indicating the likelihood of potential environmental conditions in connection with the Site. This report includes a summary of the records review and site visit, as well as copies of supporting documentation and the CDOT Form 881, Initial Site Inspection Checklist which was completed for this project.

A total of eleven sites were identified as a site of potential concern presenting recognized environmental conditions or historic recognized environmental conditions.

- JEFFCO Road and Bridge located at 9509 West Ute Avenue, Littleton, Colorado is a site of concern based on known contamination, and proximity to the Site.
- Bowen Farms located at 3220 West County Line Road, Littleton, Colorado is a site of concern based on known contamination, and proximity to the Site.
- Chevron located at 201 East County Line Road, Littleton, Colorado is a site of concern based on known contamination, and proximity to the Site.
- Jiffy Lube located at 1650 East County Line Road, Highlands Ranch, Colorado is a site of concern based on known contamination, and proximity to the Site.
- County Line Disposal located at 8422 South Colorado Boulevard, Littleton, Colorado, is a site of concern based on known groundwater contamination, and the proximity and upgradient location to the Site.
- Centennial Water and Sanitation located at 8606 Canongate Lane, Littleton, Colorado is a site of concern based on known contamination, and proximity to the Site.
- Dry Cleaning Station located at 6086 East County Line Road, Littleton, Colorado is a site of concern based on possible contamination, and proximity to the Site.
- AAMCO located at 6028 East County Line Road, Littleton, Colorado is a site of concern based on possible contamination, and proximity to the Site.
- Heritage Cleaners located at 7132 East County Line Road, Littleton, Colorado is a site of concern based on possible contamination, and proximity to the Site.
- K & G Stores located at 7130 East County Line Road, Littleton, Colorado is a site of concern based on known contamination, and proximity to the Site.
- 7-Eleven located at 8750 S Yosemite Street, Lone Tree, Colorado is a site of concern based on known contamination, and proximity to the Site.

Lead-based paint was not detected at the Quebec Street Bridge. A number of transformers (potential for polychlorinated biphenyl [PCB]-containing materials) were observed inside and within close proximity of the CDOT right-of-way (ROW). Appropriate demolition, handling, and disposal practices for these hazardous materials, as required by regulatory guidelines, should be followed during demolition activities associated with the C-470 project.

Phase I Environmental Site Assessment

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Appendices

Acronyms

AAI	All Appropriate Inquiry
AIRS	Aerometric Information Retrieval System
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
CAP	Corrective Action Plan
CDLE	Colorado Department of Labor and Employment
CDOT	Colorado Department of Transportation
CERC-NFRAP	Comprehensive Environmental Response Compensation and Liability Information System-No Further Remedial Action Planned
CFR	Code of Federal Regulations
CORRACTS	RCRA Corrective Action Sites
COSMIX	Colorado Springs Metro Interstate Expansion
COSTIS	Colorado Storage Tank Information System
DOD	Department of Defense
EA	Environmental Assessment
EDR	Environmental Data Resources, Inc.
ERNS	Emergency Response Notification System
ESA	Phase I Environmental Site Assessment
FEMA	Federal Emergency Management Agency
FINDS	Facility Index System
ISA Checklist	CDOT Form 881, Initial Site Inspection Checklist
Kumar	Kumar and Associates
LBP	lead-based paint
LPG	liquid petroleum gas
LUST	leaking underground storage tank
MESA	Modified Environmental Site Assessment
NEPA	National Environmental Policy Act
NFA	No Further Action
OPS	Oil and Public Safety
OSHA	Occupational Safety and Health Administration
PADS	PCB Activity Database
PCB	polychlorinated biphenyl
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RCRA-NonGen	RCRA-Non Generators
RCRA-SQG	RCRA-Small Quantity Generator
RCRS-CESQG	RCRA-Conditionally Exempt Small Quantity Generator
ROW	right-of-way
SCR	Site Characterization Report
SSF	Site Summary Form
SUMMIT	Summit Technical Resources, Inc.
TCLP	Toxicity Characteristic Leaching Procedure
UMCR	Upper Monument Creek
USAF Academy	U.S. Air Force Academy
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
WWTF	wastewater treatment facility

1.0 Introduction

Summit Technical Resources, Inc. (SUMMIT), conducted a Phase I Environmental Site Assessment (ESA) for the Colorado Department of Transportation (CDOT), Region 6 Environmental Re-Evaluation of C-470, from South Kipling Parkway to I-25 (Site), in Jefferson, Arapahoe, and Douglas Counties, Colorado.

The site visit was performed on June 10, 2013 by Mr. Andy Sagen and Ms. Darcy Schradeya (SUMMIT). The purpose of the inspection was to visually obtain information indicating the likelihood of potential environmental conditions in connection with the Site. The Site was traversed by foot at major intersections, and visually observed from the roadway between intersections. The weather during the site visit was sunny and dry, with an average temperature approximately 85 degrees Fahrenheit and winds up to 20 miles per hour. Traffic along C-470 was constant, with heavier traffic at the intersections.

For discussion purposes in this report, the Site is broken into five segments, moving west to east along C-470:

Segment 1 – The intersection of C-470 and South Kipling Parkway to just west of South Santa Fe Drive.

Segment 2 – The intersection of C-470 and South Santa Fe Drive to just west of South Broadway.

Segment 3 – The intersection of C-470 and South Broadway to just west of South University Boulevard.

Segment 4 – The intersection of C-470 and South University Boulevard to just west of South Quebec Street.

Segment 5 – The intersection of C-470 and South Colorado Boulevard to the intersection of C-470 and I-25.

This report includes the following figures and appendices for reference. Figure 1 presents the location of the Site, Figures 2 through 6 show each of the Segments along with selected sites identified in the regulatory database report completed by Environmental Data Resources (EDR). Appendix A includes the EDR DataMap ™ Well Search Report. Appendix B includes the EDR DataMap ™ Area Study. Topographic maps are included in Appendix C. A Hazardous Material Technical Report (HMTR) completed by Goodbee & Associates LLC in 2005 (Goodbee 2005) for the Site. is included in Appendix D. Site photographs are included in Appendix E. Appendix F includes a completed CDOT Form 881, Initial Site Assessment Checklist (ISA Checklist).

1.1 Scope of Services, Methodology, and Limitations

This ESA was performed in general accordance with American Society for Testing and Materials (ASTM) E1527-05, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* and the U.S. Environmental Protection Agency All Appropriate Inquiries (AAI) Final Rule at 40 Code of Federal Regulations [CFR] Part 312. The

ESA is also a requirement of the National Environmental Policy Act (NEPA) for federally funded projects. Deviations from the ASTM standard are discussed in Section 1.2 below.

In accordance with the Scope of Services and SUMMIT's understanding of CDOT's requirements for this project, the objectives of this ESA were to:

- Perform historical and regulatory records review for the Site;
- Conduct a visual inspection of the Site;
- Provide completed CDOT Form 881 for the Site;
- Review the HMTR and identify any Site conditions which have changed since the completion of the 2005 report.

This ESA report has been prepared for the exclusive use of CDOT for the sole purpose of assisting in the evaluation of current and/or historical environmental conditions associated with the Site. The purpose of this ESA is to identify, to the extent feasible, *recognized environmental conditions* and *historical recognized environmental conditions* in connection with the Site.

The findings of this ESA, as represented within this report, must be viewed in recognition of certain limiting conditions. The scope of work commissioned for this project represents a reasonable inquiry, consistent with good commercial practice, in accordance with ASTM Standard E 1527-05 and the USEPA AAI Final Rule (40 CFR 312). The intent of this report is not as an exhaustive investigation, nor does it include an evaluation of issues that are not addressed in the ASTM Standard. This assessment is intended to reduce, but not eliminate, the level of uncertainty regarding the potential for current and/or historical environmental conditions associated with the Site.

The findings presented herein are based upon observations of Site conditions as of the date the assessment was performed and the findings and conclusions presented herein should not be assumed to apply to conditions or operating practices on this property occurring subsequent to actual on-site investigation. During the course of this assessment, the consultant has relied on information provided by outside sources, including but not limited to Site owner(s) and/or operator(s), appropriate local government officials, regulatory agencies and *reasonably ascertainable* standard records sources. For the purposes of this assessment, such third-party information is assumed to be accurate unless otherwise noted, and the consultant cannot verify, nor does the consultant guarantee the information obtained from third-party sources. Additionally, it should be noted that the accessibility of data may be limited, particularly in regard to historical Site uses. Any such limitations that are essential to the conclusions of the Site assessment have been identified in the Phase I ESA report.

There are additional considerations CDOT may wish to address in connection with a Phase I ESA. These services are outside the scope of work considered for a Phase I ESA as defined in the ASTM Standard E 1527-05. Examples of additional, but not all inclusive, considerations are listed

below:

- Archeological, Historical, or other Cultural Resources

- Asbestos-Containing Materials
- Lead in Drinking Water
- Wetlands
- Ecological Resources
- Regulatory Compliance
- Industrial Hygiene
- Indoor Air Quality
- Occupational Safety and Health Hazards
- Radon
- Threatened or Endangered Plants and Animals
- Biological Agents
- Mold

The opinions submitted in this report are based upon the site observations, data obtained from records and historical sources, and the anticipated use of the Site. The opinions provided herein may change if the CDOT project scope or project Site changes, or if the CDOT project scope requires direct exposure to documented contamination. Nature and extent of soil or groundwater contamination was not evaluated as part of this ESA.

1.2 Exceptions, Deviations, and Data Gaps

A city directory review, environmental lien search, property tax files review, land title records review, building department records review, and interviews of current and historic property owners were not conducted/completed for the Site as these resources are not considered *reasonably ascertainable* due to the size of the Site (an approximate 14-mile long corridor).

Only the visible land surface, features, and property conditions were observed during the site visit. Not all properties were immediately accessible and were therefore observed from a distance. Due to constant traffic conditions which presented a safety issue, SUMMIT personnel did not traverse the CDOT right-of-way (ROW) between major intersections. A visual inspection was conducted from the vehicle during numerous passes, and major observations were noted. Inspections of building interiors were not conducted as part of the scope of services.

Historical resources were not readily available in 5 year increments, however the dates available were sufficient to assist with identification of historic Site uses, and the general uses of the adjacent properties.

A limited records review was conducted for sites of concern identified by the regulatory database search. Only available digital (on-line) records were reviewed in order to provide an overall summary of environmental conditions/actions which have occurred at any sites of concern.

As part of a CDOT MESA, lead-based paint (LBP) samples are required to be collected from any surfaces with suspect LBP expected to be affected by construction activities (e.g. modification or demolition). One LBP sample was collected from the bridge for Quebec Street. This was the only location where paint was observed and attainable during the site visit. Paint was also observed on the Furniture Row railing located adjacent to CDOT ROW. The Furniture Row railing was not sampled for lead as it is located on private property. Refer to Section 3 for a summary of the LBP results

A review of available Sanborn Fire Insurance Maps found that maps were available for Denver, Golden, Littleton, and Castle Rock. Denver, Golden, and Castle Rock are not include in any part of the study area. The maps available Littleton did not include the study area. Therefore, no Sanborn Fire Insurance Maps were available for the Site.

1.3 Historic and Regulatory Resources Used

This section provides a summary of the resources reviewed for this project.

- United States Geological Survey (USGS) Store Map Locator and Downloader: http://store.usgs.gov/b2c_usgs/usgs/maplocator/(ctype=areaDetails&xcm=r3standardpitrex_prd&carea=%24ROOT&layout=6_1_61_48&uiarea=2)/.do. The following available digital maps were downloaded on June 3, 2013:
    - Littleton, Colorado, 7.5-Minute Quadrangle – 1942, 1950, 1957, 1965, (photorevised 1971, 1980) and 2011.
    - Highlands Ranch, 7.5-Minute Quadrangle – 1942, 1949, 1957, 1965, (photorevised 1971, 1980, and 1994), and 2011.
    - Parker, Colorado, 7.5-Minute Quadrangle – 1942, 1949, 1957, 1965, (photorevised 1971, 1980, and 1994) and 2011.
    - Denver East, Colorado, 30-Minute Quadrangle – 1890, 1981.
    - Denver West, Colorado, 30-Minute Quadrangle – 1899, 1983.
- USGS National Geologic Map Database http://ngmdb.usgs.gov/ngmdb/ngmdb_home.html. The following geologic maps were reviewed on January 26, 2012:
    - Geology of the Littleton Quadrangle, Jefferson, Douglas, and Arapahoe Counties, Colorado: U.S. Geological Survey Bulletin 1121-L, Scott, G.R., 1962., 1:24,000, http://ngmdb.usgs.gov/Prodesc/proddesc_20820.htm. Image Creation Date: MAY. 11, 2011.
    - Geologic Map of the Highlands Ranch Quadrangle, Arapahoe and Douglas Counties, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1413, Maberry, J.O., and Lindvall, R.M., 1977., 1:24,000, http://ngmdb.usgs.gov/Prodesc/proddesc_10947.htm. Image Creation Date: MAY. 11, 2011.
    - Geologic map of the Parker quadrangle, Arapahoe and Douglas Counties, Colorado: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-770-A, Maberry, J.O., and Lindvall, R.M., 1972., 1:24,000,

http://ngmdb.usgs.gov/Prodesc/proddesc_9555.htm. Image Creation Date: MAY. 11, 2011."

- Federal Emergency Management Agency (FEMA) Issued Flood Maps for Jefferson, Arapahoe, and Douglas Counties, Colorado: https://msc.fema.gov/webapp/wcs/stores/servlet/CategoryDisplay?catalogId=10001&storeId=10001&categoryId=12001&langId=-1&userType=G&type=1&future=false. The following FEMA map panels were reviewed on July 22, 2013:

    - 0859C0405E, 08059C0410E, 08005C0433K, 08005C0434K, 08035C0009F, 08035C0009F, 08035C0028F, 08005C045K, 08005C0458K, 08035C0033F, 08035C0034F, 08059C0415E, , 08035C0016F, 08035C0017F, 08035C0036F, 08035C0037F, 08035C0041F, 08035C0042F, 08035C0061F

- FEMA Flood Map Viewer: https://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1

- FEMA Flood Zone definitions: https://msc.fema.gov/webapp/wcs/stores/servlet/info?storeId=10001&catalogId=10001&langId=-1&content=floodZones&title=FEMA%2520Flood%2520Zone%2520Designations

- University of Colorado at Boulder, Sanborn Fire Insurance Map Collection, Jefferson, Arapahoe, and Douglas Counties, Colorado: http://libcudl.colorado.edu/sanborn/central.asp

- Google Earth Aerial Photographs, 1937, 1955, 1993, 1999, 2002, 2007, and 2012.

- USGS Ground Water Atlas of the United States, Arizona, Colorado, New Mexico, Utah, HA 730-C, 1995

- EDR DataMap ™ Area Study, June 4, 2013.

- EDR DataMap ™ Well Search Report, June 4, 2013.

- Colorado Department of Labor and Employment (CDLE), Oil Inspection Section, Oil and Public Safety (OPS), Colorado Storage Tank Information System (COSTIS) records: http://costis.cdle.state.co.us/ois2000/home.asp.

- U.S. Environmental Protection Agency (USEPA), Envirofacts: http://www.epa.gov/enviro/facts/cerclis/search.html.

For both the EDR Area Study and the Well Search Report, a 1000-foot buffer was selected from the centerline of C-470 (and associated interchanges). The search radius was expanded to 1 mile outside this buffer for all regulatory databases, which meets or exceeds the minimum ASTM search distances for the standard environmental record sources.

1.4 Definitions

Recognized environmental conditions, as defined in ASTM E1527-05, are conditions that indicate "the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property." Historic recognized environmental conditions are defined by ASTM as "an environmental condition which in the past would have been considered a recognized environmental condition, but which may or may not be considered a recognized environmental condition currently. ... If a past release of any hazardous substances or petroleum products has occurred in connection with the property and has been remediated, with such remediation accepted by the responsible regulatory agency (for example, as evidenced by the issuance of a no further action letter or equivalent), this condition shall be considered an historical recognized environmental condition ... If this historical recognized environmental condition is determined to be a recognized environmental condition at the time the Phase I Environmental Site Assessment is conducted, the condition shall be identified as such ..." Conditions determined to be *de minimis* are not recognized environmental conditions.

FEMA flood zones identified as part of this ESA, and associated definitions are as follows:

Zone A: "Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply."

Zone AE: "Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply."

Zone AH: "Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between one and three feet. Base Flood Elevations derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply."

2.0 General Site Information

The following section summarizes the project description, and the overall Site description based on site visit observations and records review including geologic maps, topographic maps, and groundwater resources. This section also includes a summary of the regulatory records search. Detailed findings for each Segment of the Site are included in Section 3.

2.1 Project Description

In February 2006, a CDOT C-470 Environmental Assessment (EA) recommended implementation of tolled express lanes along 14 miles of C-470 between South Kipling Parkway and I-25. The majority of this segment was planned for implementation of the tolled express lanes with a barrier-separated typical section and a typical width of 162 feet. Access to the tolled express lanes was planned with slip ramps into and out of the lanes at strategic locations, along with direct connection ramps at Colorado Boulevard, Quebec Street, and I-25. Since 2006, no subsequent environmental decision document was completed for this project, and project implementation has not begun. Interchange improvements at C-470/ Santa Fe Drive (e.g., southbound to eastbound flyover ramp) received separate environmental clearance and have been constructed.

The C-470 Corridor Coalition, which was formed in February 2011, is a cooperative effort involving local governments and CDOT. The Coalition’s purpose is to recommend and implement a plan to pay for improvements to C-470.

In February 2013, the Coalition Policy Committee unanimously approved a new option to implement tolled express lanes, but with a revised typical section and revised access concept. The proposed typical section replaces the original barrier separation with a painted (buffer) separation, and increases shoulder widths. The proposed improvements also include the addition of multiple auxiliary lanes at strategic locations along C-470 where on-ramp to off-ramp spacing is close, and where the auxiliary lane will provide an operational improvement to C-470. Thus, some portions of the corridor will have auxiliary lanes, and other portions will not. The new proposed sections are with typical widths of 154 feet and 174 feet. Access to the tolled express lanes is planned with ingress and egress slip ramps and weaving zones, strategically placed along the corridor.

2.2 Site Description

The Site includes an approximate 14-mile long corridor of CDOT ROW along C-470 between South Kipling Parkway and I-25. The ROW varies in width throughout the corridor, depending on the location. The Site includes the undeveloped ROW on either side of C-470 and associated interchanges along with the roadways which are concrete or asphalt paved. The undeveloped land was generally covered with native grasses, bushes, weeds, and trees. No evidence of dumping or stressed vegetation was observed. Numerous utilities were located inside the ROW, including buried fiber optic cable lines, gas lines, and electric lines which were located throughout the entire Site in the ROW on the both sides of C-470, and a number of transformers (refer to Section 3).

2.2.1 Geology

The C-470 corridor is found in the Colorado Piedmont section of the Great Plains physiographic province (USGS 1995). The Colorado Piedmont is located at the base of the foothills of the Front Range in north central Colorado and is situated along the western flank of the Denver Basin. The geologic setting along the C-470 corridor includes bedrock and variable thicknesses of surficial deposits that overlie the bedrock. The bedrock is moderately hard while the surficial deposits are unconsolidated. Sedimentary rock layers dip steeply east from the flank of the Front Range eastward into the Denver Basin, then rise much more gradually up the eastern flank of the basin in eastern Colorado. The bedrock within the corridor is all of sedimentary origin.

Four major bedrock units are present in the corridor area and consist of:

1. Undifferentiated Denver and Arapahoe Formations which are primarily interbedded sandstone.
2. Laramie Formation, which consists of shale, siltstone, and sandstone.
3. Fox Hills Sandstone,
4. Pierre Shale.

Surficial material that overlay the bedrock formations are composed of alluvium, colluvium, and loess. These deposits vary considerably in depth and are composed predominantly of cobbles, gravel, sand, silt, and clay deposits.

2.2.2 Hydrogeology

Ground-water associated with the C-470 corridor is located within the Denver basin. The Denver Basin extends from the Front Range foothills east to near Limon, and from Greeley south to near Colorado Springs. The Denver Basin includes four main bedrock aquifers. All four Denver Basin aquifers are located in the C-470 corridor, and include the Dawson, Denver, Arapahoe, and Laramie-Fox Hills Aquifers.

The Denver aquifer system is the major aquifer system underlying the corridor (USGS 1995). The Denver aquifer system is a consolidated-rock aquifer system with shale, silty claystone, and interbedded sandstone. Beds of lignite and carbonaceous siltstone and shale are common. Sandstone is generally andesitic, lenticular, and moderately consolidated. The Denver aqufer is confined in the central part. Contains a water table only near outcrops, is moderately permeable and may yield as much as 200 gallons per minute.

The aquifers are generally confined, except in areas where water-table conditions exist in the upper parts of the aquifers. Shallow unconfined aquifers contained in the alluvium are most likely to be impacted by hazardous material sites identified along the C-470 corridor. Groundwater flow in these aquifers is largely controlled by surface topography and is generally towards streams and rivers. Groundwater flows from higher to lower water table elevation. Areas of shallow, unconfined groundwater are present along the corridor.

The EDR DataMap ™ Well Search Report (EDR2013a) which is included in Appendix A, identified numerous groundwater wells within the 1000-foot buffer and within the 1-mile radius of the buffer. Wells registered to the USGS provided groundwater elevation data for the various aquifers underlying the Site. Shallow groundwater within the Arapahoe Conglomerate Member of the Laramie Formation occurred at approximately 200 to 270 feet below ground surface (bgs). Other wells which appear to be screened within the shallow groundwater aquifer had a groundwater depths ranging from 9 to 25 feet bgs. Wells screened within the Dawson Aquifer had groundwater depths ranging from as shallow as 31 feet bgs, to 125 feet bgs. Privately owned wells did not provide any depth to groundwater measurements. Private well usage was noted as domestic, household use only, or municipal.

2.3 Regulatory Review Summary

As stated in Section 1.3, a 1000-foot buffer was selected from the centerline of C-470 (and associated interchanges). The search radius was expanded to 1 mile outside this buffer for all regulatory databases. The following table summarizes the number of sites identified in the associated federal, state, and local records found in the EDR DataMap ™ Area Study (EDR 2013b), which is included in Appendix B. The sites are broken into two categories: sites located within the 1000-foot buffer, and sites outside the 1000-foot buffer. Section 3 includes detailed discussions for sites located with the 1000-foot buffer. Sites located outside the 1000-foot buffer were determined to be at a sufficient enough distance from the project Site as to not pose a concern and are not discussed in this report.

Record and Brief Description	Number of Sites Within the 1000-foot Buffer	Number of Sites Outside the 1000-foot Buffer
FEDERAL RECORDS		
CERC-NFRAP: Comprehensive Environmental Response Compensation and Liability Information System-No Further Remedial Action Planned contains archived sites that have been removed from the inventory of CERCLIS sites and EPA has determined that no further action is required.	0	2
CORRACTS: Resource Conservation and Recovery Act (RCRA) Corrective Action Sites provides a list of handlers with RCRA Corrective Action Activity.	1	7
DOT OPS: Department of Transportation, Office of Pipeline Safety Incident and Accident data.	0	3
ERNS: Emergency Response Notification System provides information on reported releases of oil and hazardous substances.	4	13
FINDS: Facility Index System provides “pointers” to other sources of information that contain more detail.	46	212
FTTS: FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act) over the previous five years.	3	5
HIST FTTS: A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB).	3	5

Record and Brief Description	Number of Sites Within the 1000-foot Buffer	Number of Sites Outside the 1000-foot Buffer
ICIS: The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.	1	4
MLTS: The Material Licensing Tracking System is maintained by the Nuclear Regulatory Commission and contains a list for approximately 8,100 sites which possess or use radioactive materials and are subject to NRC licensing requirements.	0	3
RCRS-CESQG: RCRA-Conditionally Exempt Small Quantity Generator, generates less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.	10	39
RCRA-LQG: Resource Conservation and Recovery Act (RCRA) large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.	0	1
RCRA-NonGen: RCRA-Non Generators do not presently generate hazardous waste.	15	54
RCRA-SQG: RCRA-Small Quantity Generator, generates between 100 kg and 1000 kg of hazardous waste per month.	6	8
RMP: The Risk Management Program Rule (RMP Rule) was written when Congress passed the Clean Air Act Amendments of 1990, requiring EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances.	0	1
SSTS: Section Seven Tracking System (SSTS) of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year.	1	0
TRIS: The Toxic Chemical Release Inventory System identifies facilities that release toxic chemicals to the air, water, and land in reportable quantities under SARA Title III, Section 313. The source of this database is the U.S. EPA.	0	4
TSCA: The Toxic Substances Control Act identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list.	1	0
US AIRS: The database is a sub-system of Aerometric Information Retrieval System (AIRS). AFS contains compliance data on air pollution point sources regulated by the U.S. EPA and/or state and local air regulatory agencies.	16	66
US HIST CDL: A listing of clandestine drug lab locations.	0	1
US MINES: Mines Master Index File	2	1
US HIST CDL: A listing of clandestine drug lab locations.	0	1

Record and Brief Description	Number of Sites Within the 1000-foot Buffer	Number of Sites Outside the 1000-foot Buffer
STATE AND LOCAL RECORDS		
CA HAZNET: Lists and tracks hazardous waste from the generator, through the transporter, to a TSD facility.	0	1
CO AIRS: Aerometric Information Retrieval System listing of Colorado Air Pollution Control Division permits and emissions data.	13	51
CO ASBESTOS: Asbestos abatement and demolition projects.	2	30
CO AST: Registered aboveground storage tanks.	14	39
CO CDL: Meth lab locations that were reported to the Department of Health and Environment.	2	5
CO DRYCLEANERS: A list of drycleaner facilities.	4	12
CO ERNS: State reported spills.	15	61
CO LAST: A listing of leaking aboveground storage tank sites.	0	2
CO LUST: Colorado Leaking Underground Storage Tank provides an inventory of LUST sites.	12	24
CO LUST TRUST: LUST reimbursement application.	3	10
CO MINES: This dataset represents permitted mines in the State of Colorado	8	7
CO NPDES: National Pollutant Discharge Elimination System listing of permitted facilities from the Colorado Water Quality Control Division.	5	22
CO SWF/LF: The Solid Waste Facilities/Landfill Sites records typically contain an inventory of solid waste disposal facilities or landfills in a particular state.	0	1
CO UST: Registered underground storage tanks.	22	62
NY MANIFEST: Lists and tracks hazardous waste from the generator, through the transporter, to a treatment, storage, and disposal (TSD) facility.	1	1
OK COMPLAINT: Environmental complaints report to the Oklahoma corporation commission.	0	2
PROPRIETARY RECORDS		
EDR US HIST AUTO STAT: Listings of potential gas station/filling station/service station sites that were available to EDR researchers that fall within a category of information EDR classifies as "High Risk Historical Records", or HRHR.	36	115
EDR US HIST CLEANERS: Listings of potential dry cleaner sites that were available to EDR researchers that fall within a category of information EDR classifies as "High Risk Historical Records", or HRHR.	6	48

All other regulatory databases searched did not return any identified sites.

3.0 Findings

The following section summarizes the findings of the site visit (including observed transformers), review of the 2005 HTMR (Goodbee 2005), review of historical resources (aerial photographs, topographic maps, FEMA maps), and regulatory database results for each Segment outlined in Section 1. The Environmental Data Resources, Inc. DataMap™ Well Search Report (EDR 2013a) is included in Appendix A. The EDR DataMap ™ Area Study (EDR 2013b) is included in Appendix B. Topographic maps are included in Appendix C. Site photographs are included in Appendix D. Aerial photographs are available on Google Earth, and FEMA maps/data are only available for viewing on line (see Section 1 for links).

3.1 Segment 1

Segment 1 encompasses the intersection of C-470 and South Kipling Parkway to just west of South Santa Fe Drive (Figure 2).

A total of fourteen sites were listed in the database search conducted by EDR that were within the 1000-foot buffer. After review, five potential sites of concern were found. These sites were more thoroughly and visibly investigated within this Segment.

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
JEFFCO Road and Bridge (ID 304)	9509 W. Ute Ave. Littleton, CO 80128	CO ERNS	0	Work and storage area for road and bridge construction supplies.
Southside Auto & Marine (ID 232)	8537 S. Reed St. Littleton, CO 80128	EDR US Hist Auto Stat	1000	Site 232 is an auto shop. Asphalt outside the shop is stained with oil/grease and only half the lot is paved. Site 236 appears to be a cell phone tower located in a large box atop the auto shop.
Cell phone tower atop Southside Auto & Marine (ID 236)	8580 S. Saulsbury St. Littleton, CO 80128	EDR US Hist Auto Stat		
Western Paving Landfill (no site ID)	8347 Blakeland Dr. Littleton, CO 80125	Landfill	1000	Near Chatfield Lake, south of C-470. Currently, there is a building material supply store at the address listed.
Falcon Bluffs Middle School (ID 246)	8449 S. Garrison St. Littleton, CO 80128	FINDS	1000	A 113,571 square feet school building for grades 6-8.

JEFFCO Road and Bridge (ID 304) is a work and storage area for road and bridge construction supplies located south and cross gradient of C-470. It has five underground storage tanks (UST) which include: one 1,000-gallon waste oil tank, one 1,000-gallon gasoline tank, one 4,000-gallon diesel tank, and three 1,000-gallon diesel tanks (Goodbee 2005). The EDR 2013b reported a case of illegal dumping in 1997 where an unknown quantity of oil was dumped in the shop's storm water retention pond. Surface water was impacted; cleanup included breaking up and removing impacted ice, vacuuming 1,500 gallons of water/oil into a roll-off, and placing it in absorbent (material) pigs. Since this site is located within the Site extent and a spill has occurred, this property may pose a risk to the corridor. (Photo 10)

The EDR report shows two sites to be classified as “High Risk Historical Records” defined as unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches. ESR sites 232 and 236 consist of a shop that has switched names between Southside Auto and Marine Inc. and Chatfield Auto Body since 1999, and a suspected cell phone tower disguised as a large box-shaped structure atop the auto body shop. Upon investigation, the half paved parking lot had many grease and oil stains. Although this property is located upgradient to C-470, due to the distance from the ROW and no reported spills, this site likely does not pose a concern to the subject Site. (Photos 11, 12, 13)

The Western Paving Landfill, near Chatfield Lake, is now the site of Professional Build, a building materials and supply dealer. The HMTR (Goodbee 2005) shows that the landfill was identified from the State Historic Landfill list, which was developed by CDPHE in the 1980s and is often inaccurate. Tri-County Health Department records indicated that wastes from this site were disposed in the 1960’s at a landfill located in Adams County. Historic records report all material was moved and disposed of in a landfill located in Adams County. This property is at a distance of more than 1000 feet from the corridor. Therefore, this property likely does not pose a concern to the subject Site.

Falcon Bluffs Middle School (ID 246) was selected as a FINDS to investigate due to the distance (~1000 feet) from ROW. The EDR report identified this site to be on a list of the NCES (National Center for Education Statistics), the primary federal entity for collecting and analyzing data related to education in the United States and other nations and the institute of education sciences. This site was not visually inspected and does not appear to pose a concern to the subject Site due to its distance from ROW and because further research found no indication of hazardous environmental substances at the site.

3.1.1 Topographic Map Review

This Segment is included on the Littleton, Colorado 7.5-Minute Quadrangle and the Denver West, Colorado 30-Minute Quadrangle.

The 1899 Denver West map show undeveloped land with no roads visible on the map. One rail line (Colorado and Southern) crosses the current CDOT ROW near Platte Canyon Drive.

The 1983 Denver West maps show that highway C-470 along with Wadsworth Boulevard and Platte Canyon Drive have all been constructed. C-470 however does not extend to the west of Wadsworth. Residential development of the north side of C-470 is extensive and continues to the Platte Canyon Drive to the east. A gravel pit is visible just north of C-470 between Platte Canyon drive and the Platte River. The Colorado and Southern Railroad line is not visible on the map.

The 1942 and 1950 Littleton map shows primarily undeveloped land. County Highway 75 is visible at or near the current locations of Platte Canyon Drive, C-470 and south Wadsworth Blvd. The town of Chatfields and the Colorado and Southern rail line is located near current CDOT ROW and Platte Canyon Drive.

The 1957 Littleton map shows small gravel pit located near the town of Chatfields and numerous other pits located along the Platte River in the current CDOT ROW. The Colorado and Southern rail line is no longer visible, but a irrigation ditch is visible near the same area.

The 1965 Littleton map shows residential development north of the current CDOT ROW. Wadsworth Boulevard (Colorado Highway 121) has been constructed.

The 1971 Littleton map shows the completion of C-470 between Wadsworth and Santa Fe Drive. Continued residential development has occurred north of C-470. The completion of Chatfield Dam and Reservoir is visible to the south of C-470. A large gravel pit located just north of C-470 between Platte Canyon Drive and the Platte River.

The 1980 Littleton map shows continued development north of C-470.

The 2011 Littleton maps shows the completion of C-470 west of Wadsworth Boulevard and South Kipling Parkway. Significant development continues north of C-470, and is representative of current conditions.

Minor development within the CDOT ROW was observed during the topographic maps review. The development listed above likely does not pose a concern to the subject corridor.

3.1.2 Aerial Photo Review

The 1937 aerial photo shows all of section 1 is undeveloped farm and ranch land. A road that roughly aligns with Platte Canyon Drive is present.

No significant changes noted in the 1955 aerial photo with the exception of a few homes appearing near mile marker (MM) 15 on what is now highway C-470.

The 1993 aerial photo shows significant changes. The current configuration of highway C-470 is present. The area where the Jefferson County Road and Bridge Shop is currently located southeast of South Kipling Parkway and C-470 intersection has been graded and cleared, but no structures, pits or piles are visible in the photo. To the east of Wadsworth and south of C-470, Chatfield Reservoir and Dam has been constructed. Substantial residential development north of C-470 to the east and west of the Wadsworth Boulevard intersection and additional residential areas north of C-470 continuing to the Platte Canyon Drive intersection. A large gravel pit is located just north of C-470 between Plate River Canyon Drive and the Platte River.

The 1999 aerial photo shows areas north of the South Kipling Parkway/C-470 intersection have been graded and are ready for development. The Jefferson County Road and Bridge Shop has been erected and sits in its current location southeast of the intersection. Continued residential development has filled in most open areas located north of C-470 between South Kipling Parkway and Platte Canyon Drive.

The 2002 aerial photo shows that the area north of the South Kipling Parkway/C-470 intersection has undergone development and contains retail stores and restaurants. No other significant developments are visible.

Continued residential/commercial development on the north side of C-470 is visible from 2004 to 2007. The gravel pit located north of C-470 between Platte Canyon Drive and the Platte River has been filled in with water. Little development is visible from 2007 to 2012.

Minor development within the CDOT ROW was observed during the photographic review. The development listed above likely does not pose a concern to the subject corridor.

3.1.3 FEMA Flood Zones

FEMA Intranetix Viewer flood maps identify two 100-year floodplains within Segment 1 (refer to Section 1 for flood zone definitions):

- The Massey Draw flood zone is identified by the FEMA flood map viewer as Zone A (map 08059C0415E). It crosses the highway just west of the intersection at Kipling Street, runs along C-470 to the north, and crosses C-470 again where it flows into Chatfield Lake (south of C-470) at approximately 0.5 miles east of South Wadsworth Boulevard along C-470.

- The South Platte River flood zone is identified as by the FEMA flood map viewer as Zone AE (map 08005C0433K). It crosses the C-470 highway approximately a mile west of South Santa Fe Drive.

3.1.4 Transformers, Electrical Features, and Miscellaneous Items

The following items were observed during the visual site assessment.

- At MM 12.9, a traffic flow stoplight with a controller box was observed at the on-ramp from South Kipling Parkway onto east-bound C-470.

- At MM 12.5, a transformer on a power pole was observed approximately 15 feet north of ROW. The lines appear new, however PCBs may be present. (Photos 9)

- At MM 13.3, a power line crosses the highway, but no transformer spotted.

- At MM 13.9, a traffic flow stoplight with a controller box was observed at the on-ramp from Wadsworth Boulevard onto east-bound C-470.

- At MM 14.1, a power line crosses the highway, but no transformer observed.

- At MM 14.6, a power line crosses the highway, but no transformer observed.

- At MM 15.4, a transformer on a power pole was observed north of ROW, including the power line crossing the highway here. (Photograph 8)

- At MM 15.9, a traffic flow stoplight with a controller box was observed at the on-ramp from Santa Fe Drive onto west-bound C-470.

3.1.5 Lead-Based Paint

No samples of possible LBP were collected from this segment during the site investigation. The bridges above South Kipling Parkway and Wadsworth Boulevard both consisted of unpainted concrete barriers along the edges of the overpass, and an unpainted retaining wall was observed at approximately MM 15.5.

3.2 Segment 2

Segment 2 encompasses the intersection of C-470 and South Santa Fe Drive to just west of South Broadway (Figure 3).

A total of nine sites were listed in the database search conducted by EDR that were within the 1000-foot buffer. After review, five potential sites of concern were found. These sites were more thoroughly and visibly investigated within this Segment.

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
B&R Engineering Service-Ace Cleaners (ID 161)	135 W. County Line Road	CO DRYCLEANERS, AIRS, RCRA nonGen/ NLR	500	Located downgradient and north of County Line Road. No violations.
Bowen Farms (ID 207)	3220 W. County Line Rd. Littleton, CO 80126	CO UST, LUST, CO AST	0	Located cross gradient and north of C-470. 4 permanently closed USTs.
ID 244	3330 W. County Line Rd. Highlands Ranch, CO 80129	CO ERNS	0	Located cross gradient north of C-470.
Bluff Apartment Complex (ID 225)	600 W. County Line Rd. Littleton, CO 80129	CO ERNS	0	Large apartment complex located downgradient from C-470.
Highland Ranch Healthcare Center (ID 216 and 218)	206 W. County Line Rd. Littleton, CO 80129 200 W. County Line Rd. Littleton, CO 80129	CO ERNS	0	Large medical complex located downgradient from C-470.

B&R Engineering Service - Ace Cleaners (ID 161) is a dry cleaners that the EDR report shows has operated from at least 2000 until the time of the report. Tetrachloroethylene is listed as "used on site". Multiple records show compliance with the state and no violations were found by EDR. The site is located downgradient and at a distance of 500 feet with no violations. This property likely does not pose a concern to the subject corridor.

Bowen Farms (ID 207) was not located upon visual investigation. However, it is likely that the address refers to a field located adjacent to CDOT ROW north of C-470 and south of County Line Road. The EDR report indicates it is a CO LUST site with 4 permanently closed tanks: one gasoline UST, two gasoline above ground storage tanks (ASTs), and one diesel AST. The LUST was installed in 5/12/1978 and a confirmed release occurred on 10/10/2006. A site visit occurred 11/3/2006 and the closure letter was issued 12/8/2006 and referenced LT RBSLs or lower than Risk Based Screening Levels (RBSLs). Since this site is located within the Site extent and a leak has occurred on the property, the property may pose a risk to the subject corridor.

EDR site 244 was also not located during visual inspection. Adjacent to the Bowen Farms lot, the site is north of C-470, but a portion of the property is within the Site extent. The EDR report indicates that during construction in 2007, plumbers were testing drains with fresh water in a newly constructed building when an overflow event occurred. The water used to test the system overflowed to the storm drain catch basin. It was reported after testing for chlorine that none of the overflow impacted waters of the state and no actual sewage was introduced into the system. Even though the property is within the site extent no water or soil was impacted on the site. This property likely does not likely pose a concern to the subject Site.

The Bluffs Apartment Complex (ID 225) is a CO ERNS site. A portion of the property is located within the Site extent. The EDR report indicates that in 1996 a mercury spill occurred at the apartments when children had been playing with 12-15 vials of mercury. The land and groundwater were unaffected, but the surface water of McClellan Reservoir was impacted when vials were found in the storm sewer. The storm sewer runs along County Line Road from the apartment complex to McClellan Reservoir. McClellan Reservoir is located more than 500 feet from the Site extent. Due to the distance from the subject Site, the fact that most of this property is downgradient from C-470, this site likely does not pose a concern to the subject Site. (Photo 15)

EDR sites 216 and 218 (Photo 14) are both located in the Highlands Ranch Healthcare Center, a large medical complex located downgradient north of C-470. The EDR report indicates that on 2/11/2011 a spill occurred at site 216. Ninety gallons of diesel fuel spilled due to a failed generator trailer. About 10 gallons went into the storm drain and traveled approximately 250 feet to the outfall into a depressed area of land. The depressed area of land is located north of the Healthcare Center at a distance of about 800 feet. Custom Environmental was called and jetted out the storm sewer line, removed all impacted snow and excavated impacted soil near the outfall of the storm drain, and disposed of the material at a landfill. Water samples were also collected. Site 218 in the same area reports a 3.75 fluid ounce mercury spill in 2011. A blood pressure devise failed and mercury was spilled in an interior room. The physician sucked the mercury up in a syringe and placed in a urine collection container. Mercury Instruments USA responded to the clean up call. EDR 2013 states "The clean-up company was concerned because the readings for mercury in the indoor air were as high as 30 mg/cubic meter in one room and the contractor wants to close down." EDR Sites 216 and 218 likely do not pose a concern to the subject Site, as the mercury spill occurred indoors and was cleaned up, and the diesel spill was responded to and cleaned up. Additionally both sites are located downgradient of the Site extent.

3.2.1 Topographic Map Review

This Segment is included on the Littleton, Colorado 7.5-Minute Quadrangle, Highlands Ranch, Colorado 7.5-Minute Quadrangle, Denver East, Colorado 30-Minute Quadrangle and the Denver West, Colorado 30-Minute Quadrangle.

The 1890 Denver East map shows undeveloped land with one road visible near the location of South Broadway.

The 1899 Denver West map show undeveloped land with no roads visible on the map. One rail line (Denver and Silverton) crosses the current CDOT ROW near Santa Fe Drive.

The 1942 and 1950 Littleton map shows Santa Fe Drive, County Line Road, and the Highline canal. The Atchison Topeka and Santa Fe and Denver and Rio Grande rail line run north to south and are located just east of Santa Fe Drive.

The 1942 and 1949 Highlands Rand map shows that the area around current CDOT ROW is undeveloped. South Broadway terminates at County Line Road. No other development visible on map.

The 1957 Littleton map shows a country club located to the northwest of the current C-470, Santa Fe Drive interchange. a few homes are starting to show up both north and south of current CDOT ROW. Two gravel pits are visible at the intersection of County Line Road (County Road 31) and the Highline Canal.

No significant changes noted in the 1957 Highland Ranch map.

The 1965 maps shows the completion of McLellan Reservoir located north of County Line Road. More homes appear both north and south of CDOT ROW.

No significant changes noted in the 1965 Highland Ranch map.

The 1965 Littleton map (photo revised 1971) shows the completion of C-470 heading west at Santa Fe Drive.

The 1965 Highlands Ranch map (photo revised 1971) shows little change with the exception of a power line that crosses current CDOT ROW near the intersection with the highline canal. The power line continues to a substation located north of County Line Road.

The 1965 (photo revised 1980) Littleton map shows the area has not changed since 1971.

The 1965 (photo revised 1980) Highlands Ranch map shows the area has not changed since 1971.

The 1965 (photo revised 1994) Highlands Ranch map shows the completion of C-470 with bike path to the north. A pipeline that heads west and south exits a pump station located south of C-470 approximately .75 miles west of the South Broadway interchange. Two buildings are now located northwest of the C-470 and South Broadway interchange.

The 2011 Littleton map shows the completion of C-470 east of Santa Fe Drive recreating the interchange that was visible on the 1980 map. A interchange is also visible at Lucent Boulevard.

The 2011 Highlands Ranch map shows an apartment complex has been constructed just west of the two buildings northwest of South Broadway interchange. The two buildings are in the same location as Highland Ranch Medical Center (ID 216, 218). While the apartment complex is in the same location as the Bluff Apartment Complex (ID 225).

Minor development within the CDOT ROW was observed during the topographic maps review. The development listed above likely does not pose a concern to the subject corridor.

3.2.2 Aerial Photo Review

The 1937 aerial photo shows all of Segment 2 is undeveloped farm and ranch land. Roads that roughly align with County Line Road and South Broadway are present. Highline Canal can be seen intersecting with current CDOT ROW just east of the Santa Fe Drive interchange.

No significant changes noted in the 1955 aerial photo.

The 1993 aerial photo shows that construction of C-470 is underway. The South Broadway interchange is complete and extends to the west for about one mile. Area between unfinished portion of C-470 and Santa Fe Drive is still undeveloped farmland.

The 1999 aerial photo shows the completion of C-470 between South Broadway and Santa Fe Drive, including the interchange at Lucent Boulevard. Extensive development has and is taken place south of C-470 particularly between Lucent Boulevard and South Broadway. The north side of C-470 is undeveloped south of County Line Road.

No significant changes noted in the 2002 aerial photo.

Continued residential/commercial development on the south side of C-470 is visible in the 2007 aerial photos.

The 2012 aerial photo shows clearing and the addition of housing north of C-470 just east of Santa Fe Drive. Continued development south of C-470 has nearly developed all areas south of the highway.

Minor development within the CDOT ROW was observed during the photographic review. The development listed above likely does not pose a concern to the subject corridor.

3.2.3 FEMA Flood Zones

According to the FEMA Intranetix Viewer flood maps, there are no 100-year floodplains of concern within Segment 2. However, the FEMA flood map (08035C0036F) shows the Dad

Clark Gulch has potential to connect across C-470 with the Highline Canal as a Zone A flood zone, but it states that the 1% annual chance flood discharge will be contained in a culvert north of C-470 approximately 0.5 miles west of South Broadway.

3.2.4 Transformers, Electrical Features, and Miscellaneous Items

No transformers were observed in the CDOT ROW within this Section, however these observations should be confirmed prior to construction activities, and appropriate handling of materials (PCBs if present) should be conducted.

3.2.5 Lead-Based Paint

No samples of possible LBP were collected from this segment during the site investigation. The intersection of Santa Fe Drive and C-470, a bridge at MM 17.1, the overpass at the intersection of Lucent Boulevard and C-470, and a bridge at MM 18.7 did not contain painted surfaces.

3.3 Segment 3

Segment 3 encompasses the intersection of C-470 and South Broadway to just west of South University Boulevard (Figure 4).

A total of thirteen sites were listed in the database search conducted by EDR that were within the 1000-foot buffer. After review, three potential sites of concern were found. These sites were more thoroughly and visibly investigated within this Segment.

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
Chevron (ID 164)	201 E. County Line Rd. Littleton, CO 80122	CO LUST, CO LUST TRUST, CO UST	< 500	Gas station converted to a Waffle House 17 years ago. Tanks near the rear of the restaurant have been removed.
Jiffy Lube (ID 182)	1650 E. County Line Rd. Highlands Ranch, CO 80126	RCRA-CESQG, ERNS, FINDS, CO ERNS, AST	0	Still operating as a Jiffy Lube. Used oil bin located at rear on concrete that drains to a storm water system. Storm water drains downgradient, north from C-470.
Arapahoe Rental (ID 192)	1700 County Line Rd. Littleton, CO 80217	CO AST	0	Large concrete commercial sales building.

At the Chevron property (ID 164) (Photos 16, 17), a release was reported on 10/1/1990 and a site visit and LUST cleanup was initiated. Site cleanup was completed on 3/20/1992. Closure of the site and a No Further Action letter was issued on 1/12/1993. Visual inspection determined the site is now a Waffle House with abandoned boreholes and no observable current remediation. The current manager stated she has been working there for 17 years, since its opening. She further explained the tanks were located at the rear of the restaurant and had been removed. EDR confirms the 3 tanks are closed. The LUSTs have been closed and granted an NFA. The granting of an NFA is based upon contaminates not migrating off of the property. Since this site is located within close proximity to the subject Site, and a spill has occurred, this property may pose a risk to the corridor.

EDR site 182 is a Jiffy Lube (RCRA-CESQG, ERNS, FINDS, CO ERNS) still in operation. During the site visit, a used oil bin was observed at the rear of the building set on concrete. The concrete drains to the storm sewer system. Lead and benzene are known hazardous wastes stored on-site. The 2013 EDR report indicates there are 3 ASTs, two for lube oil and one for waste oil. In 2001, the facility received a notice of violation from the state regarding used oil from the generators. The site achieved compliance 10 days later. According to the CO ERNS report from 2007, an anonymous caller complained there was a dumping of materials, including motor oil, transmission fluid, and ethylene glycol, down the drain daily. This site is also a Conditionally Exempt Small Quantity Generator Site (CESQG). The storm water from this property may have impacted the area within the Site extent. It is noted that the site has a history of dumping, and therefore other dumping activities may have occurred that went unreported. Since this site is located within the Site extent and dumping of contaminates has occurred, this property may pose a risk to the corridor. (Photo 18)

The EDR report indicated that Arapahoe Rental (ID 192) contained a liquefied petroleum gas (LPG) AST that is now permanently closed. The site used to be part of the Division of Oil & Public Safety for Denver, Colorado before being converted to a large, cement building that houses the current commercial property. The property is located within the Site extent, however no reports of a spill have occurred. This property does not likely pose a risk to the subject Site.

3.3.1 Topographic Map Review

This Segment is included on the Highlands Ranch, Colorado 7.5-Minute Quadrangle, and the Denver West, Colorado 30-Minute Quadrangle.

The 1890 Denver East map shows undeveloped land with one road visible near the location of South Broadway.

The 1942 Highlands Ranch map shows that the area around current CDOT ROW is undeveloped. The improved portion of South Broadway terminates at County Line Road, but a unimproved road continues to the south crossing the current C-470 ROW. No other development visible on map.

No significant changes noted in the 1949 Highland Ranch map

No significant changes noted in the 1957 Highland Ranch map.

The 1965 Highland Ranch map shows an aqueduct that transects the current C-470 ROW just west of the University Boulevard interchange.

No significant changes noted in the Highlands Ranch map (photo revised 1971).

No significant changes noted in the Highlands Ranch map (photo revised 1980).

The 1965 (photo revised 1994) Highlands Ranch map shows the completion of C-470 with bike path to the north. Extensive residential development both north and south of C-470. Four larger possible commercial buildings are visible north of C-470 west of the University interchange.

The 2011 Highlands Ranch map shows storage units, car lots, and retail stores between C-470 and County Line Road.

No development within the CDOT ROW was observed in any of the topographic maps with the exception of the highway C-470, an undeveloped road, and an aqueduct.

3.3.2 Aerial Photo Review

The 1937 aerial photo shows all of section 3 is undeveloped farm and ranch land. Roads that roughly align with County Line Road and South Broadway are present. Unimproved road continues south from intersection of County Line Road and South Broadway and crosses current C-470 ROW.

No significant changes noted in the 1955 aerial photo.

The 1993 aerial photo shows that construction of C-470 is complete. The South Broadway and South University Boulevard interchanges are complete. Extensive residential development has taken place north and south of C-470. A retail shopping center has been built just to the west of the South University Boulevard interchange between County Line Road and C-470. Three additional building have been built to west of the shopping center that appear commercial in nature. along with a storage unit complex.

The 1999 aerial photo shown continued residential development north and south of C-470. Most areas are developed around C-470 with the exception of a strip of undeveloped land between County Line Road and C-470 that extends from the South Broadway interchange east for approximately 0.6 miles.

No significant changes noted in the 2002 aerial photo.

No significant changes noted in the 2007 aerial photo.

No significant changes noted in the 2012 aerial photo.

No development within the CDOT ROW was observed in any of the photographs with the exception of the highway C-470 and the unimproved road visible in the 1937 and 1955 photos.

3.3.3 FEMA Flood Zones

According to the FEMA Intranetix Viewer flood maps, there are no 100-year floodplains of concern within Segment 3.

3.3.4 Transformers, Electrical Features, and Miscellaneous Items

The following items were observed during the visual site assessment.

- At MM 19.1, a traffic flow stoplight with a controller box was observed at the on-ramp from South Broadway onto east-bound C-470.
- At MM 19.9, a traffic flow stoplight with a controller box was observed at the on-ramp from South University Boulevard onto west-bound C-470.

No transformers were observed in the CDOT ROW within this Section, however these observations should be confirmed prior to construction activities, and appropriate handling of materials (PCBs if present) should be conducted.

3.3.5 Lead-Based Paint

No samples of possible LBP were collected from this segment during the site investigation. The overpass guards at the intersection of C-470 and South University Boulevard were observed to not contain painted surfaces.

3.4 Segment 4

Segment 4 encompasses the intersection of C-470 and South University Boulevard to just west of South Quebec Street (Figure 5).

A total of twenty-nine sites were listed in the database search conducted by EDR that were within the 1000-foot buffer. After review, thirteen potential sites of concern were found. These sites were more thoroughly and visibly investigated within this Segment.

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
Continental Cleaners # 4 (ID 178)	2680 E. County Line Road	CO DRYCLEANERS, FINDS, AIRS, US-AIRS, RCRA-SQG	500	Located downgradient in a shopping center just south of County Line Road. No violations.
Residential House (ID 251)	8531 S. Forrest St. Littleton, CO 80126	EDR US Hist Auto Station	500	In a residential neighborhood located south of C-470. Drains away from C-470.
County Line Solid Waste Disposal Site (ID 222)	8422 S. Colorado Blvd. Littleton, CO 80126	CO ERNS, Meth Lab(CDL)	0	This is a historic landfill that closed in 1987. Groundwater flow is to the north. The highest surface of the landfill has been developed into David A. Lorenz Regional

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
				Park, a sports complex with artificial grass playing fields and a BMX track.
Centennial Water and Sanitation (ID 272)	8606 Canongate Ln. Littleton, CO 80130	CO ERNS, AST	0	Lift station for wastewater. Located on or near golf course south of C-470 ROW.
Conoco (ID 201)	5653 County Line Pl. Littleton, CO 80126	EDR US Hist Auto Stat	0	Currently a Conoco Station combined with a Quick Lube auto shop and car wash north of C-470. The paved parking lot drains to County Line Pl, then to Holly St.
Safelite Autoglass/My Auto Service Center/Just Brakes (ID 198)	5701 E. County Line Road Littleton, CO 80126	EDR US Hist Auto Stat	0	A group of auto shops up gradient and north of C-470. Site appears well kept.
Dry Cleaning Station (ID 184)	6086 E. County Line Road	CO DRYCLEANERS, AIRS, FINDS, US-AIRS, RCRA_SQG	0	North and downgradient from C-470. Appeared well kept at the time of the visit. Concrete drains north to County Line Road.
Clean Shine Car Wash (ID 184)	6028 E. County Line Road Littleton, CO 80126	CO ERNS	0	North and downgradient from C-470. Appeared well kept at the time of the visit. Concrete drains north to County Line Road.
AAMCO Transmissions (ID 184)	6028 E. County Line Road Littleton, CO 80126	LUST, UST	0	North and downgradient from C-470. Appeared well kept at the time of the visit. Concrete drains north to County Line Road.
Jim and Co. Auto Services (ID 188)	6328 E. County Line Road Highlands Ranch, CO 80126	EDR US Hist Auto Stat	0	Auto shop north of C-470 in a strip mall downgradient from the highway.
Courtesy Auto Care (ID 189)	6828 E. County Line Road Highlands Ranch, CO 80126	EDR US Hist Auto Stat	0	Auto shop north of C-470.
Brakes Plus - Highlands Ranch East (ID 190)	7040 E. County Line Road Highlands Ranch, CO 80126	EDR US Hist Auto Stat	0	Brakes Plus with a service station located north and downgradient of C-470. Asphalt drains west, then

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
				south to a retention area between C-470 and County Line Road.
Heritage Cleaners # 8 (ID 191)	7132 E. County Line Road	CO DRYCLEANERS, FINDS, RCRA-SQG, EDR-HIST CLEANERS	0	North and downgradient from C-470.
K&G Stores (ID 191)	7130 E. County Line Road	UST, LUST	0	North and downgradient from C-470.
Goodyear Auto Service Center (ID 156)	8273 S. Quebec St. Centennial, CO 80112	CO ERNS	500	This location is north and downgradient to C-470. Used oil containers are located in the rear of the building and behind a locked gate. The parking lot drains southeast into a retention basin near the northwest corner of Quebec and County Line Road.
Residential House (ID 295)	3729 E. Mallard Dr. Highlands Ranch, CO 80126	CO ERNS, CDL (Meth Lab)	1000	Residential house in a residential neighborhood.

Continental Cleaners #4 (ID 178) is a dry cleaner. Tetrachloroethylene is listed as "used on site". Multiple records show compliance with the state and no violations were found by EDR. This property is located downgradient and at a distance of 500 feet with no violations, and therefore likely does not pose a concern to the subject corridor.

EDR Site 251 is a house in a residential neighborhood south of C-470 (Photo 21). The site is cross gradient from the highway and water is likely to drain away from C-470. The EDR report explains that where the house sits now used to be a Chevron gas station, but does not give the date of operation or reason for listing. During the aerial photograph review, the 1955 photo shows no development in the area. The next photo in 1993 shows the construction for the existing subdivision with undeveloped land adjacent to the property. It is unlikely that this property was a Chevron Station. Based on site observations and database review, this property likely does not pose a concern to the subject corridor.

The County Line Waste Disposal Site (ID 222) is a solid waste municipal landfill (Photos 6, 7, 19, 20) located near the northeast corner of Colorado Boulevard and C-470. It operated from the 1960's until its closure in 1987. The landfill is owned by Arapahoe County and maintained by Waste Management Inc. Since closure, the South Suburban Recreation District has leased a part of the landfill and constructed a sports complex with artificial grass playing fields and a BMX-track. As a part of the post-closure plan, the Colorado Department of Public Health and Environment (CDPHE) requires groundwater and methane monitoring. Currently, Waste Management Inc. monitors groundwater quality via a natural attenuation remedial action program. Quarterly methane monitoring is also required and excess methane is flared in a structure located near the southwest corner of the landfill. Contaminated groundwater is present at the landfill. A plume was identified along the northern part of the landfill (opposite C-470 ROW). Groundwater flows to the north and the plume migrated off-site in that direction. As a result, a groundwater barrier was installed near the northern end of the landfill and contaminated groundwater was pumped and treated by the Englewood wastewater Treatment Plant. A remedial action program using natural attenuation is now in progress. A methane flare is situated in the southwest corner of the landfill, and the southern methane collection wells are visible from C-470. According to Waste Management Inc., methane in the northern monitoring wells was sometimes problematic and exceedances were observed. All methane-monitoring wells have been in compliance with State requirements since the additional piping was installed. The EDR report also showed evidence of criminal activity at the site in 2004. A boxed meth lab in a briefcase was found containing suspected iodine, hypophosphorus acid, naptha, acetone and HMWMD. Caldwell Environmental was notified for cleanup. The landfill was in place when C-470 was originally constructed. Since this site is located within the Site extent and a construction disturbance within the landfill area could occur, this property may pose a risk to the corridor.

Centennial Water and Sanitation (ID 272) is a lift station that is listed as a CO ERNS and AST site that was not located during site investigation. The AST was installed in 1992 and continues to be in use. The AST contains diesel fuel and no leaks or spills have been reported. The address in the EDR report plots to the Links Golf Course at Highlands Ranch where the lift station is believed to be located. The EDR report indicates two incidents involving untreated wastewater have occurred. In 2003, a force main line was hit and severed, releasing a limited amount of wastewater into the pit dug for a 42 inch main line. Most of the wastewater was contained in the pit and removed, however a small amount overflowed and impacted an adjacent waterway. The impact was reported as minimal. In 2005, there was an overflow of untreated domestic wastewater that entered a dewatering manhole adjacent to the site. The water that entered the manhole was pumped to the western tributary arm of the Big Dry Creek. As a result of the incident, a check valve was installed on the dewatering overflow line. Since the location of the spill may be located within the Site extent, this property may pose a risk to the corridor.

The Conoco gas station (ID 201) located north of C-470 was found to be an EDR US Historical Auto Station and was investigated due to its proximity to C-470. Previous names for this property include Auto Nation USA Neighborhood Service (2003) and Magic Rabbit Carwash & Lube Co (2010-2011) (EDR 2013b). The visual inspection determined that water drains away from the highway. Because no hazardous record of violations or spills were found and drainage is away from the corridor assumes, this property does not appear to pose a concern to the subject Site. (Photo 29)

Safelite Autoglass/My Auto Service Center/Just Brakes (ID 198) are all located in a building located north of C-470. The EDR report identifies it as a EDR US Historical Auto Station and reports it to have remained a Just Brakes since 2001. The building appears well kept and there are no records of hazardous spills or violations. This property likely does not pose a concern to the subject Site. (Photo 24)

Dry Cleaning Station (ID 184) is a dry cleaners that EDR shows has operated from at least 2000 until the time of the report. Tetrachloroethylene is listed as "used on site". Multiple records show compliance with the State and no violations were found by EDR. The property is located within the Site extent. Since this site is located within the Site extent, and because highly mobile chlorinated solvents are used, this property may pose a risk to the corridor.

Clean Shine Car Wash (ID 184) is a CO ERNS site. The property is located north and downgradient from C-470. The concrete is well kept and water appears to flow north, away from C-470 towards County Line Road. The EDR report indicates a spill occurred in 1997 when a driver punctured a hole in a diesel tank causing it to spill onto the street, entering a plugged storm drain. Thirty-five gallons of diesel/water mix were pumped from the storm drain and contaminated materials were disposed of at CSI in Bennett, Colorado. Because this site drains away from the highway and the affected material and areas were cleaned up, this property does not likely pose a concern to the subject Site.

AAMCO Transmission (ID 184) is a UST and LUST site. A leak was confirmed on 12/4/2001 and a site characterization was performed. Closure of the site occurred on 5/20/2002 with results less than risk based screening levels (RBSLs). Both LUST and USTs are permanently closed. , Since the property is located within the Site extent, and a spill has occurred, this property may pose a risk to the subject corridor.

Jim and Co. Auto Services (ID 188) and Courtesy Auto Care (ID 189) are auto repair shops that are located within the Site extent. During the site visit, the property appeared well kept. Both sites are listed as EDR US Historical Auto Stations under the names Jim & CO Auto Services Inc. (2005, 2011-2012) and County Line Import Automotive (2006-2010), and Courtesy Auto Care (2011), respectively. There are no reports of violations or spills, and therefore these sites likely do not likely pose a risk to the subject corridor. (Photos 22, 23)

Brakes Plus-Highlands Ranch East (ID 190) is also an EDR US Historical Auto Station. Name changes for this site include Brakes Plus (2005, 2007, 2008, 2010, 2011, 2012), Brakes Plus Car Care Center (2006), and Brakes Lube Tune (2009). The building’s asphalt drains to the west then south out to a retention area between C-470 and County Line Road downgradient from the highway. There are no reports of violations or spills, and therefore this property likely does not pose a risk to the subject corridor. (Photo 25)

Heritage Cleaners # 8 (ID 191) is a dry cleaner. Tetrachloroethylene is listed as "used on site". Records show compliance with the state and no violations were found by EDR. The site is located within the Site extent. Since this site is located within the Site extent, and because highly mobile chlorinated solvents are used, the property may pose a risk to the corridor.

K & G Stores (ID 191) is a gas station that EDR reports as a LUST and UST, which is located within the Site extent. The site contained 3 USTs that were installed in 1986. The tanks were closed in 2002. A confirmed release occurred 12/13/2002. The site was monitored and closure was approved on 10/14/2004. Since this site is located within the Site extent and a spill has occurred, this property may pose a risk to the corridor.

Goodyear Auto Service Center (ID 156) is located downgradient of C-470. The parking lot drains to the southeast into a retention basin located near the northwest corner of South Quebec Street and County Line Road. There is a used oil bin at the rear of the building behind a locked gate (Photo 26). The EDR report indicates that in 2006, it was brought to Goodyear's attention that the AST used for waste oil leaked, ran across the asphalt, and entered a storm drain detention area. Goodyear enlisted Safety Clean to drain the tank, clean up the asphalt, and try to dam the spill away from the storm drain. It was uncertain how much oil was released. Because this site is downgradient and drains away from C-470, it is not likely a concern to the subject Site.

EDR site 295 is listed as a CO ERNS and CDL- or meth lab- site. The EDR report indicates the residence was used as a fixed facility for criminal intent involving meth production in 2004. The South Metro Drug Task Force responded initially to the situation, and Caldwell Environmental was notified for clean-up activities. Due to the distance from ROW (~1000 feet), and reported cleanup actions, this site does not appear to pose a concern to the subject Site.

3.4.1 Topographic Map Review

This Segment is included on the Highlands Ranch, Colorado 7.5-Minute Quadrangle, and the Denver West, Colorado 30-Minute Quadrangle.

The 1890 Denver East map shows undeveloped land with one road visible just east of the current University Boulevard. The road is referred to as Old Colorado Road on the map. Old Colorado Road crosses the current C-470 ROW just east of the University Boulevard interchange and heads south.

The 1942 Highlands Ranch map shows that the area around current CDOT ROW is undeveloped. The Old Colorado Road shown on the 1890 map is not shown. Daniels Park Road continues south from County Line Road and crosses the current C-470 ROW.

No significant changes noted in the 1949 Highland Ranch map

No significant changes noted in the 1957 Highland Ranch map.

The 1965 Highland Ranch map shows gravel pit located near the intersection of Big Dry Creek and the current ROW of C-470.

The 1965 (photo revised 1971) Highlands Ranch map shows the addition of four buildings north of the current C-470 ROW and west of the gravel pit. The location of the four buildings is located in a similar location to the current radio facility. A large rectangular area shown as disturbed is visible just north of the current ROW of C-470. The area is roughly 2000 feet by

1500 feet and is located in the general area of the County Line Waste Disposal site (EDR ID 122).

No significant changes noted in the 1965 (photo revised 1980) Highlands Ranch map.

The 1965 (photo revised 1994) Highlands Ranch map shows the completion of C-470 with bike path to the north. Disturbed area at the location of the County Line Waste Disposal Site is no longer shown on the map. Residential development north of County Line Road. Numerous larger buildings are visible north of C-470 and south of County Line Road. The larger buildings are visible in two large groups. The first located just east of the University Boulevard interchange, the second is located west of Holly Street and east of the Quebec Street interchange. Two radio facilities are visible. The first radio facility is located north of C-470 just west of Dry Creek and a second is located South of C-470 south and just east of Daniels Park Road.

The 2011 Highlands Ranch map shows the extensive development of the highlands ranch residential subdivision south of C-470. Residential and retail development is completed north of C-470, leaving no undeveloped land. A park is now visible in the same location as the former landfill.

No development within the CDOT ROW was observed in any of the topographic maps with the exception of the highway C-470, an Daniels Park Road. The County Line Waste Disposal Site is located very near C-470, but it appears on the maps that C-470 was diverted to the south to avoid the former landfill

3.4.2 Aerial Photo Review

The 1937 aerial photo shows all of Segment 4 is undeveloped farm and ranch land. Roads that roughly align with County Line Road and Daniels Park Road are present. Daniels Park Road continues south from County Line Road and crosses the current C-470 ROW.

The 1955 aerial photo shows an disturbed area located at the same location as a gravel pit visible on the 1965 topographic map. The gravel pit is located near the intersection of Big Dry Creek and the current ROW of C-470.

The 1993 aerial photo shows that construction of C-470 is complete. The Quebec and University Boulevard interchanges are complete. Extensive residential development has taken place north and south of C-470. A retail shopping center has been built just to the east of the University interchange between County Line Road and C-470. Additional retail shopping has been built just to the west of the Quebec Street interchange between County Line Road and C-470. The County Line Disposal Site is visible. The landfill is covered with grass and methane vents are visible. No disposal activities are present at this time and it appears that the landfill is closed.

The 1999 aerial photo shown continued residential development north and south of C-470. Most areas are developed around C-470. A BMX track is visible in the area of the County Line Disposal Site.

No significant changes noted in the 2002 aerial photo.

No significant changes noted in the 2007 aerial photo with the exception of the building of recreational fields on the former landfill.

No significant changes noted in the 2012 aerial photo.

3.4.3 FEMA Flood Zones

According to FEMA Intranetix Viewer flood maps, there are no 100-year floodplains of concern within Segment 4. A short section of the highway in this Segment was unavailable for print through the FEMA website. Upon further investigation, Focus Map 21 of the EDR 2013 report contained this missing section, and confirmed that there are no 100-year floodplains within Segment 4.

3.4.4 Transformers, Electrical Features, and Miscellaneous Items

The following items were observed during the visual site assessment.

- At MM 21.3, a Telecom tower was observed about 100 feet south of ROW. Photo 1 shows what appears to be a utility box for the tower. Photo 2 shows the actual building associated with the Telecom tower.

- At MM 22.7, there are five radio towers located approximately 200 feet north of ROW. (Photograph 5)

- At MM 23.9, a traffic flow stoplight with a control box was observed at the on-ramp from South Quebec St. onto west-bound C-470.

  No transformers were observed in the CDOT ROW within this Section, however these observations should be confirmed prior to construction activities, and appropriate handling of materials (PCBs if present) should be conducted.

3.4.5 Lead-Based Paint

No samples of possible LBP were collected from this segment during the site investigation. The overpass guard rails at the intersections of C-470 and South University Boulevard, and C-470 and Colorado Boulevard, did not contain painted surfaces. A bridge's textured surface at MM 22.7 appeared to be flaking, yet it did not contain paint so a sample was not collected.

3.5 Segment 5

Segment 5 encompasses the intersection of C-470 and South Quebec Street to the Intersection of C-470 and I-25 (Figure 6).

A total of twenty-nine sites were listed in the database search conducted by EDR that were within the 1000-foot buffer. After review, five potential sites of concern were found. These sites were more thoroughly and visibly investigated within this Segment.

Site Name and EDR Site ID	Site Address	Type	Distance from Site Extent	Site Description
7-Eleven (ID 309)	8750 S Yosemite St Lone Tree, CO 80124	FINDS, USAIRS, CO LUST	0	Located southwest of C-470 with the gradient falling away to the west, downgradient/cross gradient form the highway. The tanks are located on the west side of the gas pumps.
Fairway Collision Center (ID 273)	8500 S Valley Hwy Englewood, CO 80112	CO ERNS	1000	Located north of E-470 and east of I-25. Downgradient. During site visit the entire area the was graded dirt.
Fairway Auto Service Center (ID 302)	8550 S Valley Hwy Englewood, CO 80112	EDR US Hist Auto Stat	500	
Crest Apartment Building (ID 370)	10049/10051 Park Meadows Dr. Lone Tree, CO 80124	EDR US Hist Auto Stat	1000	These locations are in a large residential apartment building cross gradient to C-470.
The Retreat at Park Meadows (ID 373)	10200 Park Meadows Dr. Lone Tree, CO 80124	EDR US Hist Auto Stat	1000	An apartment complex south of the I-25 intersection. Cross gradient.

7-Eleven (ID 309) is south and downgradient /cross gradient of C-470 (Photo 30). According to the EDR report, it contained two LUSTs closed in 2003 and 2010, and currently has two gasoline USTs in use. AIRS has determined the site emits amounts of benzene and volatile organic compounds to fit the criteria of a hazardous air pollutants site. All reported monitoring efforts showed the site remains in compliance with procedural requirements. The location is within the Site extent. Since this site is located within the Site extent and a spill has occurred, the site may pose a risk to the corridor.

During the site visit, the addresses of Fairway Collision Center (ID 273) and Fairway Auto Service Center's (ID 302) had been demolished. The site was cleared and only dirt was observed. No debris or signs of contamination was observed. Fairway Collision Center (ID 273) is listed in the EDR report as a CO ERNS. In 2010, a caller reported to the EPA that an unknown smell seemed to be coming from a drain and that "Employees" were getting sick (not further specified). Other customers claimed it to be a sewer type smell, but the report does not contain information about any follow-up measures taken. The Fairway Auto Service Center's (ID 302) address is adjacent to the Fairway Collision Center and was listed as an EDR US Hist Auto Station under the name Fairway Auto Service, Inc. in 2012. The site is located downgradient and at a distance of a 1000 feet or more from the Site. This site also had a reported sewer smell. An odor in the sewer system would not represent a risk to construction in the area. Therefore, these sites are not likely to pose a concern to the subject corridor. (Photo 33)

The Crest Apartment Buildings (ID 370) and The Retreat at Park Meadows (ID 373) currently are both apartment complexes listed as EDR US Hist Auto Stations under the names Select Auto Broker, LLC (2005) and Sejon Oil & Gas Co Inc (2006-2007), and Everything Mobile Inc. (2004-2005), respectively. Historic topographic maps and aerial photographs were reviewed and no evidence of an auto station or repair shop were observed. The two properties were undeveloped until recently. First sign of development was the current apartment building located at the sites currently. Due to the distance from ROW and no reported hazards, these sites likely do not pose a concern to the subject Site. (Photos 31, 32)

3.5.1 Topographic Map Review

This Segment is included on the Highlands Ranch, Colorado 7.5-Minute Quadrangle, Parker, Colorado 7.5-Minute Quadrangle and the Denver East, Colorado 30-Minute Quadrangle.

The 1890 Denver East map shows undeveloped land with County Line Road and a road that heads south and crosses the current ROW of C-470. The road is referred to as Happy Canyon Road on the map. Happy Canyon crosses the current C-470 ROW near the current interchange with I-25 and heads south.

The 1942 Highlands Ranch map shows that the area around current CDOT ROW is undeveloped. County Line Road is visible.

The 1942 Parker map shows large undeveloped areas with a road named Happy Canyon Road. Happy Canyon Road crosses the current C-470 ROW near the current interchange with I-25 and heads south.

No significant changes noted in the 1949 Highland Ranch map.

No significant changes noted in the 1949 Parker map.

No significant changes noted in the 1957 Highland Ranch map.

The 1957 Parker map shows that Happy Canyon Road is now named Highway 87 and is shown as under construction.

No significant changes noted in the 1965 Highland Ranch map.

The 1965 Parker map shows that Hwy 87 is now named I-25 and an interchange at County Line Road has been constructed.

No significant changes noted in the 1965 (photo revised 1971) Highland Ranch map.

The 1965 (photo revised 1971) Parker map shows a frontage road runs down the east side of I-25 from County Line Road to the south. A number of small building that appear to be a ranch are located near the current location of the C-470 and I-25 interchange.

The 1965 (photo revised 1980).Highlands Ranch map shows residential development south of the current C-470 ROW. An un-named road crosses the C-470 ROW just west of the current I-25 interchange.

No significant changes noted in the 1965 (photo revised 1980) Parker map.

The 1965 (photo revised 1994) Highlands Ranch map shows the completion of C-470 with bike path to the north. Residential development to the north of County Line is visible along with continued development south of C-470. Columbine Hospital is visible near the Quebec Street interchange. A fire Station is also visible south of C-470 at Yosemite. A large office building is now visible south of C-470 between Yosemite and the current street of Acres Green.

The 1965 (photo revised 1994) Parker map shows the completion of C-470 along with the interchange to I-25. Larger building possible office space is constructed north northeast of the I-25 interchange.

The 2011 Highlands Ranch map shows continued residential development north and south of C-470. A interchange has been constructed at Yosemite and park meadows mall and numerous retail is now present north of C-470 that continues to the west to Quebec Street. South of C-470 office buildings and retail is visible near the C-470 ROW.

The 2011 Parker map shows continued development of office buildings north and south of E-470 and east of I-25. North of C-470 and west of I-25 Park meadows mall is now visible. South of C-470 and west of I-25 development of office buildings and apartments are visible.

No development within the CDOT ROW was observed in any of the topographic maps with the exception of the construction of highway C-470 and a few intersecting roads.

3.5.2 Aerial Photo Review

The 1937 aerial photo shows all of section 4 is undeveloped farm and ranch land. Roads that roughly align with County Line Road and historic Happy Canyon Road are present.

The 1955 aerial photo shows no significant change.

The 1993 aerial photo shows that construction of C-470 and I-25 is complete. The Quebec Street and I-25 interchanges are complete. Extensive residential development has taken place north and south of C-470. Office buildings are now located north of E-470 and east of I-25. Construction on Park Meadows Mall has begun. An office building is located between Yosemite and Acres Green. Area south of C-470 between Yosemite and I-25 remains undeveloped.

The 1999 aerial photo shown continued residential development north and south of C-470 The Yosemite interchange is complete. Park Meadows Mall has been completed and other retail now fills the area between C-470, County Line Road, Quebec Street and I-25. South of C-470 many retail and office buildings have been constructed south of C-470. The area south of C-470 between Yosemite and I-25 is under heavy construction with apartment and office buildings.

The 2002 aerial photo shows continued development.

No significant changes noted in the 2007 aerial photo.

No significant changes noted in the 2012 aerial photo with the exception of a new bridge at the Quebec Street interchange.

No development within the CDOT ROW was observed in any of the aerial photos with the exception of the construction of highway C-470 and a few intersecting roads.

3.5.3 FEMA Flood Zones

FEMA identifies two 100-year floodplains within Segment 5 (refer to Section 1 for flood zone definitions):

- FEMA Intranetix Viewer flood maps 08035C0033F and 08035C0041F both show Big Dry Creek as having a winding, narrow-banded Zone AE flood plain that seems to cross underneath a C-470 bridge, directly south of where County Road 29/South Holly Street ends (halfway between South Colorado Boulevard and South Quebec Street). However, the map also states that a 1% annual chance flood discharge/floodway will be contained in a constructed channel on the north side of the highway.

- According to the FEMA Intranetix Viewer flood maps (map 08035C0034F), a narrow band along the local Willow Creek, is identified as a Zone A floodplain. It crosses C-470 approximately 1 mile west of the intersection of South Yosemite St. and C-470 and follows the Willow Creek Trail.

3.5.4 Transformers, Electrical Features, and Miscellaneous Items

The following items were observed during the visual site assessment.

- At MM 24.1, a traffic flow stoplight with a control box was observed at the on-ramp from South Quebec Street onto east-bound C-470.

- At MM 25.9, a traffic flow stoplight with an electronic box with a controller was observed at the on-ramp from I-25 onto west-bound C-470.

No transformers were observed in the CDOT ROW within this Section, however these observations should be confirmed prior to construction activities, and appropriate handling of materials (PCBs if present) should be conducted.

3.5.5 Lead-Based Paint

One paint sample was collected from the railing of a pedestrian bridge at the intersection of South Quebec Street and C-470 (Photos 27, 28). Reservoirs Environmental, Inc. Lab results on July 3, 2013 indicate that the paint sample at this location was found to be below the reporting limit for lead. Other sites investigated in this segment during the site visit include a bridge over a drainage basin at MM 24.2, the bridge at the intersection of Yosemite and C-470, and the bridge and railings at the intersection of I-25 and C-470. None of these sites were found to have painted surfaces. A railing located on a small retaining wall for a Furniture Row Retail Complex (Photo 4) was observed to have paint. The railing was located on private property immediately adjacent to CDOT ROW. However the paint was not sampled for lead as it was on private property.

4.0 Opinions and Conclusions

SUMMIT has performed a Phase I ESA in conformance with the scope and limitations of ASTM E 1527-05 for the Site. Any exceptions to, or deletions from, this practice are described in Section 1 of this report. This assessment has revealed no evidence of recognized environmental conditions in connection with the Site except for the sites discussed below. Additionally, other items to be noted are discussed below.

4.1 Segment 1

One Segment 1 site has been determined to present recognized environmental conditions, historic recognized environmental conditions, or toxic materials have been identified which should be handled in accordance with all applicable regulations.

JEFFCO Road and Bridge (ID 304) is a work and storage area for road and bridge construction supplies located south and cross gradient of C-470. It has five underground storage tanks (UST): one 1000-gallon waste oil tank, one 1000-gallon gasoline tank, one 4000-gallon diesel tank, and three 1000-gallon diesel tanks (Goodbee 2005). The EDR report indicates a case of illegal dumping in 1997 where an unknown quantity of oil was dumped in the shop's storm water retention pond. Surface water was impacted. Cleanup included breaking up and removing impacted ice, vacuuming 1500 gallons of water/oil into a roll-off, and placing it in absorbent (material) pigs. Since this site is located within the Site extent and a spill has occurred, this property may pose a risk to the subject corridor.

4.2 Segment 2

One Segment 2 site has been determined to present recognized environmental conditions, historic recognized environmental conditions, or toxic materials have been identified which should be handled in accordance with all applicable regulations.

Bowen Farms (ID 207) was not located upon visual investigation. However it is likely that the address refers to a field located adjacent to CDOT ROW north of C-470 and south of County Line Road. The EDR report indicates it is a CO LUST site with four permanently closed tanks: one gasoline UST, two gasoline ASTs, and one diesel AST. The LUST was installed in 5/12/1978 and a confirmed release occurred on 10/10/2006. A site visit occurred 11/3/2006 and a closure letter was issued 12/8/2006 which referenced lower than RBSLs. Since this site is located within the Site extent and a leak has occurred on the property, this property may pose a risk to the subject corridor.

4.3 Segment 3

Two Segment 3 sites have been determined to present recognized environmental conditions, historic recognized environmental conditions, or toxic materials have been identified which should be handled in accordance with all applicable regulations.

A release was reported at the Chevron site (ID 164) on 10/1/1990, and a site visit and LUST cleanup was initiated. Site cleanup was completed on 3/20/1992. Closure of the site and a No Further Action letter was issued on 1/12/1993. Visual inspection determined the site is now a

Waffle House with abandoned boreholes and no observable current remediation. The current manager, who has worked at the site 17 years since its opening indicated the tanks were located at the rear of the restaurant and had been removed. Since this site is located within close proximity to the Site extent and a spill has occurred, this property may pose a risk to the corridor.

EDR Site 182 is a Jiffy Lube (RCRA-CESQG, ERNS, FINDS, CO ERNS) still in operation. During the site investigation, a used oil bin was located at the rear of the building set on concrete. The concrete drains to the storm sewer system. Lead and benzene are known hazardous wastes stored on-site. The EDR report indicates there are three ASTs, two for lube oil and one for waste oil. In 2001, the facility received a notice of violation from the state regarding used oil from the generators and achieved compliance 10 days later. According to the CO ERNS report from 2007, an anonymous caller complained there was a dumping of materials, including motor oil, transmission fluid, and ethylene glycol, down the drain daily. The storm water from this property may have impacted the area within the Site extent. Since this site is located within the Site extent and a documented history of dumping of contaminates has occurred, this property may pose a risk to the corridor.

4.4 Segment 4

Six Segment 4 sites have been determined to present recognized environmental conditions, historic recognized environmental conditions, or toxic materials have been identified which should be handled in accordance with all applicable regulations.

The County Line Waste Disposal Site (ID 222) is a solid waste municipal landfill located near the northeast corner of Colorado Boulevard and C-470. It operated from the 1960's until its closure in 1987. The landfill is owned by Arapahoe County and maintained by Waste Management Inc. Currently, Waste Management Inc. monitors groundwater quality via a natural attenuation remedial action program. Quarterly methane monitoring is also required and excess methane is flared in a structure located near the southwest corner of the landfill. Contaminated groundwater is present at the landfill. A plume was identified along the northern part of the landfill (opposite C-470 ROW). Groundwater flows to the north and the plume migrated off-site in that direction. As a result, a groundwater barrier was installed near the northern end of the landfill and contaminated groundwater was pumped and treated by the Englewood Wastewater Treatment Plant. A remedial action program using natural attenuation is now in progress. A methane flare is situated in the southwest corner of the landfill and the southern methane collection wells are visible from C-470. According to Waste Management Inc., methane in the northern monitoring wells was sometimes problematic and exceedances were observed. All methane-monitoring wells have been in compliance with State requirements since the additional piping was installed. The EDR report also showed evidence of criminal activity at the site in 2004. A boxed meth lab in a briefcase was found containing suspected iodine, hypophosphorus acid, naptha, acetone and HMWMD. Caldwell Environmental was notified for cleanup. The landfill was in place when C-470 was originally constructed. Since this site is located within the Site extent and a construction disturbance within the landfill area could occur, this property may pose a risk to the corridor.

Centennial Water and Sanitation (ID 272) is a lift station that is listed as a CO ERNS and AST site which was not located during site investigation. The AST was installed in 1992 and continues to be in use. The AST contains diesel fuel and no leaks or spills have been reported. The address in the EDR report plots to the Links Golf Course at Highlands Ranch where the lift station is believed to be located. The EDR report indicates two incidents involving untreated wastewater have occurred. In 2003, a force main line was hit and severed, releasing a limited amount of wastewater into the pit dug for a 42-inch main line. Most of the wastewater was contained in the pit and removed, however a small amount overflowed and impacted an adjacent waterway. The impact was reported as minimal. In 2005, there was an overflow of untreated domestic wastewater that entered a dewatering manhole adjacent to the site. The water that entered the manhole was pumped to the western tributary arm of the Big Dry Creek. As a result of the incident, a check valve was installed on the dewatering overflow line. Since the location of the spill may be located within the Site extent, this property may pose a risk to the subject corridor.

Dry Cleaning Station (ID 184) is a dry cleaners that EDR shows has operated from at least 2000 until the time of the report. Tetrachloroethylene is listed as "used on site". Multiple records show compliance with the state and no violations were found by EDR. This property is located within the Site extent, and because highly mobile chlorinated solvent are used, the site may pose a risk to the corridor.

AAMCO Transmission (ID 184) is a UST and LUST site. A leak was confirmed on 12/4/2001 and a site characterization was performed. Closure of the site occurred on 5/20/2002 with results less than RBSLs. Since this property is located within the Site extent and a spill has occurred, this property may pose a risk to the corridor.

Heritage Cleaners # 8 (ID 191) is a dry cleaner. Tetrachloroethylene is listed as "used on site". Records show compliance with the state and no violations were found by EDR. This property is located within the Site extent, and because highly mobile chlorinated solvent are used, the site may pose a risk to the subject corridor.

K & G Stores (ID 191) is a gas station that EDR reports as a LUST and UST. The site contained three USTs that were installed in 1986 and closed in 2002. A confirmed release occurred 12/13/2002. The site was monitored and closure was approved on 10/14/2004. Since this property is located within the Site extent and a spill has occurred, this property may pose a risk to the subject corridor.

Based on the results of the LBP sampling conducted by SUMMIT in 2013, LBP is not present at the Quebec Street bridge. However SUMMIT was not to access private property to test for LBP. All work should be conducted with appropriate engineering controls and work practices, and should be conducted by properly trained and protected personnel as required by OSHA regulations. Cutting, grinding, or demolition activities where LBP is present, can cause a release of dust or fumes containing lead into the air, creating a breathing hazard to workers. Therefore, demolition activities involving LBP are covered under the Occupational Safety and Health Administration (OSHA) Construction Industry Standard for Lead (29 CFR, Part 1926.62). Strict controls for grinding, cutting, or abrading of LBP should be should be implemented during construction/demolition activities to ensure compliance with OSHA provisions and to reduce potential lead dust or fumes.

4.5 Segment 5

One segment 5 site has been determined to present recognized environmental conditions, historic recognized environmental conditions, or toxic materials have been identified which should be handled in accordance with all applicable regulations.

7-Eleven (ID 309) is south and downgradient /cross gradient of C-470. According to the 2013 EDR report, it contained two LUSTs closed in 2003 and 2010 and currently has two gasoline USTs in use. Since this site is located within the Site extent and a spill has occurred, this property may pose a risk to the subject corridor.

4.6 Other Items for Consideration

FEMA Intranetix Viewer flood maps identify two 100-year floodplains within Segment 1. One crosses the highway just west of the intersection at Kipling Street, runs along C-470 to the north, and crosses C-470 again where it flows into Chatfield Lake (south of C-470) at approximately 0.5 miles east of South Wadsworth Boulevard along C-470. The second one crosses C-470 approximately a mile west of South Santa Fe Drive.

FEMA Intranetix Viewer flood maps indicate there are no 100-year floodplains of concern within Segment 2. However, the FEMA flood map shows the Dad Clark Gulch has potential to connect across C-470 with the Highline Canal, but it states that the 1% annual chance flood discharge will be contained in a culvert north of C-470 approximately 0.5 miles west of South Broadway.

FEMA identifies two 100-year floodplains within Segment 5. One appears to cross underneath a C-470 bridge, directly south of where County Road 29/South Holly Street ends (halfway between South Colorado Boulevard and South Quebec Street). However, the map also states that a 1% annual chance flood discharge/floodway will be contained in a constructed channel on the north side of the highway. The second crosses C-470 approximately 1 mile west of the intersection of South Yosemite and C-470 and follows the Willow Creek Trail.

As summarized above, one LBP sample was collected within Segment 4 from the Quebec Street bridge and was found to not contain lead above the detection limit. Painted guard rails were observed on a number of sites within the Site extent, however samples were not collected because the rails were located on private property. Waste materials generated during demolition which have LBP require a hazardous waste determination as outlined in 40 CFR 262.11 and 261.24. Waste characterization should be conducted on all materials coated with LBP by collection of representative composite samples of the wastestream, and analysis for metals by the Toxicity Characteristic Leaching Procedure (TCLP). Any materials which exceed the TCLP limit for lead of 5 parts per million in the leachate must be disposed of as hazardous waste. Materials that do not exceed this limit may be disposed of as solid waste at an appropriate landfill.

A number of transformers were observed inside or within close proximity to the CDOT ROW. If the transformers are impacted by the construction activities, then appropriate handling and disposal of any PCB-containing materials (if present) as required by regulatory guidelines should be followed during construction activities associated with the C-470 expansion.

5.0 Certification and Qualifications

5.1 Certification

We have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject property. We have developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in 40 CFR Part 312, with the exception of the items discussed in Section 1 of this report.

Andy Sagen
Environmental Professional Completing the Site Visit and Phase I ESA
Geologist

Monique R. Ammidown, P.G.
Environmental Professional Reviewing the Phase I ESA
Senior Geologist, Project Manager

5.2 Qualifications

Ms. Ammidown has worked in the environmental consulting industry for over 15 years, conducting Phase I ESAs throughout Colorado and across the United States. The ESAs have been conducted in general accordance with the ASTM *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process (Practices E 1527-97, E 1527-00, and E 1527-05), and* the USEPA AAI Final Rule (40 CFR Part 312). In some instances, at the request of the client, the scope of work has included additional issues outside the standard practice. Her experience also includes Phase II ESAs, remedial investigations, Environmental Baseline Studies, as well as various field types of work and sampling activities. Ms. Ammidown has a B.S. Degree in Geology, and an M.E. Degree in Geographic Information Systems, both from the University of Colorado at Denver, and is a registered Professional Geologist in the State of Wyoming. Additionally, Ms. Ammidown is a Certified Asbestos Building Inspector in Colorado and Utah, and a Certified Lead-Based Paint Inspector in Colorado.

Mr. Sagen has over 7 years of environmental consulting experience including conducting Phase I and Phase II ESAs, site characterizations, remedial investigations, facility investigations, sampling, well installation, and various types of soil, surface water, and groundwater investigations. Mr. Sagen has conducted soil and groundwater sampling and analysis, emergency response, hazardous material management, and field data acquisition for several contaminated sites. He has a B.S. Degree in Geology from Adams State College, and is a Certified Asbestos Building Inspector and Lead-Based Paint Inspector in Colorado.

6.0 References

Goodbee 2005. C-470 Corridor, Hazardous Materials Technical Report. March 2005.

USGS 1995. U.S. Geological Survey Ground Water Atlas of the United States, Arizona, Colorado, New Mexico, Utah, HA 730-C, 1995.

EDR 2013b. Environmental Data Resources, Inc. DataMap ™ Area Study, June 4, 2013.

EDR 2012a. Environmental Data Resources, Inc. DataMap ™ Well Search Report, June 4, 2013.

Figures

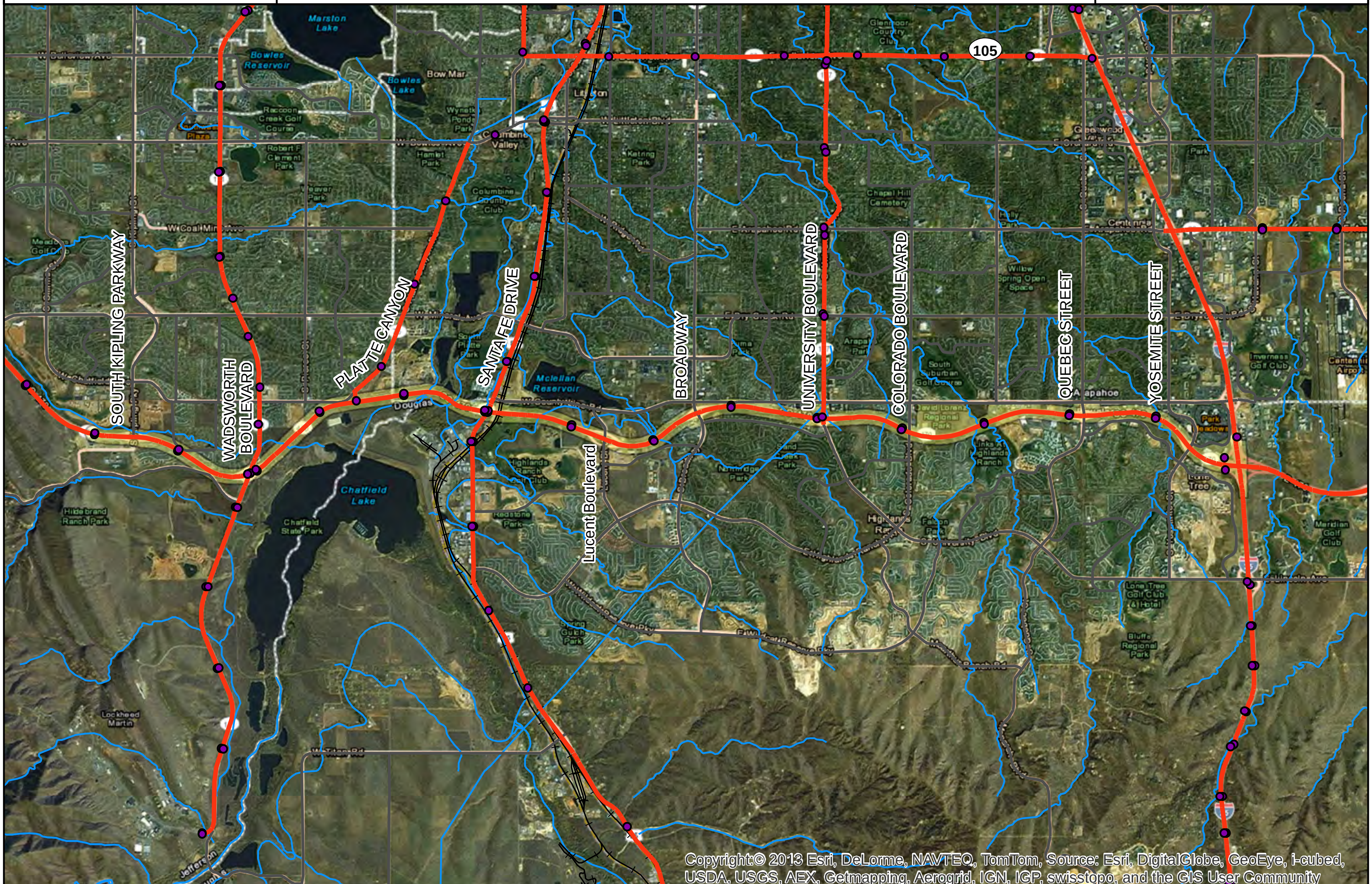
Figure 1

Site Location Map

Environmental Re-Evaluation of C-470, South Kipling Parkway to I-25, Jefferson and Douglas Counties, Colorado

N

North American Datum 1983
Universal Transverse Mercator
Zone 13 N, Meters



Legend

Approx. Site Extent
Milepost Markers
Highway
Railroad
Stream

Aerial Photo Courtesy of Google Earth, 7/1/13

1 in = 8,333.33 feet

0 | 3,200 | 6,400 Feet

Prepared for: Wilson & Company; Colorado Department of Transportation

Prepared by: Summit

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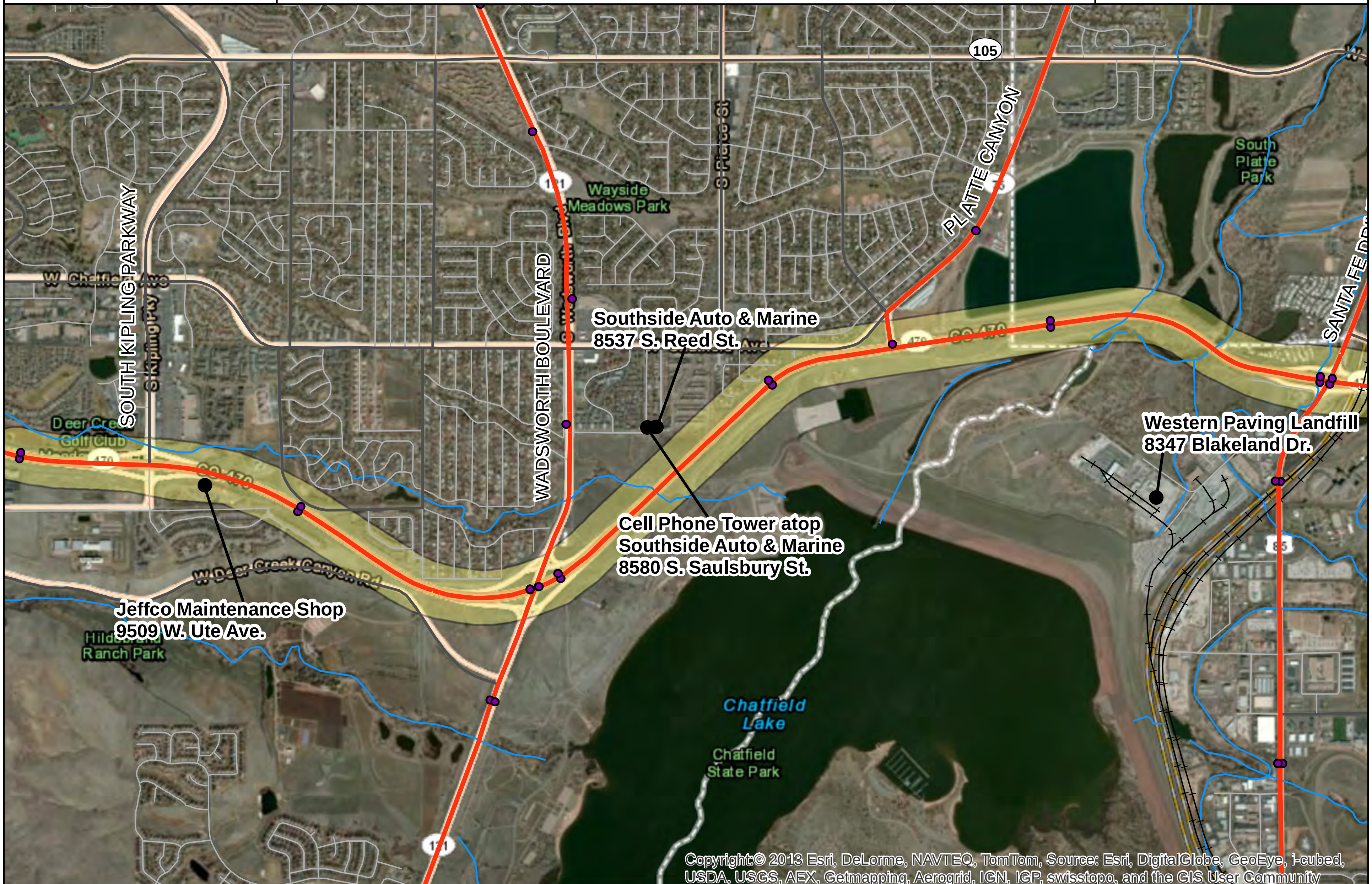
Figure 2

Segment 1 - C-470 and South Kipling Parkway to Just West of South Santa Fe Drive

Environmental Re-Evaluation of C-470, South Kipling Parkway to I-25, Jefferson and Douglas Counties, Colorado

N

North American Datum 1983
Universal Transverse Mercator
Zone 13 N, Meters



Legend

- Approx. Site Extent
- Milepost Markers
- Highway
- Railroad
- Stream
- Sites Identified in Redulatory Database (only sites with mappable addresses shown)

Aerial Photo Courtesy of Google Earth, 7/1/13

1 in = 2,500 feet

0 950 1,900 Feet

Prepared for: WILSON & COMPANY, COLORADO DOT DEPARTMENT OF TRANSPORTATION

Prepared by: Summit

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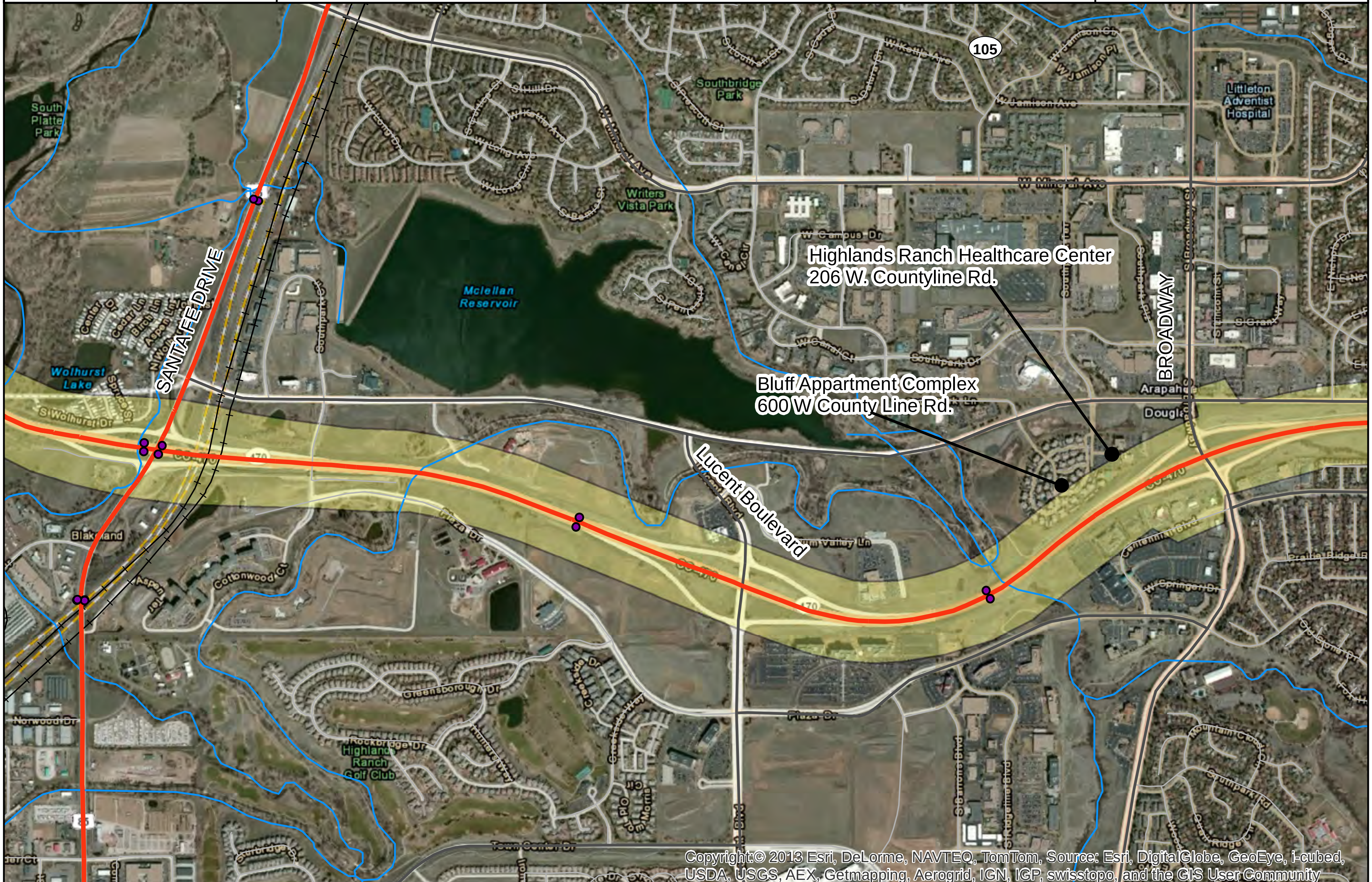
Figure 3

Segment 2 - C-470 and South Santa Fe Drive to Just West of South Broadway

Environmental Re-Evaluation of C-470, South Kipling Parkway to I-25, Jefferson and Douglas Counties, Colorado

N

North American Datum 1983
Universal Transverse Mercator
Zone 13 N, Meters



Legend

- Approx. Site Extent
- Milepost Markers
- Highway
- Railroad
- Stream
- Sites Identified in Redulatory Database (only sites with mappable addresses shown)

Aerial Photo Courtesy of Google Earth, 7/1/13

1 in = 1,666.67 feet

0 630 1,260 Feet

Prepared for: WILSON & COMPANY, COLORADO DOT

Prepared by: SUMMIT

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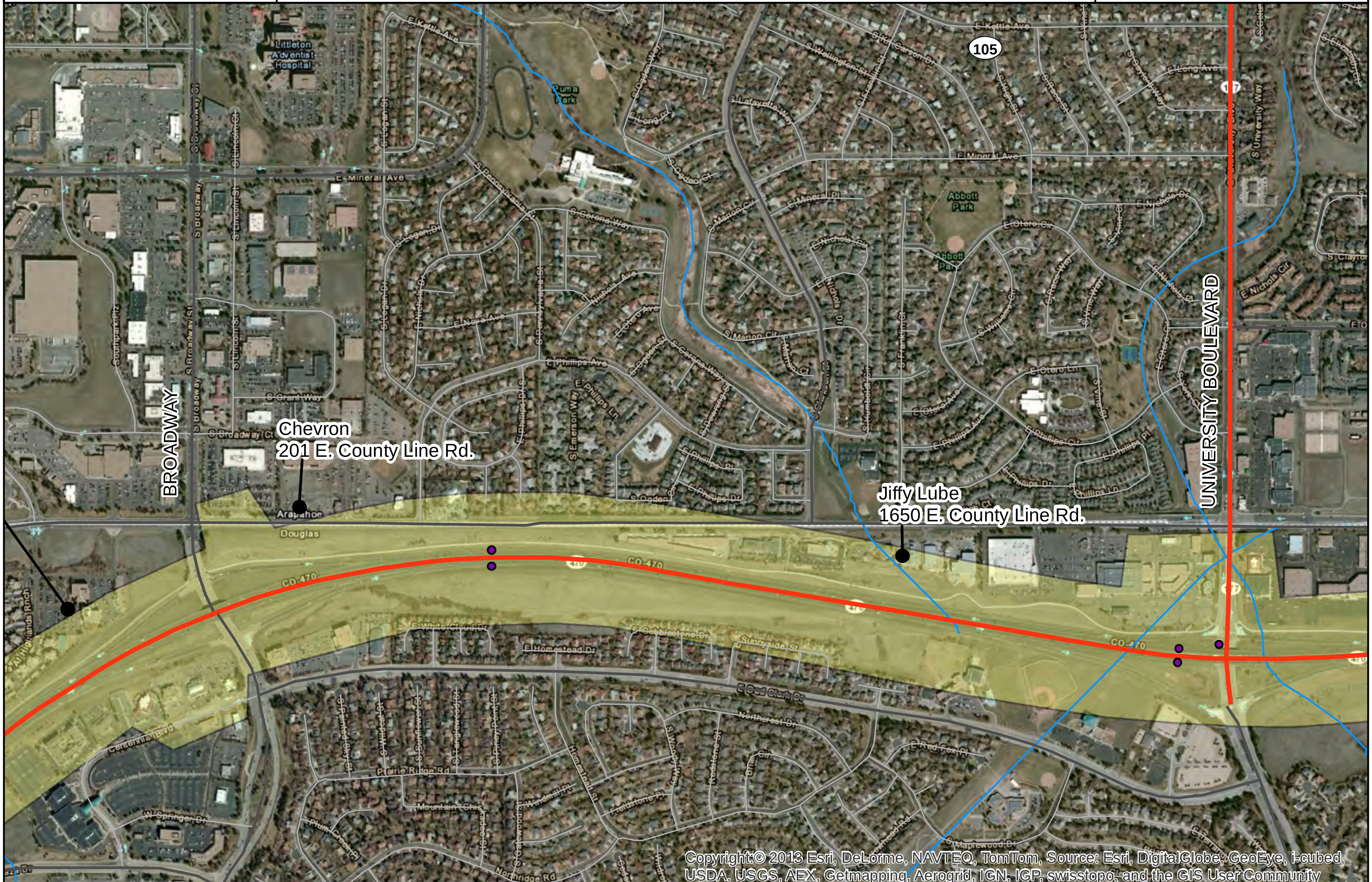
Figure 4

Segment 3 - C-470 and Broadway to Just West of South University Boulevard

Environmental Re-Evaluation of C-470, South Kipling Parkway to I-25, Jefferson and Douglas Counties, Colorado

N

North American Datum 1983
Universal Transverse Mercator
Zone 13 N, Meters



Legend

- Approx. Site Extent
- Milepost Markers
- Highway
- Railroad
- Stream
- Sites Identified in Redulatory Database (only sites with mappable addresses shown)

Aerial Photo Courtesy of Google Earth, 7/1/13

1 in = 1,041.67 feet

0 400 800 Feet

Prepared for: WILSON & COMPANY, COLORADO DOT

Prepared by: SUMMIT

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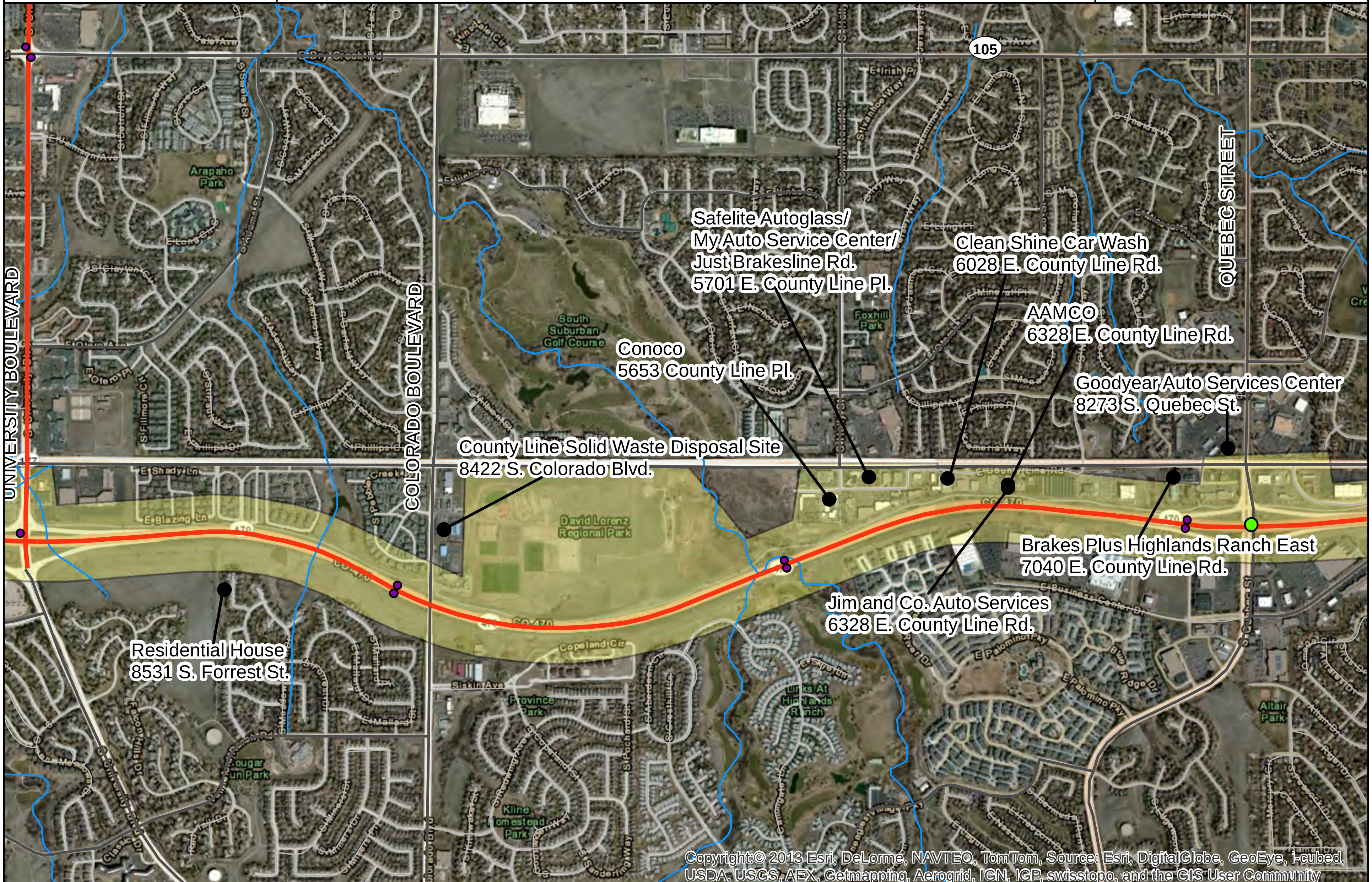
Figure 5

Segment 4 - C-470 and South University Boulevard to Just West of South Quebec Street

Environmental Re-Evaluation of C-470, South Kipling Parkway to I-25, Jefferson and Douglas Counties, Colorado

N

North American Datum 1983
Universal Transverse Mercator
Zone 13 N, Meters



Legend

- Approx. Site Extent
- Lead Based Paint Sample Location
- Milepost Markers
- Highway
- Railroad
- Stream
- Sites Identified in Redulatory Database (only sites with mappable addresses shown)

Aerial Photo Courtesy of Google Earth, 7/1/13

1 in = 1,767.36 feet

0 670 1,340 Feet

Prepared for: Wilson & Company; Colorado DOT

Prepared by: Summit

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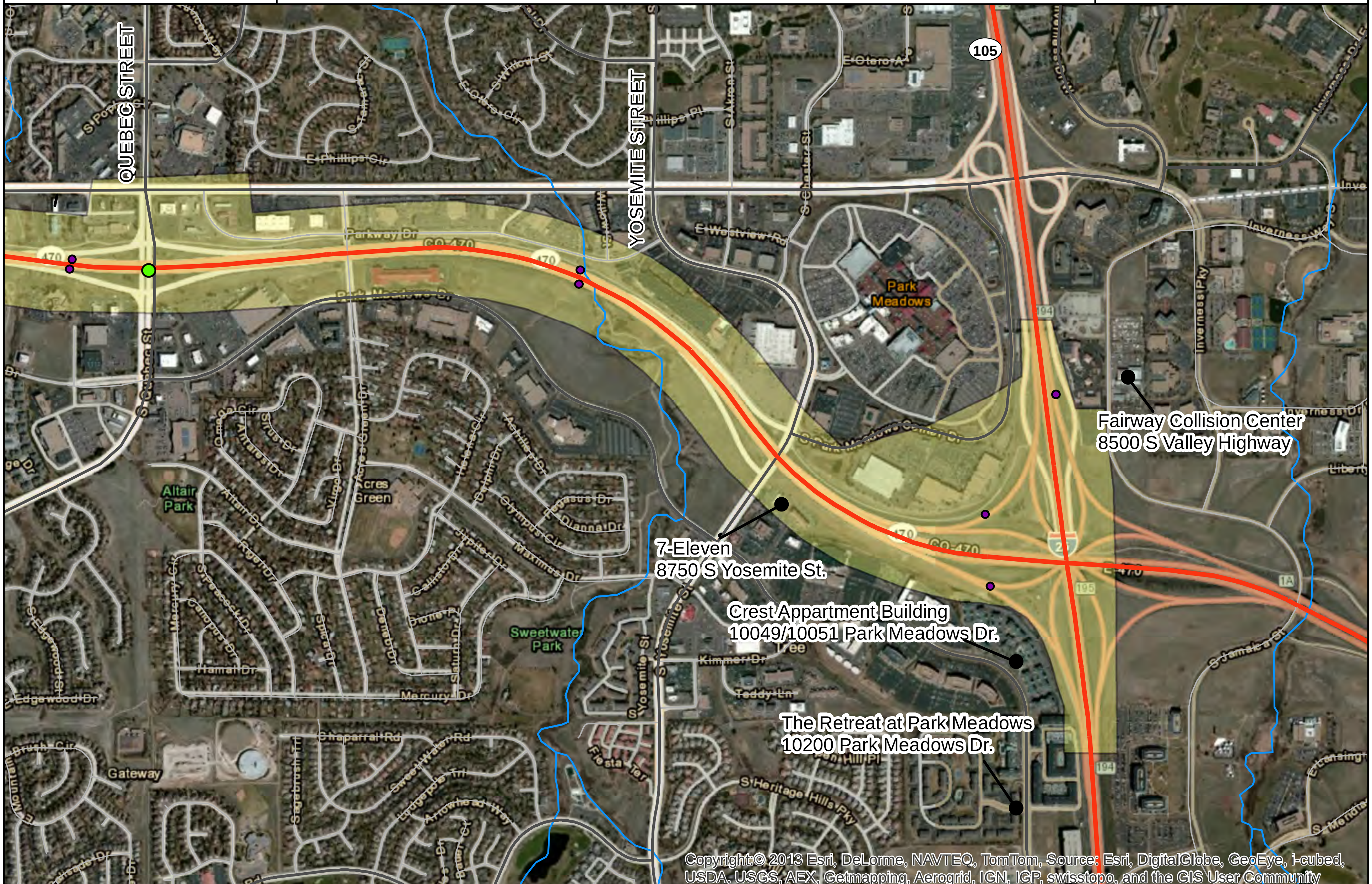
Figure 6

Segment 5 - C-470 and South Quebec Street to the Intersection of C-470 and I-25

Environmental Re-Evaluation of C-470, South Kipling Parkway to I-25, Jefferson and Douglas Counties, Colorado

N

North American Datum 1983
Universal Transverse Mercator
Zone 13 N, Meters



Legend

Approx. Site Extent
Lead Based Paint Sample Location
Milepost Markers
Railroad
Highway
Stream
Sites Identified in Redulatory Database (only sites with mappable addresses shown)

Aerial Photo Courtesy of Google Earth, 7/1/13

1 in = 1,416.67 feet
0 540 1,080 Feet

Prepared for: Wilson & Company, DOT
Prepared by:

S:\Summit 2012\CDOT\Region_6\C470_Reassessment\GIS

Historic Resource Survey

For the C-470 Corridor
Revised Environmental Assessment

June 2013

Submitted To:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted By:
Bunyak Resource Associates
10628 W. Roxbury Avenue
Littleton, CO 80127

Table of Contents

Introduction
The Colorado Department of Transportation (CDOT) and Federal Highway Administration (FHWA) have identified a need for improvements to the C-470 Corridor from Kipling Parkway to Interstate 25 (I-25). The C-470 corridor is found in Douglas, Arapahoe, and Jefferson counties in the south Denver Metropolitan area as shown in Figure 1. Map of the Study Area. The purpose of this project is to address congestion from Kipling Parkway to I-25, reduce traveler delay, and improve reliability for corridor users.

This Historic Resource Survey (HRS) is part of the 2013 Revised Environmental Assessment (EA) that updates the information provided in the original C-470 Corridor EA that was approved by CDOT and FHWA in 2006. The HRS has been prepared to meet the requirements for CDOT and the FHWA's compliance with the State Register Act (CRS 24-80.1), Section 106 of the National Historic Preservation Act (as amended), with the Advisory Council on Historic Preservation's regulations, and the National Environmental Policy Act of 1969.

In 2004 and 2005, the State Historic Preservation Office (SHPO) concurred with the findings in the Historic Resource Survey (completed in 2004) and Historic Resource Effects and Mitigation document (2005). Today these technical documents are being revised to reflect the current findings based upon 2013 data. This report meets the requirements for survey reports specified in the Colorado Cultural Resource Survey Manual, History Colorado, and the Office of Archeology and Historic Preservation.

This document contains two major sections: 1) history and national and/or state eligibility sections and 2) evaluation of effects and recommended mitigation of adverse effects.

Purpose
The purpose of the historic resources survey component of the C-470 project is to assist CDOT and FWHA in determining if there are significant historic resources within the study area and if these resources are impacted by the proposed alternatives for transportation improvements to C-470. It will also present the results of the historic resource survey for the C-470 corridor between Kipling Parkway on the west and the I-25 interchange on the east. The study area is approximately thirteen miles long. The existing right-of-ways vary from 300 to 500 feet and are outlined in *Establishing the Area of Potential Effects* section. The objective of the historic resources survey is to identify significant cultural resources and historic districts in the project area along the C-470 corridor that are over 45 years of age that may be eligible for listing or are listed in the National Register of Historic Places (NRHP) and/or the State Register of Historic Places (SRHP). The relative merits and impacts of the alternatives will be documented in the section on effects and mitigation.

Project Study Area
The C-470 corridor is a vital link between I-25 and I-70 between the mountains, southern suburbs, and the Southern Front Range, which serves essential commercial, commuter, and residential traffic.

The project study area is defined as that area from the Kipling Parkway interchange on C-470 in Jefferson County east along the C-470 corridor to and including the interchange at C-470 and I-25 in Douglas County. The general location of the survey area is shown in Figure 1.

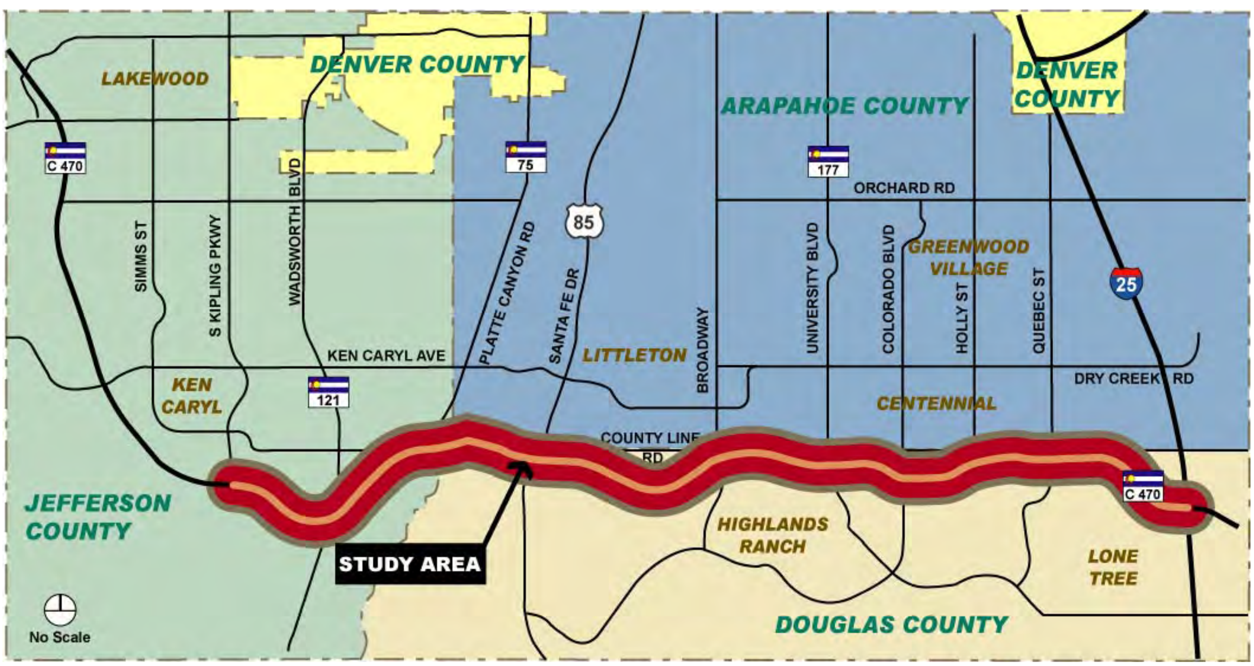
The project area can be found on the following USGS Quadrangle maps:

Littleton Quadrangle 1965/1994
Jefferson County, Township 6 South, Range 69 West, Sections 1-4, 10-11
Jefferson County, Township 6 South, Range 68 West, Sections 4-6
Jefferson County, Township 5 South, Range 68 West, Sections 31-32
Jefferson County, Township 5 South, Range 69 West, Sections 36

Highlands Ranch Quadrangle 1965/1994
Jefferson County, Township 5 South, Range 68 West, Sections 34-36
Jefferson County, Township 6 South, Range 68 West, Sections 1-3
Jefferson County, Township 6 South, Range 67 West, Sections 3-6
Jefferson County, Township 5 South, Range 67 West, Sections 31-34

Parker Quadrangle 1965/1994
Jefferson County, Township 6 South, Range 67 West, Sections 2-3, 10-11

Figure 1. Map of Study Area



Establishing the Area of Potential Effects (APE)

The Area of Potential Effects that SHPO concurred with in May 2004 was used for the 2013 historic resource field survey because all improvements will be within CDOT Right-of-Way (ROW). The intersection of S. Santa Fe Drive (S.H. 85) and C-470 has been pared down from the 2006 EA to reflect the current proposed plan. Since 2006, improvements at the Santa Fe intersection, including a flyover onto C-470, have been completed. During this project, there will be no changes at Santa Fe except for lanes on C-470. The APE has been revised and amended to show parcels associated with two historic resources recently identified that are over 45 years of age.

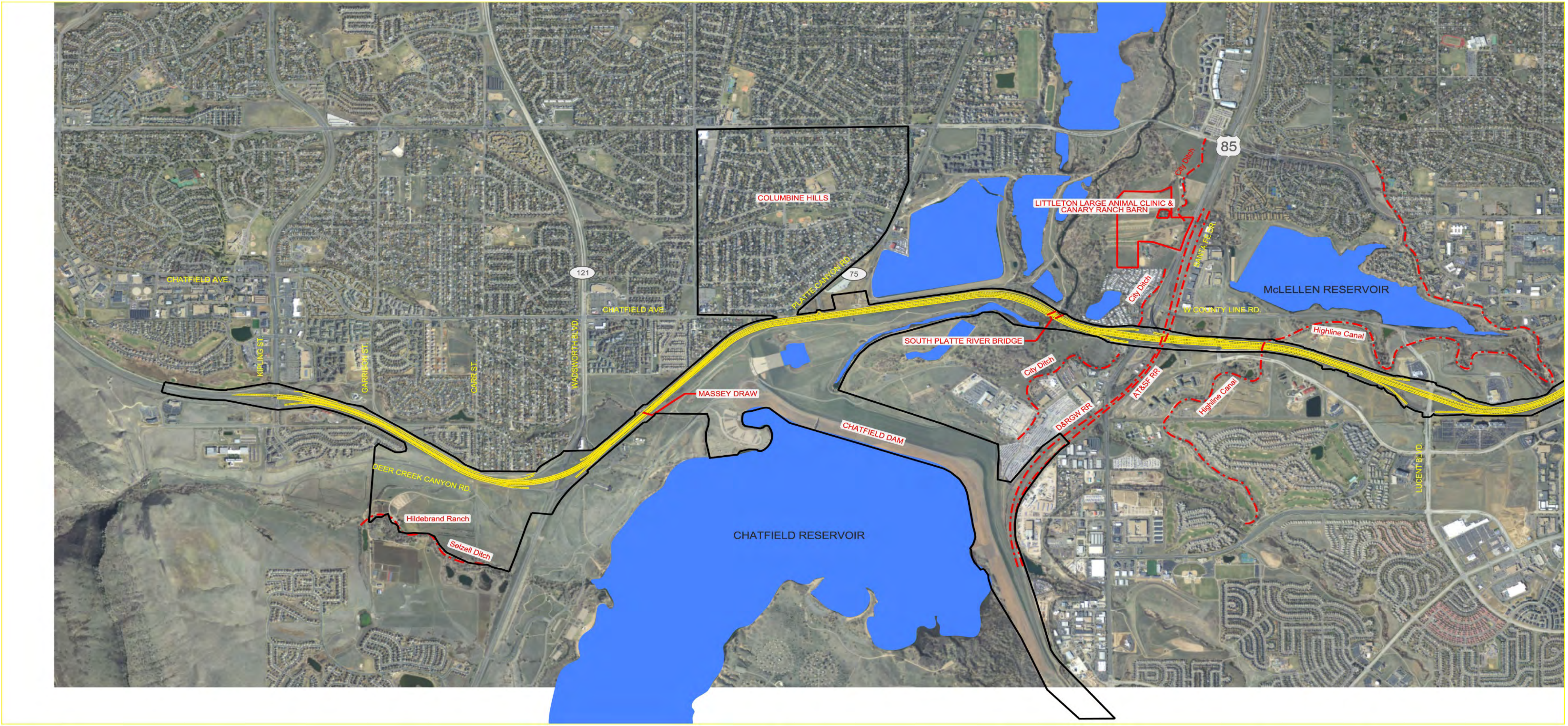
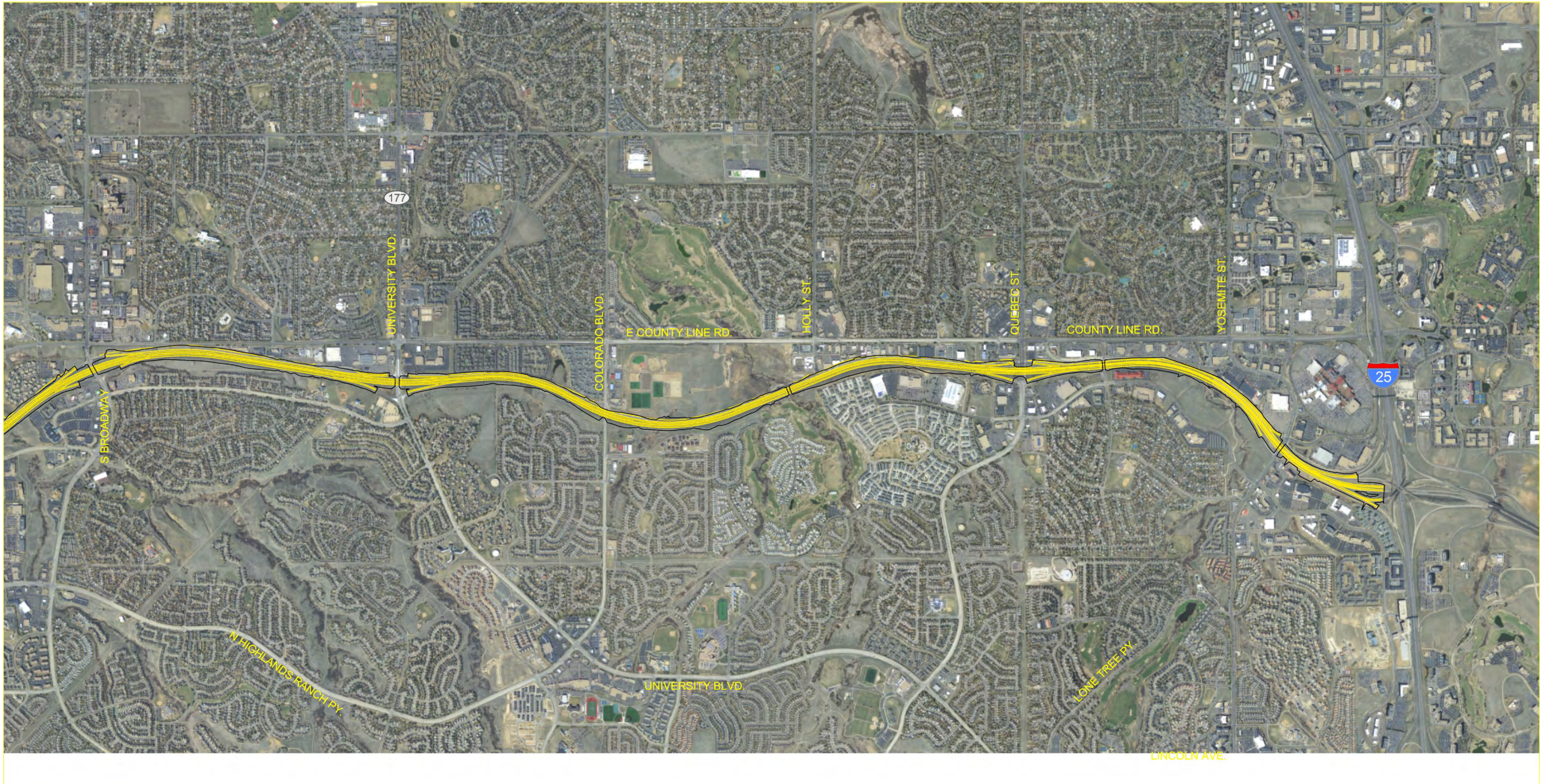


Figure 2. Map of Area of Potential Effects & Historic Resources West End from Kipling Parkway



Map of Area of Potential Effects & Historic Resources East End to I-25

Research Design

The objective of this historic resource survey for C-470 Corridor was to identify historic and potentially eligible historic resources over 45 years of age and Section 4(f) properties in the area of potential effect as defined in consultation with the State Historic Preservation Officer, and to prepare documentation to complete the Section 106 procedures and Section 4(f) evaluation (Phase II). The research design provides direction for research, interpretation, and evaluation of the resources identified.

History Colorado Resources Planning Protection Process (RP3) provides a framework to identify and record historic resources of the state and direction to analyze the significance and preservation of resources. The project area falls into the following RP3 historic contexts:

- Colorado Urbanization and Planning Context:
  - Colorado Town Form in the Early Auto Era (1910-1945);
  - Historic Residential Subdivisions Metropolitan Denver, 1940-1965; and
- Colorado Plains Historic Context:
  - Development and Expansion of the Rail Network;
  - The Urban Frontier (1860-1900);
  - Colonies and Towns (1868-1895);
  - Early High Plains Irrigation and Farming to 1900;
  - Post-1900 Agriculture—Dryland Farming;
  - Ranching since 1900;
  - The Auto Age (1890-1945); and
- Railroads in Colorado (1858-1948) Multiple Property Listing; and
- Engineering Context:
  - Water/Irrigation; Water/Dams; and
  - Transportation/Railroads, Roads, Bridges, and Trails.

Two new historic contexts, Historic Residential Subdivisions of Metropolitan Denver, 1940-1965 (2011) and Water/Dams, were added to the above list. Prior to the field survey, a file search of state inventory documents was undertaken at the Office of Archeology and Historic Preservation (OAHP). Historic research was conducted at History Colorado to determine if there were any properties in the project area with official landmark designation, which are eligible for listing in the NRHP or have been recorded in the state inventory. County offices and historical societies were contacted to determine if there were any Local Historical Landmarks.

A field survey was conducted within the established Area of Potential Effects in the project study area of the C-470 Corridor. All of the cultural resources within the project area were surveyed at the intensive level. In 2003, the survey area was so large it was divided into sections between the major interchanges beginning at Kipling Parkway and ending at the I-25 interchange. Each section was additionally divided into the north and south sides of the highway. A log of all surveyed properties was maintained by interchange segment. The log can be found in the appendix of this report. During the survey, all previously recorded properties identified in the file search were re-evaluated and photographed, as necessary, and new resources that have not been surveyed were also photographed.

Historic research was conducted at the Jefferson, Arapahoe, and Douglas Counties Tax Assessor Offices, Planning, and Clerk and Recorder's offices, county and Local History libraries, the Stephen Hart Library at the History Colorado, and the Western History Collection at the Denver Public Library. Individuals associated with significant properties in the survey area were also interviewed.

Following the examination of records and documentation, properties were evaluated for historic and architectural integrity and/or significance, as well as eligibility, using the National Register Bulletin 15, *How to Apply the National Register Criteria for Evaluation* and the State Register Bulletin 960, *How to Apply the Nomination Criteria for the Colorado State Register of Historic Properties*. Field determinations of eligibility were made and surveyed properties were recorded on Architectural Inventory Forms as required by the OAHP. Forms were submitted in 2004 and concurrence obtained at that time. A survey report was prepared and submitted according to the guidelines as drafted in OAHP's *Colorado Cultural Resources Survey Manual*. In 2013, this revised document will include forms for new historic resources and re-visitation forms for officially eligible historic resources identified in the 2005 "Historic Resource Effects and Mitigation C-470 – Kipling Parkway to I-25" technical document.

Methodology

The APE for the historic resources survey was established as previously discussed in *Establishing the APE.* A file search at History Colorado, OAHP office, was conducted on August 1 and 13, 2003. (See Table 1 for Previously Conducted Surveys.) The intensive level Class III inventory as outlined in the Research Design was conducted between November 2003 and March 2004. Survey logs were organized by section as the survey proceeded. In May and June 2013, Dawn Bunyak conducted a file search and reconnaissance survey to identify any historic resources that may have become older than 45 years of age since the earlier survey. The 2013 survey identified five new historic resources: a subdivision, a dam, two bridges, and one concrete-box culvert.

Historic research on individual resources was ongoing throughout the field survey and afterwards. Historical research provided essential information regarding individual resources and their ability to provide information about the activities and lifestyles of citizens and the influence of economic conditions and local, state, and national events. Resources were considered for their association with representative periods of development in local, state, and national history and the impact of development pressures on the resource. Information was gathered from public agencies and libraries as previously mentioned, as well as residents. General research materials about the survey area, including primary and secondary sources, were reviewed for background information. This research included the use of books, design plans, maps, photographs, newspaper articles, city directories, and other published reports from local research institutions. The records of local counties in the project area were examined to extract information on specific resources. Telephone interviews with residents, businesses, and local public agencies were also conducted to determine information about specific historical resources.

Table 1

Previously Conducted Surveys

Date	Title of Report	Author
2004-2006	Historic Resource Survey: C-470 Kipling Pkwy to I-25 & Historic Resource Effects & Mitigation	Dawn Bunyak for Goodbee & Associates
2002	Class III Cultural Resource Inventory of the Stockwell/Hildebrand Open Space Property Jeffco SWCA No. 01-515	Andrew Sawyer-Jeffco Open Space
2000	Colorado Historic Bridge Survey	Fraser Design
1998	Southeast Corridor EIS RTD Light Rail System (98-CO-28)	Gregory Newberry-RTD
1997	HRS County Line Road Arapahoe & Douglas Counties, CO	Laurie & Tom Simmons-CDOT
1995	Report RR Grade at Santa Fe Drive & County Line Road (re-eval)	Roxanne Eflin-CDOT
1995	HRS, SW Corridor Alternatives Analysis/Draft EIS	Hermsen Associates
1994	CRS of Realignment of County Line Road at S. Santa Fe Drive	Daniel Jepsen-CDOT
1994	High Line Canal: Historic American Engineering Record Doc	Fraser Design for Felsburg, Holt & Ullevig
1990	State Hwy 85: Castle Rock to C-470 (17 miles)	Rebecca Herbst/Vicki Rottman-CDOT
1988	Survey Report Mc[C]Lellan Drive at C-470	Kathy Cushman-CDOT
1987	E-470 Roadway Project I-25 South Interchange	Laurie Simmons/Christine Whitacre-CDOT
1981	Cultural Resource Survey Report for Hildebrand Ranch Area C-470	Mark Sullivan/Sherry Oaks-CDOT
1980	Project M 1030(1) S. Platte R. Crossing, Cult Res Rpt, Arapahoe and Jefferson Counties, CO	Vicki Rottman-CDOT
1979	Littleton Railroad Depression (City Ditch)	Vicki Rottman-CDOT

After completion of the field survey and following the determinations of eligibility, History Colorado Architectural Inventory forms, Re-visitation forms, and/or Management Data and Linear Resource forms were prepared in 2004 for all surveyed resources. Those inventory forms are on file at History Colorado OAHP. In 2013, Bunyak prepared inventory forms for two historic resources and re-visitation forms for officially eligible resources identified in the 2005 Effects and Mitigation technical document. Forms are attached to this document.

Historic Context

The survey area has been historically rural and agricultural in nature and associated with the South Platte River valley. The valley is backed by the peaks of the Front Range, the Dakota Ridge Hogback and the red sandstone of the Morrison formation. To the east, the valley of the S. Platte River opens onto the eastern plains of Colorado. The eastern plains are part of the “Great American Desert” a term coined by explorers Lt. Zebulon Pike and Major Stephen Long for the land west of the Missouri River and east of the Rockies. They described it as an area with no trees, little rainfall, and tough prairie sod.

Colorado and Its Counties

For centuries, Spain, England, France, the United States, Mexico and the Republic of Texas claimed ownership of sections of the Colorado region. In 1861, portions of four territories, Utah, Nebraska, Kansas, and New Mexico, were taken to create the Colorado Territory.

The Kansas Territory, which included present day Douglas, Arapahoe, and Jefferson Counties, stretched across eastern Colorado to the Rockies. The Kansas Territory was formed in 1855. Few efforts were made to provide governmental services in the distant region of eastern Colorado so local residents created their own forms of governments and law enforcement agencies. Within time, Coloradoans lobbied the federal government to create a new territorial government. After a false start in 1859 to create the Jefferson Territory by locals, Congress officially created the Colorado Territory on February 28, 1861.

The 1860 Census recorded 38,500 names of individuals in the Colorado Territory, a region most known for its mining districts and its vast regions occupied by Native American tribes. Newly appointed Gov. William Gilpin and the territorial legislature soon established boundaries for seventeen counties. The original counties were found principally in the Front Range and foothills of the Rockies where the general population of Euro-Americans were located. The Arapahoe and Cheyenne Reservation in southeastern Colorado was left outside the new county boundaries. The size of the new and unfamiliar region posed a problem for early surveyors laying out county boundaries. Original county boundaries changed as subsequent settlement led to the creation of the state of Colorado in 1876. Eventually sixty-three counties were established between 1877 and 1889.

Jefferson County

Jefferson County is situated in central Colorado and takes its name from the Jefferson Territory, the extra-legal provisional government. The area of present-day Jefferson County was one of twelve counties in the provisional territory of Jefferson until February 28, 1861, when President Buchanan signed the act of Congress creating the Territory of Colorado. On

Nov. 1, 1861, legislators organized Jefferson County and set its boundaries which were defined as part of the territory of Colorado. Golden became the Jefferson County seat.[1]

The county is principally mountainous with rolling lands along the creeks and rivers. It is drained by the S. Platte River and its tributary system which includes Bear, Turkey, Clear, Deer, Ralston, Coal, North Fork, and Dry Creeks. The altitude varies from about 5,300 feet to nearly 10,000 feet. The irregular shape of the county covers approximately 725 acres.[2]

Although Jefferson County was initially populated with mining supply centers for districts to the west of it, the importance of agriculture and raising stock soared. Farmers and ranchers settled along the bottomlands near various streams. They created a system of irrigation ditches that crisscrossed the land. By 1861, four of the earliest irrigation ditches included the Wanamaker, Swadley, Wadsworth, and Farmers High Line. The early mining districts that governed mining regions were soon followed by "claim clubs" for towns and farming areas in the new territory. Claim clubs organized and created governing bodies similar to those developed in mining districts.[3]

Arapahoe County

Situated just east of Jefferson County is Arapahoe County. The two counties are separated by the S. Platte River. One of the original seventeen counties, Arapahoe extended from the S. Platte River to the Kansas border and was approximately thirty miles wide. Georgian William Green Russell found gold-bearing sand and gravel at the point where Dry Creek flows into the Platte River. Later Russell moved down river to where Cherry Creek flowed into the river seeking gold. Russell did find gold and quickly established a camp he called Denver. Denver eventually became the county seat of Arapahoe.

Modern Arapahoe County came about as a result of the formation of the City and County of Denver at the turn of the twentieth century. The 1902 Colorado State Legislature split the original Arapahoe County into five counties and assigned respective county seats. They assigned Littleton as the temporary county seat of South Arapahoe County. The following year the "south" was dropped from the county's name. In 1904 Littleton officially became the county seat.[4] The county was named for one of the larger tribes of Plains Indians who occupied it.

The prairies of Arapahoe County were conducive to raising cattle. Farmers and cattle ranchers staked claims all along the streams and rivers of the plains to graze cattle and sheep.

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[1] Jefferson County Historical Commission, *From Scratch: A History of Jefferson County, Colorado* (Golden, Colorado: Jefferson County Historical Commission, 1985) 9; Ethel Dark, "A History of Jefferson County, Colorado," (M.A. Thesis, Colorado State College, 1939) Introduction; and Sara E. Robbins, *Jefferson County, Colorado: The Colorful Past of a Great Community* (Lakewood, Colorado: The Jefferson County Bank, 1962) 11-13.

[2] Dark, "History of Jefferson County," i.

[3] *From Scratch*, 2-3.

[4] Ray Willms, "The Birth of a County: Modern Arapahoe County from an Idea to Reality," TMs, p. 1-16, Special Collections, Littleton Historical Museum Library, Littleton, Colorado; "Richard S. Little," and Arapahoe Regional Library District, *Arapahoe County Portrait: Past and Present* (Littleton, Colorado: Arapahoe Regional Library District, 1983) 2-3.

As farmers moved away from principally dry land crops, they developed irrigation systems tapping into nearby streams and rivers to water their crops of grains. By the end of the 1860s, more than fifty farms spread along the banks of the S. Platte River. They delivered a steady supply of meat to nearby mining districts.

Richard S. Little came to Arapahoe County in 1861 as engineer for the Capital Hydraulic Company who was constructing a ditch from the Platte River to Denver. The next year Little filed a notice of claim on land along the S. Platte River and later opened the Rough and Ready Mill on a segment of the ditch that was never developed. When the Denver and Rio Grande Railroad (D&RG) passed by Little's land in the early 1870s, he envisioned a city on the plains.

On June 3, 1872, Little laid the foundations for the city of Littleton when he divided a section of his land into lots for employees at his mill. A large hotel in Littleton became a stage coach stop, as well as a popular Sunday outing spot for the residents of Denver. Nevertheless the real growth in Littleton did not appear until after 1877 with the appearance of a second railroad, the Atchison, Topeka and Santa Fe Railroad (ATS&F). In 1888, the ATS&F built a depot in Littleton.[5] Despite Little's endeavor at city building, the area remained principally rural in nature.

After completion of the High Line Canal in 1882, agricultural activity in Arapahoe County appeared to be divided between dry-land farming in the east section and irrigable land in the west. Agriculture, farming and ranching, was the county's staple industry even extending south into Douglas County.

Douglas County

Douglas County can be found almost at the center of the state. It is a region of topographic diversity with prairies in the east at 5,400 feet to a range of mountains in the west that reach as high as 9,700 feet. The spectacular red rock formations of Roxborough Park are found in northwestern Douglas County. Its three major waterways, the Cherry Creek, Plum Creek and S. Platte River, were natural routes for early travelers through the region, territory, and eventually the state. Miners heading into the Pikes Peak region passed through Douglas County on their way into the important mining centers of the Rockies.

Unlike its neighbors, Jefferson and Arapahoe Counties, who have more urban communities, Douglas County's history has long been tied to farming and ranching. As late as 1968, Lawrence C. Phipps described northern Douglas County in his book, *Forty Years of the Arapahoe Hunt*, as a "country (that) consists of rolling plains interspersed every once in a while with deep or shallow arroyos, gullies, and dry water courses." It was principally cattle country with a few ranch houses and outbuildings until the 1980s.

Douglas County, named after the Illinois Senator Stephen A. Douglas, who was also chairman of the Senate Committee on Territories, was one of the original seventeen counties. After Colorado became a territory, the legislators appointed Franktown as the temporary

[5] Dave Hicks, *Littleton from the Beginning* (Denver, Colorado: Egan Printing, 1975) 7-9; "The Birth of a County," 7; *Past and Present*, 6; and City of Littleton website, "Littleton History," accessed July 16, 2003.

county seat of the newly formed county. James Frank Gardner, founder of Franktown, moved to California Ranch in 1864 taking the Douglas County records with him. In 1874, Castle Rock became the county seat when the county was subdivided to create Elbert County.[6] Castle Rock is more centrally located within the re-drawn county boundaries. The arrival of the D&RG Railroad dramatically influenced the growth of Douglas County. With an active railroad and stage coach service, small towns sprang up along the rail lines that connected Denver and Colorado Springs.

Agricultural History

For most of its history, the lands around the C-470 corridor were rural devoted to agricultural pursuits and cattle ranching. The agricultural history of the area south and southwest of Denver has long been tied economically with the development of Denver and Colorado's mining regions. Many men who failed as miners settled on the prairies turning to the land for their livelihood. Farmers south of Denver supplied food and goods to the Denver market and nearby mining districts. The earliest recorded Denver area farmer/supplier was David Wall who farmed near Golden.[7]

The 1860s saw the transition from subsistence farming to a growth in cash crops. Farmers settled near the rivers and utilized irrigation in turning arid plains into verdant pastures and larger-scale agricultural enterprises. By 1870, one traveling correspondent for *The Colorado Tribune* wrote glowingly that the agricultural region of the Platte Valley was in a "state of improvement as will compare favorably with some of the finest grazing and agricultural sections of the east."[8] These early entrepreneurs soon realized that water was the true gold of the West.

Early High Plains Irrigation and Farming

Water and irrigation are intricately interwoven in the historical success of farming and ranching in the arid lands of Colorado and the West. Initially farmers planted dryland crops of barley and wheat or used their land for grazing. Cash crops, such as alfalfa, potatoes, tomatoes, cucumbers, and sugar beets, demanded water to survive in the arid climate. As early as the 1860s and 1870s, farmers, investors, and developers engaged in a battle to harness Colorado's limited water resources. Prior to 1879, no consistent procedures were followed when initiating the construction of an irrigation system. Settlers simply dug a ditch.

Following the adoption of the Colorado State Constitution, and its provisions regarding the doctrine of prior appropriation of water in the state, drainages were assigned a water district number, which continues to identify the state's streams and rivers. The Colorado General Assembly enacted the Irrigation Act of 1879 dividing the state into water districts and establishing a system to record water right priorities. Improvements to the water bill followed to correct ambiguities and inconsistencies. Between 1880 and 1885, concern over the amount

[6] Thomas J. Noel, Paul F. Mahoney, and Richard E. Stevens, *Historical Atlas of Colorado* (Norman, Oklahoma: University of Oklahoma Press, 1994) 17, and "General History of Douglas County, Colorado," [http://history.dpld.org/dchpb/genhist.htm], 15 December 2003.
[7] David Skari, *High Line Canal: Meandering Through Time* (Denver, Colorado: C & M Press, 2003) 2.
[8] Marr, *Douglas County*, 99.

of water taken from tributaries prompted adjudication hearings to establish water rights. At that time, approximately 250 ditches were drawing water from the S. Platte River.[9]

One of the most significant of the early organized irrigation systems in the Denver area was the Capitol Hydraulic Company's City Ditch, a franchised ditch constructed to draw water from the S. Platte River to supply water to the city and farmers along its route. Almost two decades later, in 1877, English investors undertook a heady enterprise that involved construction of three massive irrigation projects that would carry water from the S. Platte River valley to the eastern plains. Out of their vision evolved the High Line Canal.

City Ditch

In 1860, an Act of Congress granted the franchise of the Capitol Hydraulic Company (organized in 1859) to take water from the S. Platte River and Cherry Creek. The president of the company was A.C. Hunt, who later became the Territorial Governor, and its chief engineer, John Clark, who was later replaced by Richard Little, founder of Littleton. Little moved the inlet four miles upstream and recalculated the grade of the ditch. Although ditch construction began between 1861 and 1862, due to the Civil War and an irksome economy, it was not until 1869 that it carried water into Denver. Meanwhile, Little channeled the abandoned earlier segment of the ditch for his own purposes. A second ditch reorganization resulted in a name change, Platte Water Company, to reflect its wider scope and purposes for the ditch. By 1875, Denver concluded it should own the ditch "from Littleton down to Capitol Hill." A bond issue raised $60,000 to purchase the ditch. The ditch was assigned the number one water priority on the S. Platte River.

Each spring the head gates at a dam southwest of present-day Wolhurst Estates were opened to allow water to flow in a northerly direction on its 37-mile journey to Denver, Washington Park, and City Park. The original diversion point for City Ditch from the S. Platte now lies under Chatfield Dam Reservoir. The US Army Corps of Engineers created a new outlet through the dam to allow water to enter City Ditch. Southwest of Littleton only remnants of the original course of City Ditch are extant due to encroachment by development and highway improvements. The City of Englewood controls the first 15 miles of the ditch proper and has diverted water into both open channel and pipe-lines.[10] In Englewood, it fills McLellan Reservoir and provides a portion of the city's municipal water supply. To the east of City Ditch is a second larger endeavor to bring water to the parched fields in the survey area.

High Line Canal

In 1877, English capitalists led by James Duff organized the Colorado Mortgage and Investment Company, often referred to as the English Company. The company planned three irrigation projects to carry water from the S. Platte River northwest to the eastern plains. In 1880, Edwin Nettleton completed his plans for the High Line Canal. Quickly Benjamin Eaton's construction crews began work on the canal.

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[9] Skari, *High Line Canal*, 37 and 57.

[10] Marr, *Douglas County*¸99; Skari, *High Line Canal*, 64; and Colorado Department of Transportation, "The History of City Ditch" prepared by Rebecca Herbst for the Federal Highway Administration (Denver, 1983) 11.

It would reportedly extend for 70 miles with several laterals. At its head was an intake dam in the S. Platte River Canyon in the foothills. The dam was not to store water, but actually to divert water. The canal measured thirty-six feet wide and seven feet deep in areas as it coursed through northern Douglas County into Arapahoe County via the canal, wooden drops, and its flumes. Eaton's crew completed construction on the canal three years later.[11]

The name of the canal, High Line, came from its engineering design and principle. Nettleton designed and built the canal with a gradual elevation drop in grade in order to produce a gravity-controlled flow of water. The elevation of the ditch drops approximately 200 feet along its course. In the same period of ditch development, there were two other "high line" ditches: the Farmer's High Line near Golden and the Rocky Ford High Line near Manzanola, Colorado. Consequently, during its early years, locals referred to the High Line Canal as the English Ditch, or English High Line, until eventually even the word English was dropped.[12]

Farmers and ranchers in northern Douglas County benefited from the flow of water from the canal. A series of droughts initiated local water rights battles in 1887 that ended at the Colorado State courts. Eventually, in 1924, the canal became the property of Denver. There was no public access to the canal and its service road until the 1970s when Denver developed a park system along the canal and its road. Today only 67 customers possess water rights from the canal. Until recently the Rocky Mountain Arsenal was the largest consumer of water from the High Line Canal. (It will soon be supplied from an alternate source.)

The water flow through the canal is erratic dependent upon water levels of the S. Platte River and the needs of its owners. Headgate No. 22 is located on the Flyin' B Ranch once owned by Bowen Farms Incorporated, which used the water for irrigating pastureland. Since 2006, the High Line Canal and corresponding bike and hiking trail pass through "Fly'n B Park." Five acres surrounding the farm house are now part of the Highlands Ranch Metro District open space. The canal parkway system is an ecological and wildlife habitat, as well as a significant historic resource connecting Denver's agricultural past to its present urban setting.

In the survey area, there are several smaller irrigation systems associated with the regions' earliest farming and ranching concerns. Of the lesser known early irrigation networks in the area were the Selzell Ditch near the Hildebrand Ranch, Last Chance Ditch near present day S. Platte Canyon Road, and Nevada Ditch parallel to the S. Platte River and Jefferson and Douglas Counties' boundary.

Selzell Ditch

Selzell Ditch is located near the Denver Botanic Gardens at Chatfield, a nature preserve in southern Jefferson County. Ranchers Peter Selzell and Frank Hildebrand constructed the ditch in 1868 by drawing water from nearby Deer Creek to water their farm and grazing lands. During the period of establishing legal water priorities in Colorado, Peter Selzell appeared as a witness at an 1883 adjudication hearing for obtaining water rights on the

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[11] Skari, *High Line Canal*, 10-13.
[12] Skari, *High Line Canal*, 11, and Marr, *Douglas County*¸99.

Selzell Ditch.[13] The ditch was awarded priority number 37. Today it is associated with the National Register Hildebrand Ranch Historic District highlighting early attempts at domestic agriculture in the region.

Last Chance Ditch

Another Jefferson County early irrigation system is the Last Chance Ditch located in the S. Platte River Water District No. 8. Both the Last Chance and Platte Canyon Ditches are located in this district. Claimants William Hugins, Isaac W. Chatfield, and Louis Doll built the Last Chance ditch in late February and early March 1868. Platte Canon Ditch Company constructed a ditch in July 1861 and subsequently enlarged it in December 1863 and December 1864. Witnesses N.E. Mills, E.S. Nettleton, William Shellabarger and a Mr. Lehow appeared at the 1883 adjudication hearings for this ditch. In 1924, the company that owned the Last Chance Ditch merged with the Platte Canyon Ditch owners. Even though most of what was the Platte Canyon Ditch has been destroyed by Chatfield Reservoir, the name Platte Canyon/Last Chance Ditch continues to appear on present-day maps referring to the original Last Chance Ditch. Portions of it are still in use today. However, the segment of the ditch in the survey area has been destroyed as a result of development.

Nevada Ditch

Paralleling the boundary between Jefferson and Douglas counties is the Nevada Ditch. Construction on this ditch in the S. Platte River water district began on August 30, 1861. It was enlarged once again in December 1865. Witnesses John Lilley, Joseph Bowles, W.B.O. Skelton appeared at the 1883 adjudication hearings to claim their water rights.[14] It is not clear whether these men constructed the ditch or assumed ownership at a later date. Portions of Nevada Ditch are still in use today, but the segment in the survey area has been largely destroyed as a result of development.

Many of the portions of these earliest ditches are now enclosed in pipes for safety reasons, water loss, and/or convenience. Nevertheless, one can locate the course of many of these abandoned ditches by looking for rows of trees and willows.

Early farmers and ranchers depended on irrigation and agriculture to serve their needs. Generally diversion ditches off local river sources met their needs. In other regions in Colorado, ditches and canals alone did not meet the needs of the community. The 1891 Colorado State Legislator authorized several reservoirs around the state.[15] The National Reclamation Act of 1902 began a new era in irrigation, especially in the West. The Reclamation Service (renamed the Bureau of Reclamation in 1923) built reservoirs and hydroelectric plants many in Colorado.[16] However, at the same time, the U.S. Army Corps of Engineers became the lead federal flood control agency, a provider of hydroelectric energy,

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[13] L. Steele, *The Roots of Prosperity: Littleton in the 1860s* (Littleton Historical Museum, 1982) 100-101, and an article, "Ditches Overview," author unknown, files at Littleton Historical Museum, 2003.
[14] Steele, *The Roots of Prosperity*, 101, and "Ditches Overview."
[15] Michael Holleran, "Historic Context for Irrigation & Water Supply: Ditches and Canals in Colorado" (Denver: History Colorado, 2005) 42.
[16] Holleran, *Ditches and Canals*, 44.

and the country's leading provider of recreation associated with water bodies. Its role in responding to natural disasters also grew dramatically.[17]

Chatfield Dam and Reservoir

Chatfield Dam, a rolled earth dam, and Reservoir is located in both South Jefferson and Douglas counties. It is west of the S. Platte River at the confluence of the river and Plum Creek. The U.S. Army Corps of Engineers, Omaha District, constructed the dam over a ten year period beginning in 1967. The dam was built as a result of a disastrous flood in 1965.

A series of unusual storm cells resulted in tornadoes and an unprecedented rainfall beginning June 14. Flooding on the East and West branches of Plum Creek began the next day and on June 16 a wall of water 200 feet wide and 20 feet high hit the City of Littleton at 9:30 PM before moving on through Englewood into Denver. Loss of life and millions of dollars of damages in the S. Platte River Valley prompted cries for new flood control measures.

Congress approved the Flood Act of 1950 which included construction of a dam in the S. Platte River Valley, but no funding appropriations were included in the bill. Without funding, the dam was never built. After Colorado's devastating spring floods in 1965, Congress approved funding not only for the dam, but recreational facilities that are now under the auspices of the State of Colorado as a state park. The City and County of Denver owns the water in the reservoir. The dam itself is under the jurisdiction of the Corps of Engineers.

The 1966 Chatfield Dam and Lake Project became one of three in a comprehensive plan for flood control of the S. Platte River and its tributaries. The other two units are Cherry Creek Dam (built as a dry dam in 1946) and Bear Creek Dam (dam and reservoir, 1974). In May 1977, the Rocky Mountain News reported that recreational facilities at Chatfield Dam and Reservoir, "Denver's newest playground," was opened for day use. The Corps of Engineers finished Bear Creek Dam, the last of the three dams for flood protection, in 1979.

Transportation

Several factors contributed to the transformation of the Colorado Territory. With the end of the Civil War and the removal of the Plains Indians to reservations, migration west increased as settlers followed trails into the region. With the rapid advancement of railroads into the West, larger number of immigrants and freight made their way into the territory. Towns sprang up along the rail lines. The territory's population dramatically increased and the territory became a state in 1876.

Railroads

The railroad may have been the single greatest influence on growth and prosperity in Colorado. By the 1880s, railroads steamed westward into the eastern plains of Colorado and into the State's mining regions. Railroads provided cheap travel and an economical means for shipment of grains and livestock to market.

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[17] US Army Corps of Engineers website, "US Army Corps of Engineers: A Brief History," accessed at www.usace.army.mil/About/History/BriefHistoryoftheCorps/Introduction.aspx, 3 July 2013.

Denver and Rio Grande Railroad

"Following the construction of the First Territorial Road between Denver and Colorado City, a similar north-south route along the foothills was surveyed for the site of the first narrow-gauge railroad in the United States."[18] General William Jackson Palmer and the National Land and Improvement Company provided funds to construct a railroad between Denver and Colorado Springs. The Denver and Rio Grande Railroad was initially constructed as a narrow gauge rail line. A month after construction was started on the line in July of 1871, builder Union Contract Company with its ties, rails, spikes, timber and telegraph poles reached Littleton and Acequia, in Douglas County. A news reporter poetically described his experience on the maiden voyage of the newly christened D&RG and his first view of Arapahoe and Douglas counties,

> The train was by this time speeding by the valley of the Platte, its beautiful farm houses and cultivated fields and long line of cottonwoods in the somber glories of autumn, with the grand mountains beyond, forming a charming landscape view.[19]

Regular service began on January 1, 1872. A year later the D&RG first built a wood-frame depot in Littleton replacing it with a stone depot two years later.[20] New settlements in Douglas County and later into El Paso County sprang up along the route. By 1881, the D&RG added a standard gauge track to its double track narrow gauge line and temporarily agreed to share it with the AT&SF Railroad.

In 1902, the middle rail was removed and the line operated solely as a standard gauge line. Palmer envisioned his railroad opening a route between Denver and El Paso, Texas. Although the line never reached its original goal, the D&RG played a critical role in the development of Colorado at the end of the nineteenth century. In addition, it played a role in the development of Littleton and its surrounding community when the D&RG began regular commuter service between Littleton and Denver in 1889. Over the decades, the railroad has experienced ownership changes and is currently part of the Union Pacific Railroad.[21]

Atchison, Topeka, and Santa Fe Railroad

A second rail line in the survey area was the Atchison, Topeka and Santa Fe Railroad (AT&SF). Due to lack of funding and support, the Atchison and Topeka railroad grew at a slower pace than the D&RG. Although chartered in 1859, it was not until after President Lincoln signed an Act of Congress allowing construction of the railroad across Kansas that the company found economic security to begin building westward. The company reorganized

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[18]Colorado Department of Transportation, Colorado Historical Society, Historic Inventory Record, "Atchison, Topeka and Santa Fe Railroad (5AH256.3)" prepared by Rebecca Herbst and Vicki Rottman,

[19] Josephine Lowell Marr, *Douglas County: A Historical Journey* (Gunnison, Colorado: B&B Printers, 1983) 96.

[20] "Denver & Rio Grande Railroad Depot," City of Littleton website, accessed at www.littletongov.org on 28 April 2004.

[21] Colorado, Department of Transportation, Region 2, *Interstate 25 Environmental Assessment*, Proj. No., 151077.13, HRS by Barbara Norgren, Dawn Bunyak, Dianna Litvak (Colorado Springs, 2003): 10-11; and Colorado Department of Transportation, Colorado Historical Society, Historic Inventory Record, "Atchison, Topeka and Santa Fe Railroad (5AH256.3)" prepared by Rebecca Herbst and Vicki Rottman, revision 1995.

in 1863 as the AT&SF, with high hopes of reaching Santa Fe, New Mexico, via Colorado. Westward construction began in 1868. Twenty years later, the AT&SF bought out the Denver and Santa Fe Railway (D&SF), which had laid track between Denver and Pueblo that paralleled the D&RG. The volatility of the national economy and its effects on the railroad industry resulted in mergers and buy-outs among the smaller lines. Eventually, the AT&SF emerged out of the pool of Colorado railroads. In 1900, the AT&SF bought out the D&SF line.

Twentieth-Century Development of the Railways

By WWI, the federal government nationalized the rail industry and the D&RG and AT&SF consolidated to run northbound trains on the old AT&SF lines and the southbound trains on the D&RG lines. In 1944, the AT&SF was one of the four leading railroads operating in Colorado with some 617 miles of main track. The parallel tracks of the D&RG and the AT&SF railroads between Denver and Colorado Springs were badly damaged during the 1965 Plum Creek flood near Littleton. The company repaired sections of the line but abandoned others. In 1968, the company became a subsidiary of the holding company of the incorporated Santa Fe Industries. Six years later the company sold its passenger service to Amtrak. By 1983, this company and the Southern Pacific Transportation Corporation agreed to merge into the Santa Fe Southern Pacific Corporation. However in 1987 the ICC rejected the proposed merger. In 1988 Southern Pacific sold its rail system. The next year, the Santa Fe's parent company changed its name to the Santa Fe Pacific Corporation. The Burlington Northern purchased that corporation in 1995 resulting in a new company name, the Burlington Northern Santa Fe Corporation.[22] Its trains currently use the Union Pacific rails south from Denver through Littleton.

Many major changes to the railroads and their alignment have been made due to natural disasters, upgrade in rail equipment and materials, development of the light rail, road widening and reduction of curves, and construction of grade separations. In the late 1980s, CDOT built a railroad bridge across the newly-constructed C-470 highway at Santa Fe Drive and C-470. With the addition of the Light Rail at the same time, track alignment was moved to accommodate the new line running parallel to the railroad tracks.

Territorial and Automobile Roads

Because of its isolation, as early as 1861, the fledgling territory of Colorado realized the importance of road building. The Kansas Legislature, whose jurisdiction the new territory fell under, authorized construction of some toll roads and bridges. By the 1880s, toll roads could be found all over the state. One of the most famous road builders in Colorado's history is Otto Mears.

Earliest Road Systems

Colorado's first north-south roads followed established Native American trails. A series of territorial acts beginning in 1864 established Colorado's earliest roads with one of the first

[22] "Atchison, Topeka and Santa Fe Railway," Burlington Northern website, accessed at www.bnsf.com on 16 February 2004; Clay Fraser, *Railroads in Colorado, 1859-1948, National Register Multiple Property Document Form*, 1997; Colorado Springs *Gazette Telegraph*, 2 May 1971;

near present day Littleton and along the S. Platte River as part of the Denver City and Pueblo road.[23]

Remnants of this early wagon road, Colorado Springs Wagon Road, parallel portions of present day S.H. 85 in Douglas County south of C-470 and were visible into the 1990s. On a 1901 Proposed Line Change Map for the D&RG Railroad between Wolhurst and Sedalia, the wagon road is located east of the tracks in Section 7 and crossed the tracks to the west side in Section 6.[24] The first real effort to develop a system of integrated roads in Colorado came with the establishment of counties.

Like the rest of the United States, Colorado had a period in time called the "good roads" movement. At the beginning of the 20th Century, bicyclists and automobile drivers pushed for state and counties to pave roads for better driving conditions. In a M.E. Salek's history of Colorado roads, he writes:

> In 1902, 42 auto owners formed the Colorado Auto Club. The CAC and the Colorado Chapter of the National Good Roads Association (1905) persuaded the legislature to pass a bill in 1909 to establish the Colorado Highway Commission, and it became effective January 1, 1910. The only problem was the funding: the legislature allocated a measly $65,000. The Colorado highway system was established by having the counties submit maps showing their most traveled roads, and the first state primary system covered 1643.5 miles.

The early road system in Colorado was primitive by today's standards. It was not until the American Automobile Association (established in 1902) lobbied local, state, and federal governments for better roads that many dirt roads were finally paved in the first decades of the 1900s.[25] Road crews relocated routes and improved dangerous railroad crossings. In 1907, the State Legislature authorized construction of a road between Wyoming and New Mexico.[26] Construction began in May of 1908 and within two years the road between Denver and Colorado Springs opened as State Primary Road No. 3. State Primary Road No. 2 ran between Denver and Fort Collins with No. 4 between Colorado Springs and Pueblo. These roads followed the earliest Native American trails, wagon roads, and stage coach lines.

A 326-mile ribbon of highway connects Wyoming to New Mexico running north-south through Colorado. The State Highway Commission began using the North-South Road as a principal trunk line through the state that connected the state's most important cities.[27] Dusty and treacherous, the road was dirt until 1919.

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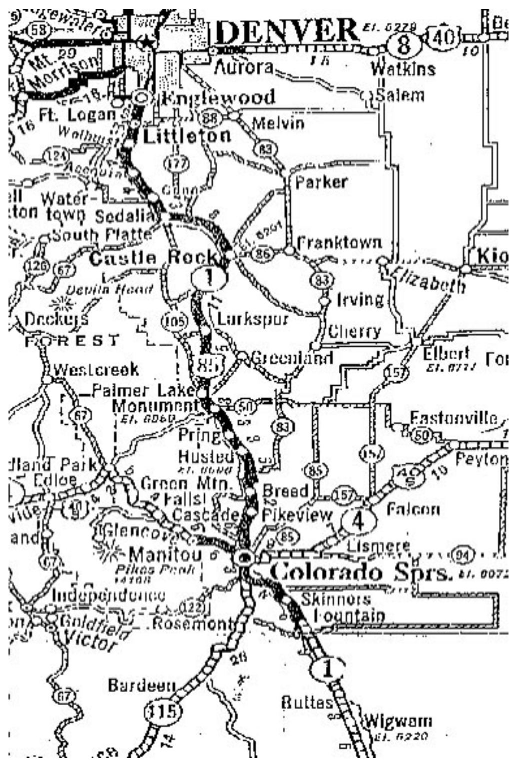
[23] Wallis M. Reef, "The Development of Colorado's State Highway System," in *Look Around* 29, no. 3 (May-June 1964): 26.
[24] 1901 Map for the Proposed Line Change for the D&RG Railroad can be found at the Local Archives at the Douglas County Public Library in Castle Rock, Colorado.
[25] *The Motorist* March/April 2002.
[26] Denver *Post*, 22 September 1969.
[27] Clayton Fraser, Highway Bridges in Colorado, 1880-1958.

U.S. Highway 85

In 1916, the Federal Highway Act started the Federal Aid Primary system, with 50-50 matching funding. One of the first federally funded primary highways in Colorado was FAP 1, Denver-Littleton. As a result, the present day S. Santa Fe Drive (S.H. 85) was the first paved road in Colorado.[28]

Figure 3

1929 Conoco Road Map



Source: Denver Public Library, Denver, CO.

Construction on the Denver to Littleton road began in the fall of 1917 and was completed in 1918. Eventually, the road became part of the proposed highway from Denver to Colorado Springs. The FAP-1, two-lane road provided a direct route from Denver to the growing city of Littleton.

In 1928, the State Department of Transportation began construction on a 73-mile stretch of concrete road between Denver and Colorado Springs, Figure 3.[29]

The last link of newly concrete-paved section on the Denver-Colorado Springs Highway (S.H. 85) was completed in August of 1928 with a procession of 1,200 automobiles celebrating its opening. During the paving, the highway department eliminated thirteen

[28] Salek, "Colorado Highways History."
[29] Denver *Post*, 10 August 1928.

railroad crossings and numerous dangerous curves. The August 5, 1928, issue of the Denver *Post* speculated that the elimination of the dangerous spots and new road surface was expected to "materially increase the traffic in the future." And increase it did.

In 1938, the State Highway Commission, after repeated petitions by the city of Littleton, rerouted U.S. 85 west of downtown Littleton along the present S. Santa Fe Drive. Within a decade, the highway was nicknamed "the ribbon of death" because of numerous accidents and fatalities on the stretch between Denver and Colorado Springs.[30] Beginning in 1947, plans were made to widen the highway and make improvements along the route. Despite these improvements, the north-south highway would be soon be usurped by the construction of Interstate 25.

Today S.H. 85's identity has merged with many sections of the modern highways that run north and south through the state. Although the roads follow the same route of the old S.H. 85, the number is not usually noted on highway signs.

Interstate 25

In the 1940s, led by its chief engineer Charles Vail, the Colorado Department of Highways commissioned a study to improve the highway system in Denver. Vail hired the engineering firm of Crocker and Ryan as consultants. Their report suggested that a limited-access route be opened, which would be independent of the cross-flow of city traffic. Vail died that year and the project appeared to flounder until 1946, when Mark Watrous became CDOH's state highway engineer.[31] Nevertheless the Valley Highway project did not begin until 1948. As segments were completed, they were opened to drivers. The last segment opened in 1958. It was not officially an interstate at that point in time, but formally identified as U.S. 87.[32] The federal interstate system began construction on Interstate 25 in 1956 and finished a continuous ribbon of highway between Wyoming and New Mexico in 1969.[33] Officially in 1970, Interstate 25 opened as a ribbon of concrete, an "interstate standard" highway, between Wyoming and New Mexico. Today I-25 is not only a route through our city, but an integral artery for travel within the city.

Colorado 470 or C-470

Beginning in the 1970s, it was evident that a connection between I-25 and I-70, by-passing the Denver metro area, would alleviate some of the congestion on the city's highway system. Despite support by Jefferson and Boulder counties, plans in 1973 for this proposed highway, then referred to as I-470, were stymied by then Governor Richard Lamm, who was concerned about land use and air quality.[34] Federal funds were redirected to projects on S. Kipling Parkway and S. Santa Fe Drive. Eventually construction began in 1980 as a 26-mile segment of Colorado 470 (C-470). It was built in four stages with openings between December 1985

[30] Denver *Rocky Mountain News*, 2 March 1946 and 18 June 1947.
[31] "The Valley Highway: The Road that Colorado Loves to Hate," in *Colorado Heritage* (1995): 40; and "Denver's Valley Highway," in *The High Road*, 41-45, Highways file at Colorado Springs Pioneer Museum.
[32] "The Valley Highway," 41.
[33] Denver *Post*, 22 September 1969.
[34] Susan Carey, "C-470's Long and Winding History," in the *Denver Business Journal* 10 August 1998, accessed at www.bizjournals.com/denver/stories on 11 February 2004.

and October 1990. It is a locally-funded, state-maintained highway, and unlikely to become an interstate as first proposed.

A popular bike trail north of C-470 branches off of the High Line Canal Recreational Trail (associated with the Highline Canal, discussed under the Agricultural History section) near McLellan Reservoir and parallels the highway eastward to the vicinity of Park Meadows Mall and Interstate 25. The popularity of Colorado's paths and trails did not originate in the twentieth century, as many believe. At the end of the nineteenth century a new craze was sweeping the country—bicycling.

Bicycling

In the 1890s, at the height of railroad popularity, leisure bicycling swept the country. Denver boasted the highest per capita bicycle ownership in the country claiming 40,000 bicycles for its 100,000 residents.[35] As early as 1869, Denver residents' complaints about the number of bicycles on its streets resulted in an ordinance prohibiting their use on sidewalks. Cyclists soon established paths in and around the metro area. One of the most popular bicycle paths was between Denver and Littleton following City Ditch. Bicyclists followed the course of the ditch to Littleton to stop at the Harwood Inn, across from the Rough and Ready Mill, for lunch or to attend horse races held nearby. Another path followed Broadway south to the banks of the High Line Canal. A longer, popular route was to Palmer Lake in Douglas County. Cyclists left Littleton traveling south along S. Santa Fe Drive and the City Ditch to a bridge that carried them east across the railroad tracks to the old abandoned Colorado Springs Wagon Road. From there bicyclists continued south paralleling the D&RG Railroad to Palmer Lake.

The sport became so popular that the League of American Wheelmen held their annual meeting in Denver in 1894. Littleton cyclists organized in 1898 to form the Littleton Cycle Path Association with the purpose of improving bike paths along the banks of the City Ditch into Littleton. In 1899, Colorado cycling clubs lobbied the State Senate for funds to improve the bicycle path to Littleton and received five thousand dollars.[36] Today thousands of dollars each year go into the development and maintenance of Colorado's bike trail system. The modern High Line Canal Recreational Trail is a popular route for cyclists and on weekends hordes of cyclists, walkers, and joggers follow the trail along C-470.

Suburban Development

Agriculture remained the staple industry of south Jefferson and Arapahoe Counties until after World War II. Beginning with electronics, munitions, and aerospace, manufacturing became a principle employer and a catalyst for the boom in housing development in the 1950s into the 1970s. It first started with Glenn L. Martin Company (today Lockheed Martin) announcement in 1950 that they planned to build a $27 million major defense facility in south Jefferson County near Waterton Canyon. It was followed in the 1970s with the construction of the Johns Manville World Headquarters on Deer Creek Canyon Road south of Ken Caryl Ranch. South of C-470, the Chatfield basin area, between the S. Platte River and the Dakota Hogback, remained relatively agricultural and state park lands until the

[35] James Whiteside, *Colorado: A Sports History* (Niwot, Colorado: University Press of Colorado, 1999) 61.
[36] *Castle Rock Journal*, 7 April 1899.

1990s. Now residential and commercial development covers the valley leaving only historical remnants of its earlier agricultural history.

South Unincorporated Jefferson County

Southern Jefferson County's history and place names have strong associations to its early agricultural history. The area west of Littleton and east of the mountains remained sparsely settled and primarily agricultural until after World War II, when residential subdivisions began developing. Located off of Ken Caryl Avenue is an area that was once part of an enormous cattle ranching operation, the Ken Caryl Ranch. The long narrow valley lies between the Dakota Ridge Hogback and the foothills, sloping gently from Willow Springs on the north to Deer Creek Road on the south.

Ken Caryl Valley

In 1859, Major Robert J. Bradford developed the Denver, Bradford and Blue River Toll Road from Denver southwest to the north end of the Ken Caryl Valley over the foothills into the mining districts. In the valley, Bradford built a ranch with plans to plat a town site. However, the town site failed when a competing freighting firm built a toll road into the lower Turkey Creek Canyon. Bradford's toll road closed in 1867. After Bradford died in 1876, the property passed through several hands before it eventually became part of Ken-Caryl Ranch. In 1914, John C. Shaffer, owner of the Rocky Mountain News, purchased land along the hogback and foothills and named the 10,000-acre cattle ranch, Ken Caryl after his two sons, Kent and Carrol. Shaffer purchased a turkey farm (believed to be the Chatfield Turkey Farm) east of the valley and added it to his holdings from present-day Ken Caryl Avenue south to Kipling Parkway. In the early 1930s, the ranch came up for sale and was owned by a series of hopeful, but greenhorn, cattle ranchers.

In 1971, the Johns Manville Corporation purchased the property to develop a master-planned community and build their world headquarters. The headquarters, now the Lockheed Martin Facility, was built in 1976. The community spreads up the valley and east of the hogback to Kipling Parkway. In 1987, Martin Marietta Astronautics Group bought the headquarters from Johns Manville. A second complex arose east of the original one. Residential construction in the master community finished in 1997. Commercial development now extends along the C-470 corridor from Ken Caryl Avenue to Kipling Parkway.

Plum Creek Valley and Chatfield Reservoir Area

Both Chatfield Reservoir and the Chatfield State Park lie south of the Ken Caryl Valley. In 1973, the U.S. Army Corps of Engineers dammed the S. Platte River after torrential rains caused the east and west branches of the Plum Creek to overflow into the river on June 16, 1965. Rising waters flooded the City of Littleton and communities along its course into Denver. The former Plum Creek Valley area is under the Chatfield Reservoir.

The Chatfield Basin was homesteaded by farmers and ranchers who cultivated the fertile land along the S. Platte River Valley, Deer Creek, and East and West Branches of the Plum Creek. One of the earliest inhabitants was Daniel Witter, a lawyer and surveyor who owned a ranch at the juncture of the S. Platte River and Plum Creek. Between 1870 and 1871, Isaac Chatfield purchased the 720-acre property to raise cattle and cultivate crops. Isaac Van

Wormer acquired land along Plum Creek and was noted for his cattle and horse breeding. He was also one of the first members of the Colorado Stock Grower's Association.[37] Other ranches in the area included Riverside Acres, the Chatfield Turkey farm, Hildebrand Ranch, Green Ranch, and the Great Western Sugar Company sugar beet farms (1920s).

Hildebrand Ranch

After the Civil War, an influx of people settled in the Chatfield Basin region. Hildebrand Ranch carved out a section of what is now Jefferson County. Frank and Elizabeth Hildebrand settled at the head of Deer Creek Canyon in 1866 after building a log cabin. Little is known about the family's antecedents. However the ranch is historically significant as one of the earliest agricultural operations in South Jefferson County. The site is currently interpreted under the auspices of the Denver Botanic Garden at Chatfield. [38]

Twentieth-Century Development in South Jefferson County

In the 1950s and 1960s, manufacturing became the leading employer in the south area prompting a boom in housing development.[39] In the late 1950s, the Glen L. Martin Aerospace Plant, now Lockheed Martin, purchased the Atchison and C.K. Verdos ranches to build a twenty-seven million dollar manufacturing plant. Prompted by the introduction of the Martin-Marietta Facility in South Jefferson County, a spurt of subdivisions appeared to offer affordable housing for the facility's employees.[40]

Subdivisions and Additions

Two of the earliest subdivisions in the survey area were the Meadowbrook Heights Subdivision and Herrick-Dale Acres. Meadowbrook Heights Filing No. 1 was platted in May 1955 and extended from Sobey Avenue north to Chatfield Avenue and between Pierce Court on the east and Dudley on the west. The subdivision with its dirt and gravel streets was slow to develop until the 1980s. East of Meadowbrook Heights is the Herrick-Dale Acres subdivision.

In November of 1883, Mattie Fox sold 29 ½ acres of land to Robert D. and Mary Herrick for one hundred dollars. At the time, the property was located in Section 1, Township 6 South, Range 69 West of Douglas County. Later, in 1889, Herrick deeded the property to their son, Robert Herrick. In October 1925, Robert S. Herrick and Helen Herrick Dale platted Herrick-Dale Acres. Three years passed before the first house was built. The builder and owner of the house are unknown. When Jefferson County obtained this section of land from Douglas County, the original deed was refiled with the Jefferson County Clerk and Recorder's office. Construction in this subdivision did not begin until 1956 and then at a slow pace. [41] A second spurt of residential construction in Herrick-Dale Acres took place in the 1970s.

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[37] Marr, *Douglas County*, 100.

[38] In a 2001 Cultural Resource Inventory, SWCA, Inc., surveyed a turn-of-the-century property, Stockwell Ranch, located on the Denver Botanic Garden leased property. The Stockwell Ranch (5JF612) was recommended as eligible to the NRHP.

[39] Hicks, *Littleton*, 7-9; "The Birth of a County," 7 and 16; Skari, *High Line Canal*, 57-58; and City of Littleton website, "Littleton History."

[40] Skari, *High Line Canal*, 57-58.

[41] Jefferson County Tax Assessor, Planning Department and Clerk and Recorder records, Jefferson County Offices, Golden, Colorado.

Between Wadsworth Boulevard and the Jefferson-Douglas county line, two of the largest subdivisions noted are Columbine Hills and Columbine Knolls. In August 1959, Eugene Sanders platted Columbine Hills in Jefferson County bounded by Ken Caryl Avenue, S. Depew Street, Locust Way, and Platte Canyon Road.[42] Trend Homes of Nebraska, a new builder in the Denver market, constructed many of the earliest homes in Columbine Hills. Subsequent filings in the Hills expanded the subdivision to S. Pierce Street and W. Chatfield Avenue.

Columbine Hills is a multiple filing subdivision based on a Master Plan that includes amenities, such as shopping, schools, churches, and parks. When built, it was one of many subdivisions built to meet a growing demand for postwar subdivision development in the Denver metropolitan region. At the time, there was a growing demand for housing for young professionals moving to Denver to work in the region's expanding industrial and technological markets. A majority of Columbine Hills' early residents worked at the Martin plant southwest of the community.

West of Columbine Hills, Columbine Knolls appeared in March of 1964 with its boundaries defined as Coal Mine Avenue, W. Roxbury Place, Kendall and Depew Streets, and S. Pierce Street.[43] It also developed well into the 1970s. These and successive subdivisions stimulated commercial and community development along Wadsworth Boulevard and the C-470 corridor.

Arapahoe County Development

Just over the Arapahoe and Douglas county lines, is the Wolhurst Estate, a retirement community. The modular home park is on the former site of an estate with a colorful past.

U.S. Senator Edward Wolcott purchased property south of Denver and three miles south of Littleton to build a summer home that he called the Wolhurst Estate. Wolcott served the U.S. Senate between 1889 and 1901. He first bought the Legere ranch in Douglas County and eventually, purchased additional land north of it into Arapahoe County.[44] For years, the Wolcotts held many parties for dignitaries at their country home. After Wolcott's death in 1905, Wolhurst was sold to Thomas F. Walsh, a financier and mining magnate who made his money in silver at the Camp Bird Mine in Ouray, Colorado. Walsh remodeled the house and renamed the estate Clonmel after his Irish ancestral home. When Walsh died in 1910, the estate was sold to Horace W. Bennett, who changed the name back to Wolhurst.[45]

Bennett purchased sufficient acreage to raise cattle, horses, and chickens. No longer was the home a summer house, but a year round residence. Early in 1921, the road from Rapp Avenue to the Littleton City limits was paved with macadam connecting Wolhurst to the community. This was unique in that the earliest roads between cities remained primarily

[42] Jefferson County Planning Department, Columbine Hills, Filing No. 1, 12 August 1959, Book 20, page 1.
[43] Jefferson County Planning Department, Columbine Knolls, Filing No. 1, 10 March 1964, Book 26, pages 3-4.
[44] Dave Hicks, *Littleton: From the Beginning* (Denver: Egan Printing, 1975) 21.
[45] Hicks, *Littleton*, 22-23, and "The Story of Littleton: Denver's Best Suburb," *Littleton Independent*, 22 July 1938.

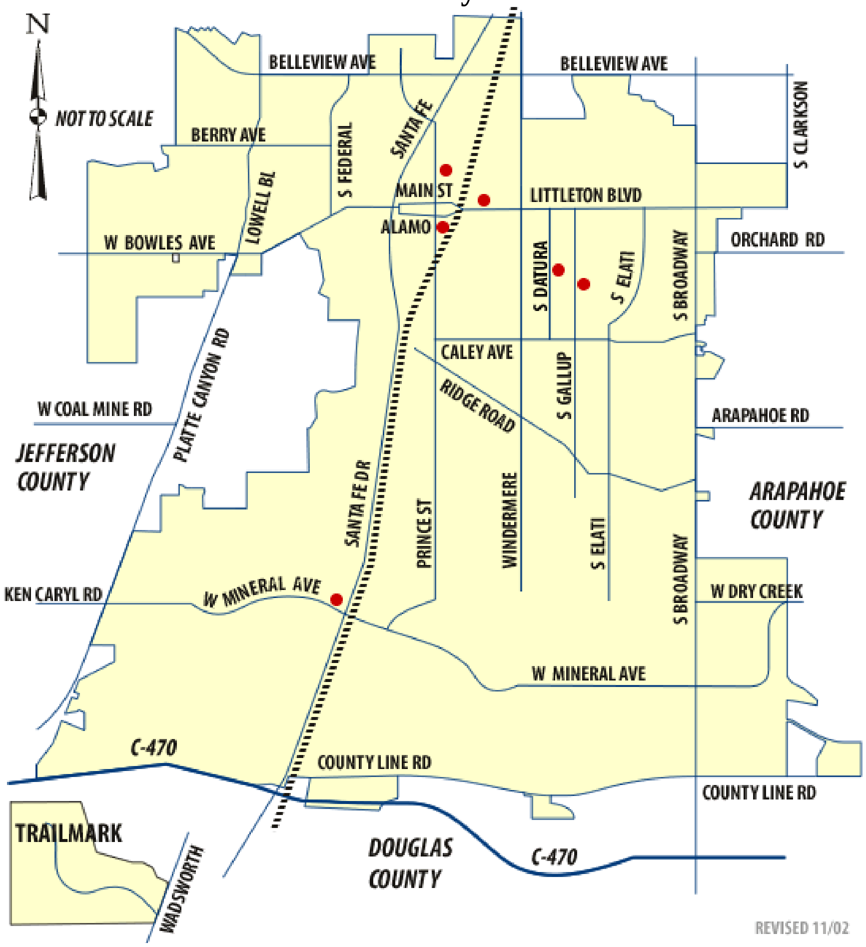
oiled surfaces even into the 1930s. In 1941, Horace Bennett died. When Mrs. Bennett could not keep up with the property, she sold the house with its 750 acres of land in 1944 to Ova E. Stephens.

Stephens, a reputed mobster and gambler, renamed the Wolhurst Estate calling it the Wolhurst Saddle Club. The club offered “elegant dining, riding, swimming, tennis, and – reportedly—high stakes gambling.[46] Over the years, local law enforcement from Arapahoe and Douglas counties raided the club for its illicit gambling practices. The land lay on both sides of the county line allowing illegal activities to move to one “county” or the other when alerted of imminent raids. Several fires, robberies, and raids highlight the Stephens’ era at Wolhurst Estate. After 1946, Stephens sold his share in the business to his nephew, Eddie Jordan, who continued to operate the Wolhurst Saddle Club. In 1971, Jordan sold the property to the Codeca Corporation of Illinois, who planned to develop a mobile home park on the site.[47] In 1973, twenty-four-and-a-half acres of land and the lake were sold to the City of Littleton.[48] Fire destroyed the vacant mansion on March 29, 1976. It was not replaced. The estate is now an all adult-community. Northeast of Wolhurst is the city of Littleton.

[46] Todd Engdahl, “85-Year-Old Club Led Rich and Racy Life until Second Fire,” *The Denver Post*, 30 March 1976.
[47] *Rocky Mountain News*, 30 August 1971.
[48] Engdahl, “Club Led Rich and Racy Life,” *The Denver Post*, 30 March 1976.

Figure 4

Littleton City Limits



Source: City of Littleton website

Littleton

North of Wolhurst is the City of Littleton, founded by Richard S. Little. The east-west boundaries of his land lie between the S. Platte River on the west and the D&RG tracks on the east. Officials of the fledgling city filed papers of incorporation several times before finally becoming incorporated in March of 1890 with a population of 245. In 1901, Jerome C. Smiley, author of the *History of Denver*, referred to Littleton as a suburb of Denver with a population of 738.[49] However, Littleton's earliest years are associated with its agricultural ties to Little's Rough and Ready Mill and the farms and ranches that surrounded it.

Railway lines through Littleton provided transport for local farmers' produce and goods up and down the Front Range. The number of truck farms east of Littleton eventually led to the construction of the Merry Canning and Pickling Factory in the downtown area. As the city prospered, it managed to win the site of Arapahoe County's seat of government in 1904 from Englewood. With its new status, an influx of population and the creation of more commercial

[49] Hicks, *Littleton*, 29.

businesses expanded within the Littleton environs. Nevertheless agriculture remained the staple industry of Littleton.

Despite its early manufacturing history and its significance as the county seat, the city of Littleton was actually slow to develop until World War II when the electronics, defense, and aeronautics industries moved into the city and nearby Jefferson County.

During WWII, Heckethorne Manufacturing Company, an armament manufacturer, became one of Littleton's largest employers. Post war highway construction closed the gap between the Denver metropolitan areas and prompted a population boom as automobiles carried residents in and out of the suburban city to jobs in Denver and nearby Jefferson County. Within a few years the aeronautics industry located in nearby Jefferson County and its employees found homes in Littleton. The city quickly expanded its boundaries east as its population swelled to 13,670 in 1960. Eventually the city's boundaries expanded south to the Douglas County line. As of the 2000 census, the city had a population of 40,340. Located southwest of Littleton and near Wolhurst is a ranch that has long felt associated with the history of Littleton, but is actually located in Douglas County.

Douglas County Development
In 1896, Jesse Estlack, who owned a great deal of northern Douglas County, filed for a land patent near present-day C-470, S. Santa Fe Drive, and County Line Road. Within a short time, Mathew Plews purchased the farmland that is now associated with the Flyin' B Ranch.

Plews built a two-story frame house on his property between 1899 and 1900 with the assistance of neighbors. Plews, a gardener for the Littleton Cemetery, developed his ranch land as a small cattle ranch. Later his family entered the nursery and gardening industry; family members continue as nurserymen to this day.

About 1936, Ova E. Stephens bought 80 acres that included the Plews house, but within a year Stephens was sent to prison for five years for illicit activities and attempted murder. His wife and a nephew continued to live on and operate the ranch until Stephens was released. Within a few years, between 1964 and 1965, Fred Eberhart bought the property eventually selling to Gates Rubber Company, who was looking for a southern location for plant operations. Throughout this time the ranch was primarily used for cattle. In a land swap between Gates Rubber Co. and the John Bowens family in 1965, the 80-acre parcel came under the ownership of the Bowens' family. A joint effort, eventually the property became part of Bowen Farms Inc., which is owned by eight family members who live on the property.

After the Bowens' family moved onto the ranch in 1965, it became known as the Flyin' B Ranch due to the aeronautic abilities of the progenitor and his family. The family developed two runways on the property for small, single engine airplanes and applied for FAA licensing. The Bowen men flew daily to and fro to their ranch near Strasburg, their principal ranching operations. The land on County Line Road had become too crowded. Over the years, various family members moved or built residences on the old Plews Ranch crowding out the cattle and crops. The land still supports a small herd of cattle, but gone are the days of large wheat and grain fields. Development on all sides impedes their operations and the property is now for sale.

Highlands Ranch

Douglas County, south of the city of Littleton and Arapahoe County, is predominantly farming and ranching community. On its northern boundary and adjacent to C-470 is the 22,000 acre ranch called Highlands Ranch. It is the result of land acquisitions of some of Douglas County's earliest ranches.

Once one of Colorado's fastest growing communities Highlands Ranch was originally open cattle range. In 1891, John Springer began to acquire land in northern Douglas County for his Cross Country Ranch. He amassed over 12,000 acres of land in order to breed his imported German Oldenburg horses. He built a "baronial mansion" that became Springer's Castle, rivaling Tweet Kimball's Sedalia Charlford Castle, which is adjoined to Springer's on the south. Springer went on to be the first president of the National Livestock Association organized in 1898 in Denver. In 1920, Springer sold the ranch to Waite Phillips, one of the founders of Phillips Petroleum, who in turn sold in 1926 to Frank E. Kistler. Kistler acquired several ranches including the Springer Ranch, Wolhurst Farm, Blakeland Poultry Farm, Plum Creek Ranch, Grig's Farm, and O'Neill Farm to create the Diamond K Ranch. The Diamond K specialized in raising Angus cattle and purebred sheep.[50] In 1937 Kistler sold the ranch to Lawrence C. Phipps, Jr.

The nearby Welte Cheese Ranch, owned by Austrian immigrant Johanne Welte, was well known for its quality cheeses. In 1878, Welte and his brother-in-law, Plazidus Gasner, borrowed funds to purchase twenty milk cows and 160 acres in northern Douglas County along the Big Dry Creek. Through hard work and diligence, the men began a dairy ranch that grew to 3,380 acres. On their spread, they built and operated a successful cheese operation that produced some of the finest Brick and Limburger cheeses in Colorado. The ranch became well known for their animal husbandry and manufacturing processes, well enough to be featured in farm journals such as *Scientific Farmer*. Later Philip Renner, purchased the ranch and the cheese operation from his father-in-law Johanne. In 1938, Renner stopped making cheese. Five years later, he sold to Lawrence C. Phipps. Phipps' Highlands Ranch now covers 22,000 acres.[51]

After Phipps' death in 1976, Marvin Davis of Davis Oil Company bought the ranch as a business investment, eventually selling it in 1978 to a California corporation, Mission Viejo. The developer envisioned a planned residential and commercial community to stretch across the entire property in northern Douglas County. Since 1981 the community has continually grown and even in 2013 continues to expand and grow adding more and more houses,

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[50] Josephine Marr, *Douglas County: A Historical Journey* (Gunnison, Colorado: B & B Printers, 1983) 132-134; Susan Consola Appleby, *Fading Past: The Story of Douglas County, Colorado* (Palmer Lake, Colorado: Filter Press, 2001) 62; and Richard F. Carrillo, "An Historical, Architectural, and Archeological Study of the Big Dry Creek Cheese Ranch at Highlands Ranch, Douglas County, Colorado," prepared for Mission Viejo Company, 1986, manuscript is part of the Littleton Historical Museum collection.

[51] Marr, *Douglas County,* 132-134, and Appleby, *Fading Past,* 63 and 69.

schools, and commercial properties within its boundaries. The community, with its population over 96,000 in 2010, stretches from S. Santa Fe Drive east to Yosemite.

Lone Tree

At the eastern terminus of C-470 at the Interstate 25 interchange is the city of Lone Tree. In November 1995, the Lone Tree subdivision voted to incorporate in order to reap the benefits from nearby commercial developments.

Results and Evaluations

The historic resource survey completed as part of the Section 106 process, *Historic Resource Survey: C-470 - Kipling Parkway to I-25*, and letter requesting a determination of eligibility for identified historic resources was submitted to SHPO on 16 September 2004. SHPO concurred with the findings on 23 September 2004. A complete list is available as Table B. *C-470 Corridor Historic Resources 45 Years or Older* in the Appendix. In January 2005, SHPO concurred with the findings of the *Historic Resource Effects and Mitigation, C-470 Kipling Parkway to I-25* document.

In 2013, a follow-up field survey on the project corridor identified five historic resources that had reached the 45 year threshold:

- Columbine Hills, a post-WWII subdivision (5JF5143),
- U.S. Army Corps of Engineers' Chatfield Dam (5JF5142 and 5DA3091),
- S. Platte River Bridges (5DA2819 and 5DA2826), and
- Massey Draw Concrete-Box Culvert (5JF4795).

Upon consultation with CDOT Region 1 and History Colorado in June 2013, historic resources identified as Eligible or Listed on the NRHP in the 2005 Effects and Mitigation technical document were re-evaluated and OAHP Re-visitation forms completed if they were within the boundaries of the 2013 APE.

Eligible or Listed Properties

Of the twenty-three properties 45 years or older identified in the 2004 field survey, thirteen are either officially eligible or listed in the National Register of Historic Places. A summary of the 2004 historic resources and eligibility determinations is found in Table 2 with any updates on NRHP Eligibility. A description of each eligible or listed historic property is provided after the table.

In June 2013, each of these thirteen historic resources were re-evaluated for any changes in determination. There are no suggestions for changes in determination. Two historic resources on this table were not re-visited as part of the 2013 historic resource survey since they are out of the 2013 project area. They are Littleton Large Animal Clinic (5AH732) and a segment of High Line Canal (5AH388).

Table 2

Summary of 2004/2005 Historic Resources

State ID#	Name	Location	NRHP Eligibility
5JF188	Hildebrand Ranch HD	8500 Deer Creek Road	National Register (1975)
5JF2613	Selzell Ditch	8500 Deer Creek Road	Officially Eligible (2004)
5AH254.7	City Ditch	Arapahoe County	Officially Eligible (1979), Non-contributing (2004)
5DA987.1	City Ditch	Douglas County	Officially Eligible (1979), Non-contributing (2004)

State ID#	Name	Location	NRHP Eligibility
5AH732	Littleton Lg. Animal Clinic and Canary Ranch Barn	8025 S Santa Fe Drive, Littleton	Officially Not Eligible (2012)
5AH256.4	AT&SF Railroad	Arapahoe County	Officially Eligible (1995), Supports (2012)
5DA922.1	AT&SF Railroad	Douglas County	Officially Eligible (1990), Contributing (2004)
5DA922.2	AT&SF Railroad	Douglas County	Officially Eligible (1995), Contributing (2004)
5AH255.2	D&RG Railroad	Arapahoe County, Littleton	Officially Eligible (1995), Contributing (2004)
5AH255.5	D&RG Railroad	Arapahoe County	Officially Eligible (2004), Supports (2012)
5DA921.1	D&RG Railroad	Douglas County	Officially Eligible (1990), Contributing (2004)
5AH388	High Line Canal	Arapahoe County	Officially Eligible (2000)
5DA600.3	High Line Canal	Douglas County	Officially Eligible (1981), Contributing (2004)

5JF188 Hildebrand Ranch (Re-visitation)
Hildebrand Ranch was listed on the National Register of Historic Places on March 13, 1975. It is significant under criterion A for its association with 1) domestic agriculture in the Rocky Mountain region prior to the advent of Colorado's railroad era, 2) its continuous occupation for over a century by a single family, and 3) its nineteenth-century historical integrity. Today the ranch is part of the Denver Botanic Gardens at Chatfield, which leases the land from the U.S. Army Corps of Engineers. The property is within the flood plain of the Chatfield Reservoir.

5JF2613 Selzell Ditch, Hildebrand Ranch, Jefferson County (Re-visitation)
This linear resource is eligible for National Register criterion A for its association with water rights and irrigation and its contribution to early agricultural and ranching development in Jefferson County. Following the adoption of the Colorado State Constitution, and its provisions regarding the doctrine of prior appropriation of water in the state, every drainage was assigned a water district number that continues to identify the state's streams and rivers. Deer Creek is the water source for the Selzell Ditch owned by Peter Selzell and Frank Hildebrand who constructed the ditch in 1868. Peter Selzell appeared as a witness at the 1883 adjudication hearing for water rights on the Selzell Ditch located in Jefferson County, Colorado. The ditch was determined Officially Eligible (2004).

5AH254.7 City Ditch, Arapahoe County (Re-visitation)
City Ditch (5AH254) is an historic irrigation ditch that began at a point south of Littleton at the S. Platte River. It runs through Littleton, Englewood, and into Denver where it provided water to Washington and City Park. Portions of the ditch through Littleton are still open as originally designed and the section through Washington Park has been found eligible to the

NRHP on December 13, 1979. The section (5AH254.7) in the survey area is non-contributing because it has been enclosed in pipes. A historic flume is located on the property at Green Valley Turf farm where the water leaves the pipes and proceeds northerly in an open ditch until it nears Mineral Avenue where it then is directed into pipes. This segment of the ditch is a non-contributing portion of City Ditch (2004).

5DA987.1 City Ditch, Douglas County (Re-visitation)
The section of City Ditch located in the vicinity of SH 85 and C-470 has lost integrity due to development along S. Santa Fe Road (SH 85) and the enclosure of portions of the ditch in to pipes. It is non-contributing to the significance of City Ditch (2004).

5AH256.4 Atchison, Topeka and Santa Fe Railroad (Re-visitation)
The AT&SF Railway Company was one of the largest railroads in the United States. It was chartered in Kansas, but did not reach solid footing until after its reorganization in 1863. During Colorado's railroad building era, the AT&SF managed to stay afloat as others failed. The railroad played an important role in state's history and development. It was determined officially eligible in 1979 and 1995. This segment of the railroad in the project area contributes to the historic significance of the AT&SF Railroad (2012).

5DA922.1 Atchison, Topeka and Santa Fe Railroad (Re-visitation)
The AT&SF Railway Company was one of the largest railroads in the United States. It was chartered in Kansas, but did not reach solid footing until after its reorganization in 1863. During Colorado's railroad building era, the AT&SF managed to stay afloat as others failed. The railroad played an important role in state's history and development. It was determined officially eligible in 1979 and 1995. This segment of the railroad in the project area contributes to the historic significance of the AT&SF Railroad (2012).

5DA922.2 Atchison, Topeka and Santa Fe Railroad (Re-visitation)
The AT&SF Railway Company was one of the largest railroads in the United States. It was chartered in Kansas, but did not reach solid footing until after its reorganization in 1863. During Colorado's railroad building era, the AT&SF managed to stay afloat as others failed. The railroad played an important role in state's history and development. It was determined officially eligible in 1979 and 1995. This segment of the railroad in the project area contributes to the historic significance of the AT&SF Railroad (2004).

5AH255.2 Denver & Rio Grande Railroad (Re-visitation)
Following the construction of the First Territorial Road between Denver and Colorado City, a similar north-south route along the foothills was surveyed for the site of the first narrow-gauge railroad in the United States. General William Jackson Palmer and the National Land and Improvement Company provided the funds to construct the railroad between Denver and Colorado Springs. This segment of the railroad in the project area contributes to the historic significance of the D&RG Railroad (2004).

5AH255.5 Denver and Rio Grande Railroad (Re-visitation)
Following the construction of the First Territorial Road between Denver and Colorado City, a similar north-south route along the foothills was surveyed for the site of the first narrow-

gauge railroad in the United States. General William Jackson Palmer and the National Land and Improvement Company provided the funds to construct the railroad between Denver and Colorado Springs. This segment of the railroad in the project area contributes to the historic significance of the D&RG Railroad (2004).

5AH388 High Line Canal, Arapahoe County
In 2000, SHPO determined that High Line Canal was officially eligible for its association with Colorado's early agricultural development. High Line Canal is a 71-mile long linear resource found in Arapahoe, Douglas, and Denver counties. The segment north of C-470 has been surveyed and is not within the APE of the C-470 Corridor study. Therefore, a re-visitation form was not completed.

5DA600.3 High Line Canal, Douglas County (Re-visitation)
In 2000, SHPO determined that High Line Canal was officially eligible under criterion A for its association with Colorado's early agricultural development. High Line Canal is a 71-mile long linear resource found in Arapahoe, Douglas, and Denver counties. This segment of the canal contributes to the significance and association with agricultural development of northern Douglas County.

2013 Survey Results

In May and June 2013, an intensive-level survey was conducted to re-evaluate historic resources identified in earlier reports and to identify any historic resources that may have reached the 45 year threshold since the 2006 Environmental Assessment document. The 2013 Historic Resource Survey identified five historic resources that have reached 45 years of age. A description of each eligible or listed historic property is provided after the table.

Table 3

Summary of 2013 Historic Resource Survey

State ID#	Name	Location	NRHP Eligibility
5JF5142 & 5DA3091	Chatfield Dam	S Wadsworth Blvd	Eligible
5JF5143	Columbine Hills	S Platte Canyon Road	Eligible
5DA2819	S Platte River Bridge F-16-HW	Eastbound C-470, Milepost 16.562	Not Eligible
5DA2826	S Platte River Bridge F-16-HV	Westbound C-470, Milepost 16.563	Not Eligible
5JF4795	Massey Draw Culvert F-16-HY	Eastbound & Westbound C-470, Milepost 14.160	Not Eligible

5JF5142 & 5DA3091 Chatfield Dam
The US Army Corps of Engineers built the dam, reservoir, and associated recreational areas over a ten year period between 1967 and 1977. Chatfield Dam is historically significant under NRHP Criterion A for its association with the US Army Corps of Engineers and their

role as dam builders. In the 20th-Century, the U.S. Army Corps of Engineers became the lead federal flood control agency, a provider of hydroelectric energy, and the country's leading provider of recreation associated with water bodies. Its role also included responding to natural disasters. The Corps built Chatfield Dam after a devastating flood in 1965 in the S. Platte River Valley. The rolled-earth dam is significant under NRHP Criterion C for its embodiment of the distinctive characteristics and method of construction for a Rolled Earth-Fill Dam used by the Corps. The dam is eligible for the NRHP.

5JF5143 Columbine Hills

Columbine Hills subdivision is a good example of a multiple filing subdivision based on a Master Plan that includes amenities, such as shopping, schools, churches, and parks constructed between 1959-1977. It is significant under NRHP Criterion A for its association with postwar development in the Denver metropolitan region to meet growing demand for housing for young professionals who worked in the region's expanding industrial and technological markets. Under NRHP Criterion C, the subdivision is representative of patterns of the metro area's postwar community planning and development that utilized a master plan to create a cohesive, individual community for its residents. The subdivision is eligible for the NRHP.

The following structures 5DA2819, 5DA2826, and 5JF4795 were evaluated in conjunction with the 2013 Update to the Colorado Historic Bridge Inventory, and are submitted for eligibility concurrence with this submission.

5DA2819 S Platte River Bridge, F-16-HW

Colorado Department of Highway (CDH) constructed the T-Beam Bridge in 1968 on a portion of the original Highway 470 in Douglas County. Bridge F-16-HW carries the eastbound traffic on the highway, a sister bridge F-16-HV carries the westbound traffic. The continuous T-beam Bridge is a later example of a design variation dating to the late 1920s and revived by CDH after 1955. The 2013 Historic Bridge Survey determined the bridge not eligible.

5DA2826 S Platte River Bridge, F-16-HV

Colorado Department of Highway (CDH) constructed the T-Beam Bridge in 1968 on a portion of the original Highway 470 in Douglas County. Bridge F-16-HV carries the westbound traffic on the highway, a sister bridge F-16-HW carries the eastbound traffic. The continuous T-beam Bridge is a later example of a design variation dating to the late 1920s and revived by CDH after 1955. The 2013 Historic Bridge Survey determined the bridge not eligible.

5JF4795 Massey Draw Culvert, F-16-HY

The concrete-box culvert is a later example of a structure type used for drainage during the 1910s, common in Colorado by 1940. True to design, the culvert is used as a low-rise, rigid frame bridge for use by a minor stream, Massey Draw, under C-470. The 2013 Historic Bridge Survey determined the culvert not eligible.

In conclusion, the 2013 historic resource survey identified five new properties 45 years or older that are either eligible or not eligible for listing on the National or State Register of Historic Places. Two historic resources, the subdivision (5JF5143) and the dam (5JF5142, 5DA3091) are eligible to the NRHP. The 2006 Environmental Assessment identified 13 historic resources that are officially eligible or listed on the National Register of Historic Places. Two of these historic resources are no longer in the proposed 2013 Area of Potential Effects.

We hereby request your concurrence with these determinations of eligibility for the five (5) historic resources identified in this 2013 revision of the historic resource survey.

Effects & Mitigation Introduction

The purpose of this document is to meet the requirements of Section 106 (36 CFR Part 800 as amended in August 2001), to determine if there are significant historic resources that are listed or eligible for listing in the National Register of Historic Places (NRHP) within the study area, and if these resources are impacted by the Proposed Alternatives for transportation improvements to C-470. This effort is being completed on behalf of the C-470 Revised Environmental Assessment (EA).

This analysis discusses the following elements:

- Applicable portions of the Section 106 regulations of the National Historic Preservation Act, with guidelines on determining adverse effects to historic properties eligible for or listed on the NRHP

- Assessment of direct and indirect and/or overall cumulative impacts to historic properties

- Recommended measures to minimize adverse effects or mitigation to historic properties

In this effects analysis, the term “historic properties” has been used for those structures, sites, or linear features (i.e. railroads, ditches, or roads) that have been either determined to be on or eligible to the NRHP or the State Register of Historic Properties (SRHP), or previously determined to be eligible for or listed on the NRHP or SRHP through consultation on the survey effort for both the 2006 C-470 EA and the 2013 *Revised Historic Resource Survey C-470 – Kipling Parkway to I-25*.

The Colorado SRHP is a list of the state’s significant cultural resources. Resources listed on the State Register can include buildings, structures, objects, districts, or historic and archeological sites. Resources listed in the NRHP are automatically placed on the State Register. However, resources can also be nominated to the State Register without being included in the National Register.[52]

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[52] History Colorado, Office of Archeology and Historic Preservation, *Directory of State Register Properties* (Colorado Historical Society, Office of Archeology and Historic Preservation, Updated Published 2008) 4-5.

National Historic Preservation Act Section 106 Regulations

The Section 106 regulations, 36 CFR Part 800 (“Protection of Historic Properties”), of the National Historic Preservation Act include specific criteria of adverse effects that must be applied to federal undertakings with the potential to impact historic properties. When considering the potential for adverse effects, all reasonably foreseeable impacts must be taken into account, including direct, indirect, and cumulative impacts. In addition, it is essential to understand the criteria of significance for an historic property, or why a property has been determined to be eligible for or listed on the NRHP. Determination of adverse effect on a historic property is assessed on the potential of the undertaking to alter or diminish the qualities of significance.

Criteria of Adverse Effect

An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP or SRHP in a manner that would diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property’s eligibility for the National Register. Adverse effects may include cumulative impacts defined as reasonably foreseeable effects caused by either undertaking that may occur later in time or further removed in distance than the Proposed Alternatives.

Examples of adverse effects on historic properties include, but are not limited to:

(i) Physical destruction of or damage to all or part of the property;

(ii) Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary of Interior’s standards for the treatment of historic properties (36 CFR Part 68) and applicable guidelines;

(iii) Removal of the property from its historic location;

(iv) Change of the character of the property’s use or of physical features within the property’s setting that contribute to its historic significance;

(v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property’s significant historic features;

(vi) Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an [Native American] or Native Hawaiian organization; and

(vii) Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance. (36 CFR 800.5)

The revised Section 106 regulations, effective January 11, 2001, contain additional guidance for determining and assessing adverse effects during the preparation of an EA or Environmental Impact Statement (EIS), as follows in Section 3.2 and 3.3.

Environmental Consequences

Project Study Area

The Area of Potential Effect (APE) for this project is defined as that area from the Kipling Parkway interchange on C-470 in Jefferson County east along the corridor to and including the interchange at C-470 and I-25 in Douglas County as shown in Figure 2. SHPO concurred with this APE in May 2004. The APE has been revised at the S. Santa Fe Interchange with C-470 because no improvements will be outside of CDOT's ROW.

Travel demands on C-470 include regional, commuter, destination and local trips. Since its completion in 1990, C-470 has served the transportation needs of communities throughout the southwest Denver metropolitan area, including Littleton, Lakewood, Greenwood Village, Lone Tree, Centennial, Highlands Ranch, Ken Caryl and portions of unincorporated Jefferson County. In addition, C-470 is a vital link between I-25, U.S. Highway 85 (US 85)/Santa Fe Drive, and Interstate 70 (I-70) between the mountains, southern suburbs, and the southern Front Range, which serves essential commercial, commuter, and residential traffic. In this regard, C-470 must serve a variety of roles for a variety of users.

The purpose of this project is to address congestion, reduce traveler delay, and improve reliability and safety for corridor users while at the same time minimizing impacts to the environment and surrounding communities.

In the vicinity of the C-470 Corridor, US 85/Santa Fe Drive was recently improved and as part of a safety project to add lanes and construct a flyover onto C-470 from southbound Santa Fe Drive.

Survey Results

A complete list of the historic resources surveyed in both 2004 and 2013 is provided in Table 4. The historic properties are listed in the order of their location from west to east between Kipling Parkway and I-25. Determinations of adverse effect, also shown in Table 4, are made based on the potential of the undertaking to alter or diminish the qualities of significance of a historic property as outlined in Section 1.1 *Criteria of Adverse Effect* (as stated in Section 106 of 36CFR, Part 800).

Of the sixteen (16) historic resources identified in the 2013 survey area, one is on the NRHP (5JF188), ten (10) are officially eligible or segments that may or may not support the entire linear resource, two (2) are field eligible to the NRHP, and three (3) are field not eligible to the NRHP. If an entire linear resource is eligible, segments of that resource were considered for potential effects.

Table 4

Analysis Summary of Properties & Determination of Effects

Site Number	Site Name	Location	NRHP Eligibility & Date	Determination of Effect
5JF188	Hildebrand Ranch HD	8500 Deer Creek Road	National Register (1975)	No historic properties affected
5JF2613	Selzell Ditch	8500 Deer Creek Road	Officially Eligible (2004)	No historic properties affected
5JF4795	Massey Draw CBC, F-16-HY	Massey Draw	Not Eligible	No historic properties affected
5JF5142, 5DA3091	Chatfield Dam	S Wadsworth Blvd	Eligible	No Adverse Effect
5JF5143	Columbine Hills	S Platte Canyon	Eligible	No Adverse Effect
5AH254.7	City Ditch	Arapahoe County	Officially Eligible (1979)	No historic properties affected
5DA987.1	City Ditch	Douglas County	Officially Eligible (1979)	No Adverse Effect
5DA2819	S Platte River Bridge, F-16-HW	S Platte River	Not Eligible	No historic properties affected
5DA2826	S Platte River Bridge, F-16-HV	S Platte River	Not Eligible	No historic properties affected
5AH256.4	AT&SF Railroad	Arapahoe County	Officially Eligible (1995)	No historic properties affected
5DA922.1	AT&SF Railroad	Douglas County	Officially Eligible (1990)	No historic properties affected
5DA922.2	AT&SF Railroad	Douglas County	Officially Eligible (1995)	No historic properties affected
5AH255.2	D&RG Railroad	Arapahoe County, Littleton	Officially Eligible (1995)	No historic properties affected
5AH255.5	D&RG Railroad	Arapahoe County	Officially Eligible (2004)	No historic properties affected
5DA921.1	D&RG Railroad	Douglas County	Officially Eligible (1990)	No historic properties affected
5DA600.3	High Line Canal	Douglas County	Officially Eligible (2004)	No Adverse Effect

C-470 Current and Proposed Alternative Descriptions

The existing C-470, a four-lane highway, currently has a 110-foot span that includes two (2) General Purpose Lanes in each direction with a depressed median, as shown in Figure 5 below. In February 2006, CDOT's completed C-470 Environmental Assessment (EA) recommended implementation of tolled express lanes along 13 miles of C-470 between Interstate 25 and Kipling Parkway, now referred to as Segment 1. The majority of this segment was planned in 2006 to implement the tolled express lanes with a barrier-separated typical section and a typical width of 162 feet, as shown in Figure 6 below. Access to the tolled express lanes was planned with slip ramps into and out of the lanes at strategic locations, along with direct connection ramps at Colorado Boulevard, Quebec Street, and Interstate 25. In the past six years, no subsequent environmental decision document was completed for this project, and project implementation has not begun. Interchange improvements at C-470/Santa Fe (e.g., southbound to eastbound flyover ramp) received separate environmental clearance and have been constructed.

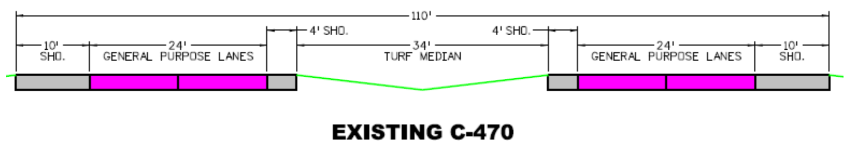


Figure 5 Current Alignment

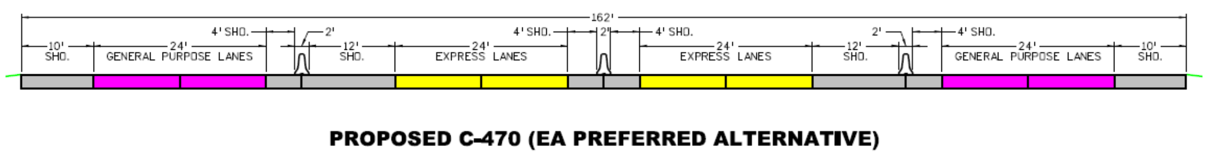
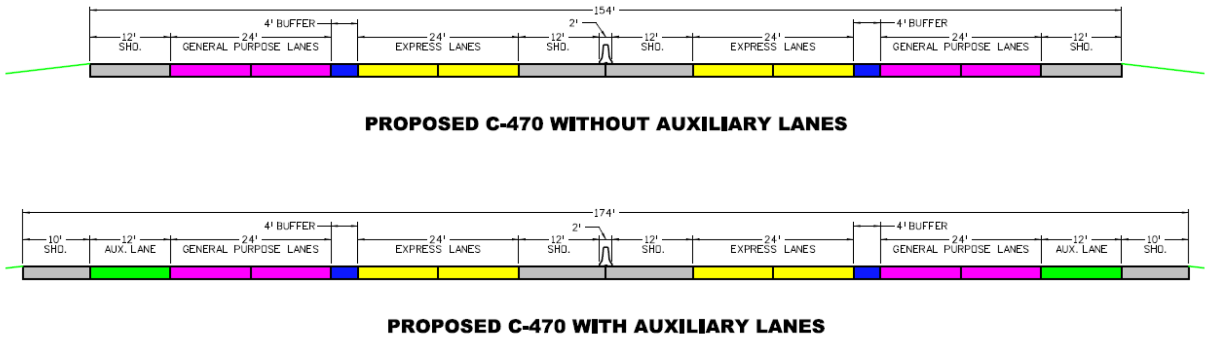


Figure 6 2006 Proposed Alignment

Since the 2006 EA, a coalition of interested parties and agencies has formed to bring this project to fruition. Formed in February 2011, the C-470 Corridor Coalition is a cooperative effort involving local governments and CDOT. The Coalition's purpose is to recommend and implement a plan to pay for improvements to C-470 in Segment 1, and ultimately continue improvements along C-470 from Kipling Street to Interstate 70, now referred to as Segment 2.

In February 2013 the Coalition Policy Committee unanimously approved a new option to implement tolled express lanes in Segment 1, but with a revised typical section and revised access concept. The proposed typical section replaces the original barrier separation with a painted (buffer) separation, and increases shoulder widths. The proposed improvements also include the addition of multiple auxiliary lanes at strategic locations along C-470 where on-ramp to off-ramp spacing is close, and where the auxiliary lane will provide an operational improvement to C-470. Thus, some portions of the corridor will have auxiliary lanes, and other portions will not. The new proposed typical sections are shown in Figure 7, with typical widths of 154 feet and 174 feet. Access to the tolled express lanes is planned with ingress and egress slip ramps and weaving zones, strategically placed along the corridor. EL traffic will be monitored by electronic devices similar to those used on E-470 located on overhead sign bridges and individual transponders mounted on vehicle windshields. No toll collection booths will be required.

Figure 7 2013 Proposed Alignment



In summary, the proposed 2013 Express Lane Alternative includes the addition of Express Lanes and other improvements as follows:

- Expansion from the corridor's current four (4) General Purpose Lanes (GPL) to include two to four tolled Expressed Lanes (EL) – one to two lanes in each direction – depending upon location,
- Addition of ingress and egress lanes to access ELs,
- Widening or new construction of existing bridges to accommodate increased number of lanes include but are not limited to the S. Platte River, Broadway, University, Acres Green, and Yosemite bridges.

An analysis of impacts and effects of specific Express Lanes to the historic properties is discussed in the following sections.

Analysis Guidelines

For the purposes of the effects determination, the discussion will only focus on that portion of the corridor between Kipling Parkway and Lucent Boulevard where historic properties are located. Each of the historic properties will be discussed with regard to the potential for the Express Lane Alternative to result in direct or indirect impacts to that property. Graphics depicting proposed improvements in the vicinity of historic resources are included as needed for descriptive purposes. Historic resources and the Express Lane Alternative limits of construction are shown in Figure 8.

Figure 8 Limits of Construction

Analysis of Impacts

Kipling Parkway to Wadsworth Blvd
The first section of the Corridor in this discussion is between Kipling Parkway east to Wadsworth. The Express Lane Alternative in this section will involve adding tolled ELs to the existing GPLs including Auxiliary Lanes eastbound and westbound. The existing Kipling Parkway/C-470 interchange will not be improved. Express Lanes will be constructed within the existing center median. Toll collection for the ELs will operate through the use of electronic overhead toll collection devices and individual transponders mounted on vehicle windshields.

Specifically, the design includes the addition of one EL, in each direction (eastbound and westbound) with a barrier separation between opposing directions of traffic, and a buffer separation between the ELs and GPLs. Barrier separation consists of a two-foot concrete barrier, while a buffer separation consists of a four-foot painted asphalt separation, painted with yellow chevrons on the surface stressing demarcation between lanes. In addition, two (2) Auxiliary Lanes (eastbound and westbound) will allow access to the ELs. Total pavement width will be 150 feet. The existing C-470 Bridge over Wadsworth Boulevard will be widened to accommodate increased lanes. However the bridge will not be completely reconstructed.

The Express Lane Alternative will have no effects on two eligible historic properties in this segment between Kipling and Wadsworth.

Hildebrand Ranch HD (5JF188). West of Wadsworth Boulevard, the entrance to the Hildebrand Ranch located on the grounds of the Denver Botanic Gardens at Chatfield is approximately 1800 feet from the interchange limits, as shown in Figure 8. The addition of ELs and auxiliary lanes will not cause the highway to encroach on the property associated with the Denver Botanic Gardens at Chatfield and the National Register District, as they will be constructed within the existing median and ROW.

At its closest point, the limits of construction are 1,957 feet from the National Register District. Construction limits are extended from the highway at this point to add a drainage feature to treat a water outlet and direct water to natural drainage along Deer Creek Road. Indirect visual impacts are not expected as the addition of the single EL in each direction is within the existing right-of-way. No property acquisition is necessary.

With regard to indirect effects based on noise, it is assumed that the proposed improvements could lead to increased traffic levels and traffic-related noise. Increased noise levels are expected in the vicinity of Chatfield Bluffs subdivision (non-historic) located northwest of the ranch and a noise wall is recommended. However, there are no elevated noise levels in the vicinity of the ranch due to its distance from the highway and the subdivision.

The Express Lane Alternative will not result in any impact to this property and no cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. **The resulting determination of effect is no historic properties affected.**

Selzell Ditch (5JF2613). West of Wadsworth, Selzell Ditch is located on the property associated with the Denver Botanic Gardens at Chatfield, also shown in Figure 8. The addition of ELs with auxiliary lanes will not cause the highway to encroach on the property associated with the Botanic Gardens or the Selzell Ditch. At its closest point, the limits of construction are approximately 1,642 feet from Selzell Ditch. Construction limits are extended from the highway at this point to add a drainage feature for a water outlet and direct water to natural drainage along Deer Creek Road. This drainage feature will not drain into Selzell Ditch.

The Express Lane Alternative will not result in any impact to the ditch. There have been no indirect visual or noise impacts identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. **The resulting determination of effect is no historic properties affected.**

Wadsworth Blvd to Platte Canyon Road
The Express Lane Alternative in this section will involve adding tolled ELs to the existing GPLs including a westbound Auxiliary Lane for access to tolled ELs. The existing Wadsworth Boulevard/C-470 interchange will not be improved. Express Lanes will be constructed within the existing center median. Toll collection for the ELs will operate through the use of electronic overhead toll collection devices and individual transponders mounted on vehicle windshields.

Specifically, the design includes the addition of one (1) EL in each direction with a barrier separation between opposing directions of traffic, and a buffer separation between the ELs and GPLs. Barrier separation consists of a two-foot concrete barrier, while a buffer separation consists of a four-foot painted asphalt separation, painted with yellow chevrons on the surface stressing demarcation between lanes. There will only be one auxiliary lane westbound. Total pavement width will be 138 feet. The existing C-470 Bridge over Wadsworth Boulevard will be widened to accommodate increased lanes. However the bridge will not be completely reconstructed.

The Express Lane Alternative will have the following effects on these three historic properties:

Massey Draw CBC, F-16-HY (5JF4795). Massey Draw, as a linear feature, was determined not eligible for listing on the NRHP in 2013 Revised Historic Bridge Survey. The portion of the draw under C-470 east of Wadsworth Boulevard may not be replaced as part of this project. Retaining walls will be implemented to limit grading impacts and allow the CBC to remain in place. Other improvements may take place to improve on-going drainage issues at Massey Draw and C-470, which in turn may prompt replacement of the CBC.

The Express Lane Alternative will not result in any impact to this property. There have been no indirect visual or noise impacts identified. No cumulative impacts have been identified. **The resulting determination of effect is no historic properties affected.**

Chatfield Dam (5JF5142, 5DA3091). Chatfield Dam is eligible for listing on the NRHP. The addition of ELs with westbound auxiliary lane will not cause the highway to encroach on the property associated with the Corps of Engineers dam site. Construction limits will be within CDOT ROW.

With regard to indirect effects based on noise, it is assumed that the proposed improvements could lead to increased traffic levels and traffic-related noise in the vicinity of the Chatfield Dam embankments. With regard to indirect effects based on visual impacts, the span of pavement will increase but within CDOT ROW. The visual impact would be visible only from the top of the west embankment overlook. Figure 9, the photograph taken from the west embankment, illustrates that the line of traffic is sufficiently distant to not detract. The current highway does not impede the view. Noise at the top of the embankment is minimal.

Figure 9 View from West Embankment north towards C-470

The Express Lane Alternative will not result in any impact to this property. Both indirect noise and visual impacts have been identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. **The resulting determination of effect is no adverse effect.**

Columbine Hills (5JF5143). Columbine Hills, a post-WWII subdivision, is eligible for listing on the NRHP. The addition of ELs with westbound auxiliary lane will not cause the highway to encroach on the historic boundaries associated with the subdivision.

With regard to indirect effects based on noise, it is assumed that the proposed improvements could lead to increased traffic levels and traffic-related noise in the vicinity of Columbine Hills. In the 2006 EA, a proposed sound wall and berm (850 feet by 20 feet) in the vicinity of Columbine Hills was recommended. That recommendation stands in 2013. On-going analysis will determine whether the size of the sound wall will be increased to address noise issues. If the sound wall is installed, that visual element will have an indirect effect on the subdivision, but remove the indirect noise effect.

The Express Lane Alternative will not result in any impact to this property. Both indirect visual and/or noise impacts have been identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. **The resulting determination of effect is no adverse effect.**

Platte Canyon Road to Santa Fe Drive

The Express Lane Alternative between Platte Canyon and Santa Fe Drive consists of the addition of ELs to the existing highway and a westbound Auxiliary Lane. East of Platte Canyon Road, the highway will widen further to include a total of two (2) ELs in each direction (eastbound and westbound) plus the existing four (4) GPLs with a barrier separation between opposing directions of traffic and between ELs and GPLs. Specifically, there will be a barrier separation between opposing directions of traffic and a buffer separation between the ELs and GPLs. Barrier separation consists of a two-foot concrete barrier, while a buffer separation consists of a four-foot painted asphalt separation, painted with yellow chevrons on the surface stressing demarcation between lanes. There will only be a westbound Auxiliary Lane in this section. Total width of pavement is 162 feet.

One exception to this typical section layout will occur where C-470 passes under the Union Pacific Railroad Bridges east of Santa Fe Drive, where the EL section narrows to a buffer separation instead of a barrier separation due to restricted distance between the railroad bridge piers. Although the railroad bridges over C-470 do not meet the minimum 50-year age requirement for eligibility to the NRHP, they will not be replaced as part of the Express Lane Alternative.

The Express Lane Alternative will have the following effects on these four historic properties:

Chatfield Dam (5JF5142, 5DA3091). Chatfield Dam is eligible for listing on the NRHP. The addition of ELs with westbound auxiliary lane will not cause the highway to encroach on the property associated with the Corps of Engineers dam site. Construction limits will be within CDOT ROW.

With regard to indirect effects based on noise, it is assumed that the proposed improvements could lead to increased traffic levels and traffic-related noise in the vicinity of the Chatfield

Dam embankments. With regard to indirect effects based on visual impacts, the span of pavement will increase but within CDOT ROW. The visual impact would be visible only from the top of the west embankment overlook. Figure 9, the photograph taken from the west embankment, illustrates that the line of traffic is sufficiently distant to not detract. The current highway does not impede the view. Noise at the top of the embankment is minimal.

The Express Lane Alternative will not result in any impact to this property. The indirect noise and/or visual impacts have been identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. **The resulting determination of effect is no adverse effect.**

South Platte River Bridge, F-16-HW (5DA2819). The bridge, as a linear feature, was determined not eligible for listing on the NRHP in 2013 revised Historic Bridge Survey. The bridge will be widened to accommodate increased lanes.

The Express Lane Alternative will not result in any impact to this property. There have been no indirect visual or noise impacts identified. No cumulative impacts have been identified. **The resulting determination of effect is no historic properties affected.**

South Platte River Bridge, F-16-HV (5DA2826). The bridge, as a linear feature, was determined not eligible for listing on the NRHP in 2013 revised Historic Bridge Survey. The bridge will be widened to accommodate increased lanes.

The Express Lane Alternative will not result in any impact to this property. There have been no indirect visual or noise impacts identified. No cumulative impacts have been identified. **The resulting determination of effect is no historic properties affected.**

City Ditch (5AH254.7 and 5DA987.1). City Ditch, as a linear feature, was determined eligible for listing on the NRHP in 1979; these segments are non-contributing. The portion of City Ditch located under C-470 in the vicinity of the C-470/Santa Fe Drive interchange will be re-aligned and re-constructed as the highway is reconstructed as part of the Express Lane Alternative. During the initial construction between 1982 and 1985 of this section of C-470, these segments of City Ditch were significantly altered when they were re-aligned and put into pipes south of C-470, under the highway, and north of the highway along Santa Fe Drive. As a result, the two segments in the APE lack historical integrity. A majority of the linear resource north of the APE, within the City of Littleton is still intact providing an exemplary example of this resource and its historical significance. While the linear resource as a whole still maintains its historic value and is eligible for listing on the NRHP, the portion of City Ditch the segments within the C-470 Corridor APE are not historically significant. Therefore, the re-construction of the ditch’s pipeline as a result of implementing the Express Lane Alternative would not be an adverse effect.

The Express Lane Alternative will not result in any impact to this property. There have been no indirect visual or noise impacts identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. The resulting determination of effect is **no adverse effect** because it was already altered between 1982 and 1985 with the initial construction of C-470.

Santa Fe Drive to Lucent Blvd

The Express Lane Alternative between Santa Fe Drive and Lucent Boulevard consists of the addition of ELs to the existing highway and a westbound Auxiliary Lane. The highway will widen to include a total of two (2) ELs in each direction (eastbound and westbound) plus the existing four (4) GPLs with a barrier separation between opposing directions of traffic and between ELs and GPLs. Specifically, there will be a barrier separation between opposing directions of traffic and a buffer separation between the ELs and GPLs. Barrier separation consists of a two-foot concrete barrier, while a buffer separation consists of a four-foot painted asphalt separation, painted with yellow chevrons on the surface stressing demarcation between lanes. Total width of pavement is 162 feet.

One exception to this typical section layout will occur where C-470 passes under the Union Pacific Railroad Bridges east of Santa Fe Drive, where the EL section narrows to a buffer separation instead of a barrier separation due to restricted distance between the railroad bridge piers. Although the railroad bridges over C-470 do not meet the minimum 50-year age requirement for eligibility to the NRHP, they will not be replaced as part of the Express Lane Alternative.

The Express Lane Alternative will have the following effects on these three historic properties:

Denver and Rio Grande Railroad (5AH255.5, 5AH255.2, 5DA921.1). The Denver and Rio Grande Railroad (D&RG RR) runs parallel to US 85/Santa Fe Drive, east of the roadway in the project study area. The railroad was determined eligible for listing on the NRHP in 1995; these segments are contributing. The addition of the ELs to C-470 will not impact this resource. The highway road surface under the railroad overpasses will be reduced to a buffer separation instead of a barrier separation due to the restricted distance between the bridge piers. Flared, poured-concrete barriers will abut to the current bridge piers protecting the piers and will remain permanently in place. The wing walls under the overpasses on either side of the highway will be expanded, but expansion will not impact this resource. The railroad overpasses, constructed between 1982 and 1985, do not meet the minimum 50-year age requirement for eligibility to the NRHP.

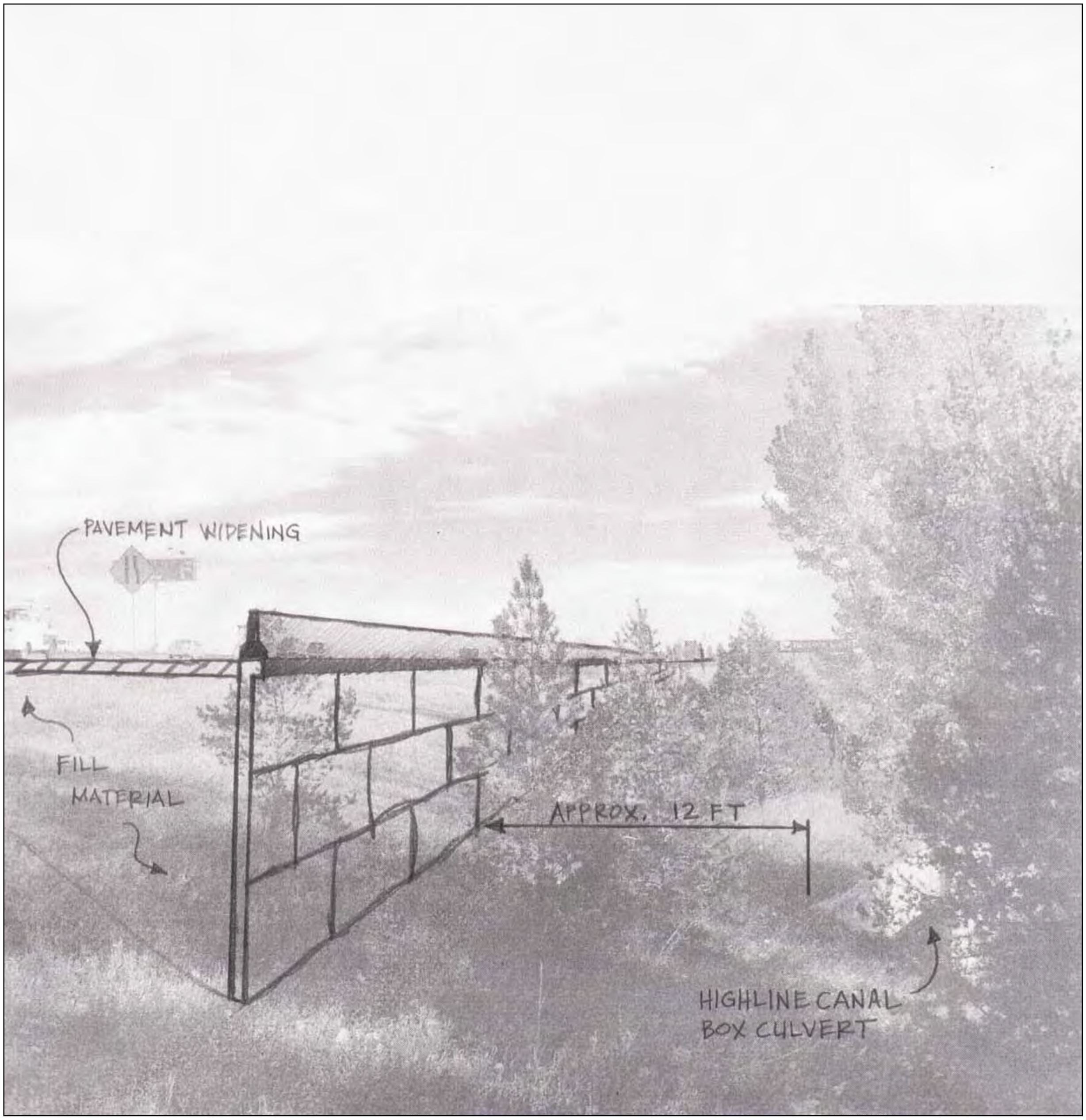
The Express Lane Alternative will not result in any impact to this linear feature. There have been no visual or noise impacts identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. The resulting determination of effect is **no historic properties affected**.

Atchison, Topeka and Santa Fe Railroad (5AH256.4, 5DA922.1, 5DA922.2). The Atchison, Topeka and Santa Fe Railroad (AT&SF RR) runs parallel to US 85/Santa Fe Drive, east of the roadway and the D&RG RR in the project study area. The AT&SF RR was determined eligible for listing on the NRHP in 1990 and 1995; these segments are contributing. The addition of the ELs to C-470 will not impact this resource. The highway road surface under the railroad overpasses will be reduced to a buffer separation instead of a barrier separation due to the restricted distance between the bridge piers. Flared, poured-concrete barriers will abut to the current bridge piers protecting the piers and will remain permanently in place. The wing walls under the overpasses on either side of the highway will be expanded, but expansion will not impact this resource. The railroad overpasses, constructed between 1982 and 1985, do not meet the minimum 50-year age requirement for eligibility to the NRHP.

The Express Lane Alternative will not result in any impact to this linear feature. There have been no visual or noise impacts identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. The resulting determination of effect is **no historic properties affected**.

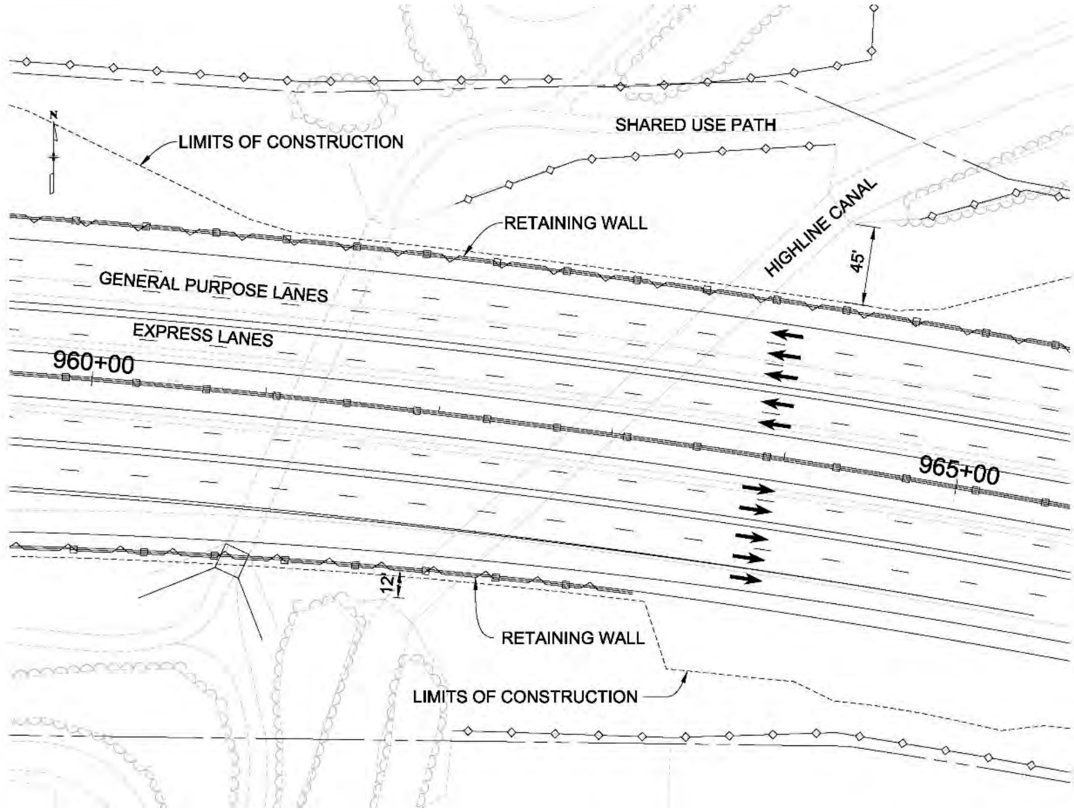
High Line Canal (5AH388 and 5DA600.3). The High Line Canal is a 71-mile long linear resource extending through the project study area crossing under C-470 just east of Santa Fe through Fly'n B Park. Associated Smithsonian numbers to this linear resource include 5AH388, 5DA600 and 5DA600.3. It was determined eligible for listing on the NRHP in 2004. Segment 5DA600.3 is contributing. During the initial construction of C-470, a segment of the High Line Canal was put in a low, concrete-box culvert to allow the highway to cross over the ditch and not interrupt the flow of water. Despite the widening of the corridor, there will be no need to extend the existing box culvert. However, the EL Proposed Alternative will extend a concrete retaining wall from the edge of pavement down the slope to within fifteen feet of the box culvert on both the north and south sides. The concrete wall will stabilize the earthen slope protecting the High Line Canal from erosion associated with the corridor, as shown in Figure 10. An earthen slope will continue from the edge of the wall down to the head wall of the box culvert. Limits of Construction are shown in Figure 11. This action does not constitute an alteration or change in the qualities of significance of the resource.

Figure 10 Retaining Wall at Highline Canal



Construction of the retaining wall is considered an indirect visual impact. The canal at this location was directly impacted during the initial construction when the box culvert was installed. The setting was altered at that time. Presently, the tops of vehicles are visible from the canal. With the construction of the wall in the Express Lane Alternative, vehicles should not be visible from the canal.

Figure 11 Express Lane Alternative Limits of Construction at High Line Canal



During construction, existing vegetation will be removed and the earth will be disturbed, resulting in a temporary incursion into the area above the canal to construct the additional lanes and the retaining wall. However, erosion control measures including installation of silt fence and berm will be taken to protect High Line Canal. Following construction, the area will be re-graded to existing conditions, seeded with native grasses, and the vegetation will be restored to existing conditions. Erosion control measures will be removed after adequate time has elapsed for new vegetation to take root.

The Express Lane Alternative will not result in any impact to this linear feature. Indirect effects are limited to visual impacts from the retaining wall. No noise impacts have been identified. No cumulative impacts have been identified that would diminish the qualities that make this property eligible to the NRHP. The resulting determination of effect is **no adverse effect**.

There are no eligible or listed historic properties further east along the corridor.

Conclusion

This survey recorded sixteen historic properties 45 years or older, including several segments of linear resources. Two ditches, two railroads, and one canal are officially eligible to the National Register of Historic Places. One historic district is listed on the National Register. Three bridges were identified as not eligible, which we hereby request your concurrence on eligibility. In addition, one post-WWII subdivision and one dam were identified as eligible, which we hereby request your concurrence on eligibility. Of these eleven historic properties, four will be indirectly impacted (no adverse effect) by the Proposed Alternative. They include Chatfield Dam (5JF5142, 5DA3091), Columbine Hills (5JF5143), City Ditch (5DA987.1), and High Line Canal (5DA600.3) that will be indirectly impacted (no adverse effect), by the Proposed Alternative. The Proposed Alternative will not impact the remaining properties either directly or indirectly. The determination of effect for these properties is either no historic properties affected or no adverse effect. Additionally, no cumulative impacts are expected to historic resources as a result of these proposed alternatives.

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Appendix

Revised C-470 Corridor Historic Resources
Older than 45 years for 2013 Revised Environmental Assessment

Road Segment & Property Address	Site #	Built	Elig	Re-evaluation	NE-Altered	N Sign
Kipling St. to Wadsworth Blvd						
Green Ranch, 8500 Deer Creek Rd	5JF443	1890	ONE	X		
Hildebrand Ranch, 8500 Deer Creek Rd	5JF188	1860s	NR	X		
Selzell Ditch, 8500 Deer Creek Rd	5JF2613	1868	OE/C	X; addl info		
Wadsworth Blvd to Platte Canyon Rd						
Herrick Dale Acres, 8419 S Otis St	5JF3739	1928	ONE		X	
Columbine Hills, S Platte Canyon Road	5JF5143	1959-1977	FE			
Platte Canyon to S Santa Fe Dr						
Chatfield Dam	5JF5142 & 5DA3091	1967-1977	FE			
Last Chance Ditch, Jefferson County	5AH136.1 5JF258.1	1861-1868	ONE	X	X	
Nevada Ditch, Jefferson County	5AH135	1861	ONE	X	X	
S Platte River Bridge, F-16-HW	5DA2819	1968	FNE			
S Platte River Bridge, F-16-HV	5DA2826	1968	FNE			
City Ditch & Flume, Arapahoe County Line	5AH254.7	1865	OE/NC		X	
City Ditch, Intersection SH 85 & C-470	5DA987.1	1865	OE/NC	X	X	
Wolhurst Estate Club, 8201 S Santa Fe Dr	5AH166	1891	ONE	X	X	
Littleton Large Animal Clinic, 8025 S Santa Fe Dr	5AH732	1913	ONE	X		
Canary Farm Barn, 7951 S Santa Fe Dr	5AH732	1918	ONE			
State Highway 85, S Santa Fe & C-470	5AH2868	1917	ONE		X	
Dad Clark Gulch Bridge, SH 85 & DC Gulch	5AH1576	1939	ONE		X	
Stephens' House, 13837 S.H. 85	5DA1912	1963	ONE			
S Santa Fe Dr to Lucent Blvd						
AT&SF RR, Arapahoe County	5AH256.4	1887	OE/C	X		
AT&SF RR, Douglas County	5DA922.1	1887	OE/C	X		
AT&SF RR, Douglas County	5DA922.2	1887	OE/C	X		
D&RG RR, Arapahoe County	5AH255.2 5AH255.5 5DA921.1	1870-1871	OE/C OE/C OE/C	X X		
Plews Ranch/Flyin' B Ranch	5DA1913	Various	ONE		X	
High Line Canal, Douglas County	5DA600.3	1880-1883	OE/C			
Broadway to University Blvd						
711 E County Line Rd, Wilmore Nurseries	5AH2867	1949	ONE		X	

Note: OE=Officially Eligible, ONE=Officially Not Eligible, FE=Field Eligible, FNE=Field Not Eligible, NR=National Register

PHOTO LOG

Location Arapahoe, Douglas, & Jefferson Counties Project C470 EA Date June 2013

No	Address	Description	View/Elevation
5AH255.2_1	S Santa Fe Drive & C-470	D&RG Railroad	Shot S
5AH255.2_2	S Santa Fe Drive & C-470	D&RG Railroad	Shot N
5AH256.4_1	S Santa Fe Drive & C-470	AT&SF Railroad Upper Track Grade	Shot NE
5AH256.4_2	S Santa Fe Drive & C-470	AT&SF Railroad Upper Track Grade	Shot SE
5AH256.4_3	S Santa Fe Drive & C-470	AT&SF Railroad Bridge at C-470	Shot SE
5DA600.3_1	C-470	High Line Canal	Shot S
5DA600.3_2	C-470	High Line Canal	Shot NE
5DA600.3_3	C-470	High Line Canal Culvert under highway	Shot S
5DA921.1_1	S Santa Fe Drive & C-470	D&RG Railroad Lower Track Grade	Shot N
5DA921.1_2	S Santa Fe Drive & C-470	D&RG Railroad Lower Track Grade	Shot NE
5DA922.1_1	S Santa Fe Drive & C-470	D&RG Railroad Lower Track Grade	Shot SE
5DA922.1_2	S Santa Fe Drive & C-470	D&RG Railroad Lower Track Grade	Shot NE
5JF188_1	Deer Creek Road	Hildebrand Ranch HD farm residence	Shot W
5JF188_2	Deer Creek Road	Hildebrand Ranch HD farm buildings	Shot W
5JF2613	Deer Creek Road	Hildebrand Ranch HD Selzell Ditch	
5JF5142_1	S Wadsworth Blvd	Chatfield Dam Intake & Riprap Water Face	Shot SE
5JF5142_2	S Wadsworth Blvd	Chatfield Dam Embankments	Shot SE
5JF5142_3	S Wadsworth Blvd	Chatfield Dam Boat Ramps	Shot W
5JF5142_4	S Wadsworth Blvd	Chatfield Dam Outlet Channel & Stilling Pond	Shot N
5JF5142_5	S Wadsworth Blvd	Chatfield Dam Chute & Spillway	Shot NW
5JF5142_6	S Wadsworth Blvd	Chatfield Dam 1967 Corps Office	W & S
5JF5142_7	S Wadsworth Blvd	Chatfield Dam 1967 Corps Office	S & E
5JF5142_8	S Wadsworth Blvd	Chatfield Dam 1967 Corps Lab	S & E
5JF5142_9	S Wadsworth Blvd	Chatfield Dam 1967 Corps Lab	E & N
5JF5142_10	S Wadsworth Blvd	Chatfield Dam 1967 Corps Lab	W & S
5JF5142_11	S Wadsworth Blvd	Chatfield Dam 1967 Corps Warehouse	W & S
5JF5142_12	S Wadsworth Blvd	Chatfield Dam 1967 Corps Warehouse	E & N
5JF5142_13	S Wadsworth Blvd	Chatfield Dam Modern Admin Bldg	Shot E
5JF5142_14	S Wadsworth Blvd	Chatfield Dam Bldg 1 (moved in)	W
5JF5142_15	S Wadsworth Blvd	Chatfield Dam Bldg 1 (moved in)	E & N
5JF5142_16	S Wadsworth Blvd	Chatfield Dam Bldg 2 (moved in)	W
5JF5142_17	S Wadsworth Blvd	Chatfield Dam Bldg 2 (moved in)	E

Hydraulic Study

For the C-470 Corridor
Revised Environmental Assessment

April 2015

Submitted to:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted by:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

Table of Contents

List of Figures

1.0 Introduction

1.1 Location

The Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA) have identified a need for improvements to the C-470 corridor from Kipling Parkway to Interstate 25 (I-25). This portion of the C-470 corridor, approximately 13.75 miles in length, is herein referred to as the “Study Area”. The Study Area is located in the South Denver Metropolitan area and crosses through portions of Douglas, Arapahoe, and Jefferson Counties as shown in **Figure 1**.

Figure 1. C-470 Corridor and its Surrounding Vicinity

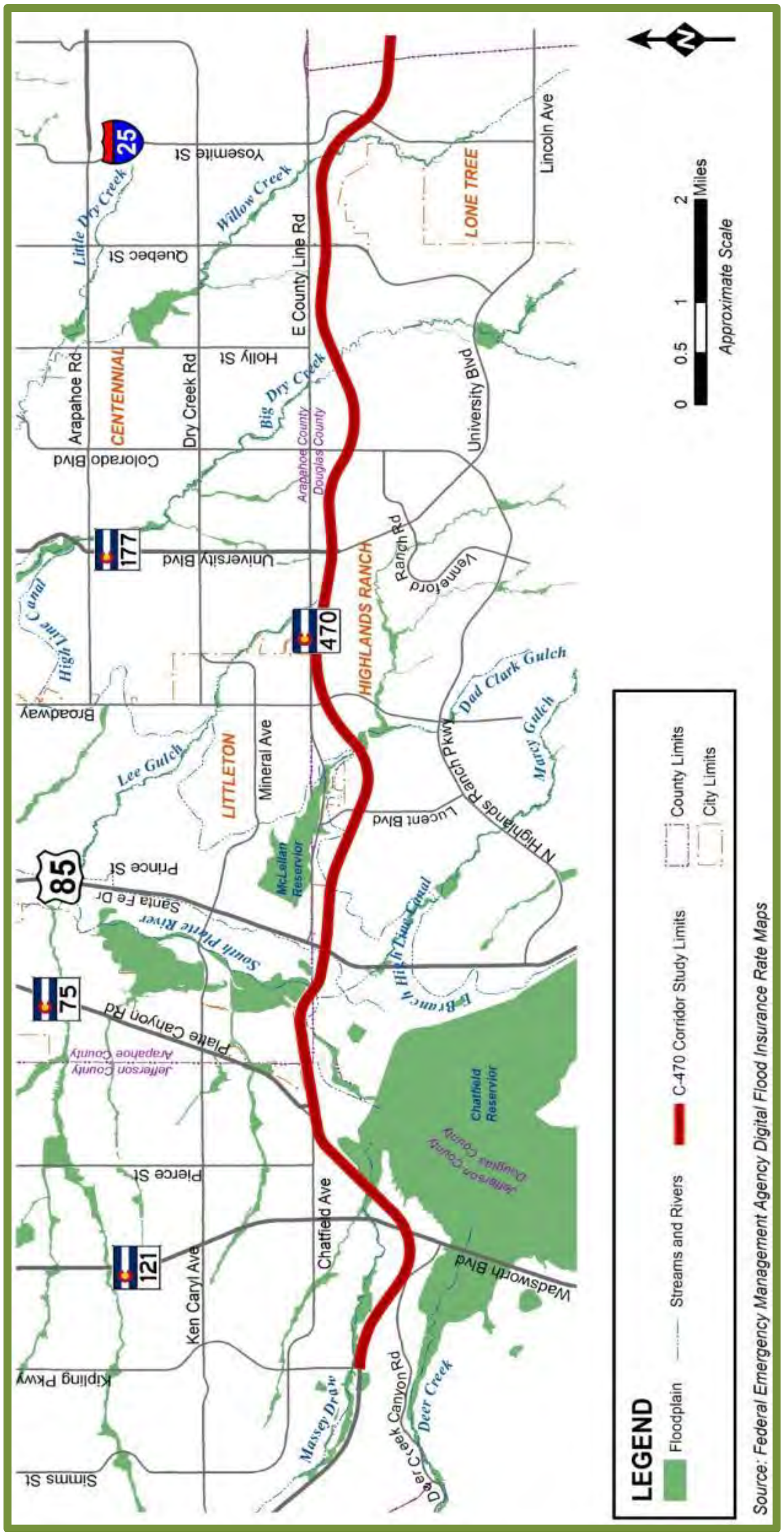
1.2 Purpose and Need

The purpose of proposed C-470 improvements is to address congestion and delay and improve travel time reliability for C-470 users.

During an interim phase of the Proposed Action, improvements will be completed through a portion of the Study Area. This hydraulic study was prepared in accordance with the requirements of the CDOT NEPA Manual, Section 9.5, Floodplains, which is based on requirements from FHWA, 23 CFR 650A. This Hydraulic Study for the ultimate project improvements is part of the Revised EA for the project and addresses potential environmental impacts on floodplains adjacent to or within the Study Area. Requirements to address potential changes to regulatory floodplains created under the National Flood Insurance Program are addressed in the *30% Design Drainage Report for the C-470 Corridor Coalition, Segment 1*.

The Study Area crosses several major drainageways. These drainageways include Massey Draw, the South Platte River, Dad Clark Gulch, Big Dry Creek, and Willow Creek. The locations of these major drainageways and their associated floodplains are shown on **Figure 2**.

Figure 2. Major Drainageways and Floodplains



1.3 Alternatives

Two alternatives are presented and evaluated in the 2015 Revised EA for the project. These are a No-Action Alternative and the Proposed-Action Alternative. The aspects of these alternatives that have potential environmental impacts on floodplains adjacent to or within the Study Area are described in the following paragraphs.

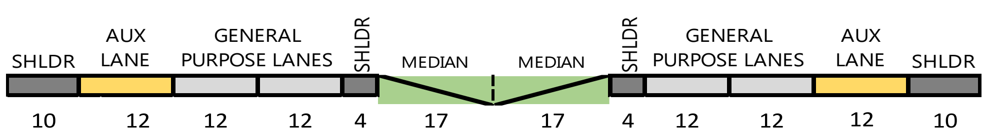
C-470 No-Action Alternative

The No-Action Alternative involves taking no action to improve the existing C-470 roadway or its drainageway crossing structures between Kipling Parkway and Interstate 25 other than performing basic maintenance and/or safety improvements to maintain roadway operation.

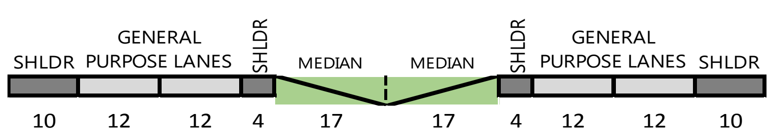
Within the Study Area, the existing C-470 roadway consists of two general-purpose lanes in each direction. An auxiliary lane in each direction exists between the Quebec Street interchange and the I-25 interchange, serving as continuous acceleration and deceleration lanes. The existing roadway (No-Action Alternative) consists of 12-foot travel lanes, including auxiliary lanes, with inside and outside shoulders, plus a 34-foot un-paved median, as shown in **Figure 3**. Paved shoulder widths vary between four and ten feet.

The major drainageways cross C-470 by means of culverts and by bridges over the South Platte River and over Big Dry Creek.

Figure 3. Typical Sections for No-Action Alternative



QUEBEC ST. TO I-25 – TWO LANES PLUS AUX LANE EACH DIRECTION
TOTAL WIDTH 134 FEET, 100 FEET IMPERVIOUS



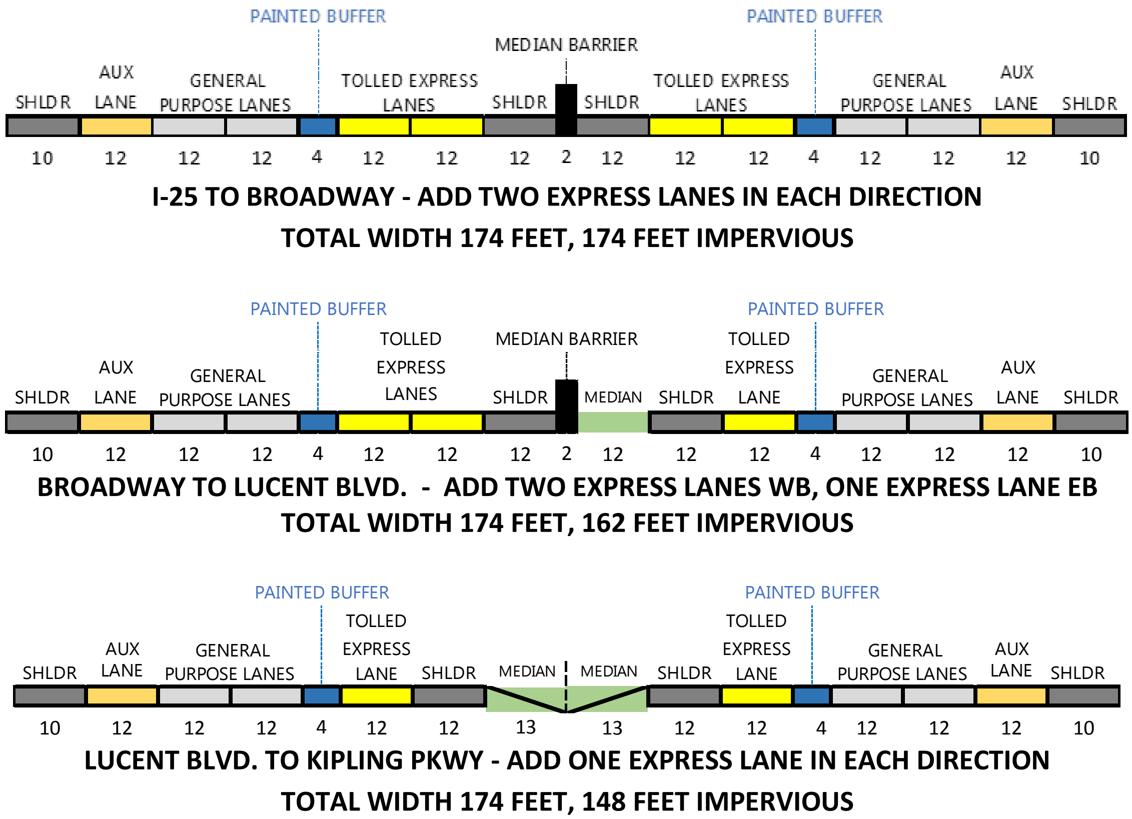
KIPLING PKWY TO QUEBEC ST - TWO LANES EACH DIRECTION
TOTAL WIDTH 110 FEET, 76 FEET IMPERVIOUS

C-470 Proposed Action

The Proposed Action would add one tolled express lane in each direction between I-25 and Kipling Parkway, and a second express lane between I-25 to Lucent Boulevard, westbound and Broadway to I-25, eastbound. These new through lanes, plus new auxiliary lanes, where warranted, would supplement the existing (free) general-purpose lanes, which would be reconstructed. The proposed typical sections are shown in

Figure 4. The project will also add new direct-connect ramps to serve some movements at the C-470/I-25 interchange.

Figure 4. Typical Sections for Proposed-Action Alternative



Potential impacts to adjacent regulatory floodplains could result from roadway widening, requiring the extension of cross culverts, or the replacement and widening of bridges over the S. Platte River and Big Dry Creek.

1.4 Flood History

Flooding in drainageways along the C-470 Corridor is typically due to short-duration, high-intensity precipitation events between the months of May and September. The various drainage master plans that are published document the history of significant flood events through the period from May 1844 to September 2002. The most noteworthy and destructive of these floods occurred in 1965. The 1965 flood caused a flow of approximately 110,000 cubic feet per second (cfs) in the South Platte River at Littleton and resulted in an estimated $300 million in damage to Denver. This flood occurred before C-470 and Chatfield Reservoir were constructed. Chatfield Reservoir was constructed on the South Platte River just upstream of the C-470 crossing after the 1965 flood to reduce the potential for flooding downstream.

With Chatfield Reservoir in place immediately upstream of C-470, flood flows on the South Platte River are controlled by how the reservoir is operated. The normal maximum release out of Chatfield Reservoir has been set at 5,000 cfs based on the U.S. Army Corps of Engineers (USACE) operating criteria and agreed upon regulations as described in the *Chatfield Reservoir Storage Reallocation Study*, USACE, July 2013. Therefore, this flow rate is used for the 100-year and 500-year flood events. If an extreme flood event were to occur in the Chatfield Reservoir watershed and the reservoir emergency spillway were overtopped, releases of a greater magnitude could occur.

1.5 Relevant Regulations

Federal

100-year floodplains within communities that participate in the National Flood Insurance Program (NFIP) must be managed in conformance with Code of Federal Regulations (CFR) Title 44, Part 60. One requirement of participating in the NFIP is that local communities adopt floodplain management ordinances that, at a minimum, are as stringent as CFR 44, part 60.

Local

The local jurisdictions that overlap the Study Area are Jefferson, Arapahoe, and Douglas Counties and the cities of Littleton and Lone Tree. All are participants in the NFIP and all have 100-year floodplain ordinances. The floodplains of the major drainageways within the Study Area are subject to the local floodplain regulations of the jurisdictions as follows:

- **Massey Gulch** - Jefferson County
- **South Platte River** - Jefferson, Arapahoe, and Douglas Counties and the City of Littleton
- **Dad Clark Gulch** - Douglas County
- **Big Dry Creek** - Douglas County
- **Willow Creek** – City of Lone Tree

1.6 Floodplain Mapping

All of these major drainageways have FEMA regulatory floodplain mapping that cross the Study Area. Images of FEMA Flood Insurance Rate Maps (FIRMs) at each of the crossing locations are provided in Appendix A-Floodplain Maps.

There are also Flood Hazard Area Delineation (FHAD) studies, Master Plans and Outfall System Planning Studies (OSPS) available for these drainageways and their tributaries, through the Urban Drainage and Flood Control District (UDFCD). A list of the above-mentioned documents is included in the reference section of this document.

The location of each floodplain is shown in relation to C-470 Study Area on **Figure 2**. Each major drainageway crossing is discussed in detail in Section 3.0.

2.0 No-Action Alternative Floodplain Impacts

No construction, excavation or fill is proposed with the No-Action Alternative and thus there would not be any impacts to the regulatory floodplains associated with any of the major drainageways.

3.0 Proposed Action Floodplain Impacts and Mitigation

3.1 General Discussion

Potential impacts to adjacent floodplains could result from roadway widening, requiring the extension of cross culverts, or the replacement and widening of bridges over the S. Platte River and Big Dry Creek. Relevant floodplains are discussed below in order from west to east as follows: Massey Draw, South Platte River, Dad Clark Gulch, Big Dry Creek and Willow Creek.

3.2 Massey Draw

Massey Draw crosses C-470 east of S. Wadsworth Blvd. and west of Chatfield Reservoir.

3.2.1 Floodplain and Impact Description

Where C-470 crosses Massey Draw, two existing reinforced concrete box culverts with approximate openings of 12'x10' and 12'x8.5' convey runoff from an approximately 8.5 square mile watershed. A photo of the downstream side of the box culvert at Massey Draw is shown in **Figure 5**.

Massey Draw has experienced recent flooding, most notably during the summer of 2004, in which floodwaters inundated numerous houses upstream of its crossing at South Oak Street. As a result, a revised FHAD and Conceptual Design Report were published for Massey Draw in 2005 and 2006 as part of a Major Drainageway Planning Update sponsored by UDFCD. Per the FHAD report, a 100-Year design flow of 3,816 cfs was determined to reach the crossing. Although the reports indicated that the culvert size should be increased somewhat (two 12'x10') to comply with allowable headwater standards, replacement of this structure is not proposed as part of this project. This structure is not proposed for replacement due to the cost of structure replacement and because no habitable structures are at risk of flooding on the adjacent public land.

Since the time of the master planning outfall study several LOMR's have been approved along the drainageway, however the detailed study and subsequent revisions to the FEMA floodplain have not extended east of Wadsworth Blvd. The FEMA Floodplain Map contained in Appendix A shows the effective floodplain as Zone A.

Figure 5. Downstream Side of Box Culvert at Massey Draw

3.2.2 Potential Risks Associated With the Proposed Action

The Federal government granted the C-470 easement, in which the project is contained at this location, and its conditions are administered by the USACE. This portion of the project is also located upstream of the Chatfield Reservoir. Due to the difficulty in modifying the easement (action by the U.S Congress) any disturbance or improvement beyond its limits have been excluded from consideration. In addition, the operational storage for Chatfield Reservoir extends up to elevation 5,500.0 feet. Any fill below this elevation requires that a compensatory storage volume be provided elsewhere below this level.

Although the roadway will be widened in this portion of the project, its profile is anticipated to closely match the existing roadway profile and the extension of the roadway embankment will be contained by proposed retaining walls. The culvert will not be extended and **No Encroachment** into the regulatory floodplain will occur at this location.

3.2.3 Potential Impacts on Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aqua culture, forestry, natural moderation of floods, water quality maintenance, groundwater discharge, etc. Due to the proposed installation of retaining walls, the Proposed Action would not encroach into or modify the floodplain. Therefore, potential impacts on the Natural and Beneficial Floodplain values at this location will be avoided.

3.2.4 The Support of Probable Incompatible Floodplain Development

The Proposed Action would not encroach into or modify the Massey Draw floodplain. Therefore it would not create developable space or promote development within the FEMA floodplain. In addition, the floodplain is located on publicly owned land, which is not available for development.

3.2.5 Measures to Restore and Preserve Natural and Beneficial Flood Plain Values

Measures that can be implemented to restore, preserve, and enhance the floodplain values with construction include the implementation of temporary and permanent stormwater Best Management Practices (BMP's). The C-470 Proposed Action will address potential impacts during construction through the implementation of erosion and sediment control measures. It will provide for mitigation of increased runoff, and improved runoff quality through permanent flood control and water quality facilities.

3.2.6 Potential Concerns

There are no concerns related to the Proposed Action and the floodplain at this location. There may be some concerns regarding maintenance and the function of the trail crossing. The existing concrete box culverts are cracking, repair is needed, and the trail may be too frequently flooded due to the limited capacity of the crossing before the trail is overtopped.

3.3 South Platte River

The South Platte River crosses C-470 east of the Chatfield Reservoir and about one-half mile west of S. Santa Fe Dr.

3.3.1 Floodplain and Impact Description

The existing C-470 crossing over the South Platte River consists of both an east and westbound triple span bridge, supported by concrete abutments with riprap slopes and two concrete piers. The bridges are each roughly 40.5 feet wide by 171.5 feet in length possessing spans of approximately 50, 70 and 50 feet with an elevated 10' wide pedestrian walkway located under the westerly span. A photo of the upstream face of the crossing is shown in **Figure 6**.

A large grouted boulder grade control structure is located just downstream of the crossing about 250 feet from the roadway centerline. This structure establishes the elevation of the streambed and eliminates any concerns regarding long-term degradation.

As previously discussed, flood flows at the crossing are determined by releases from the Chatfield Reservoir operated by the USACE. The maximum design discharge from the reservoir is 5,000 cfs as stated in the *Chatfield Reservoir Storage Reallocation Study*, USACE, July 2013.

Figure 6. Upstream Side of Existing Bridges on the South Platte River

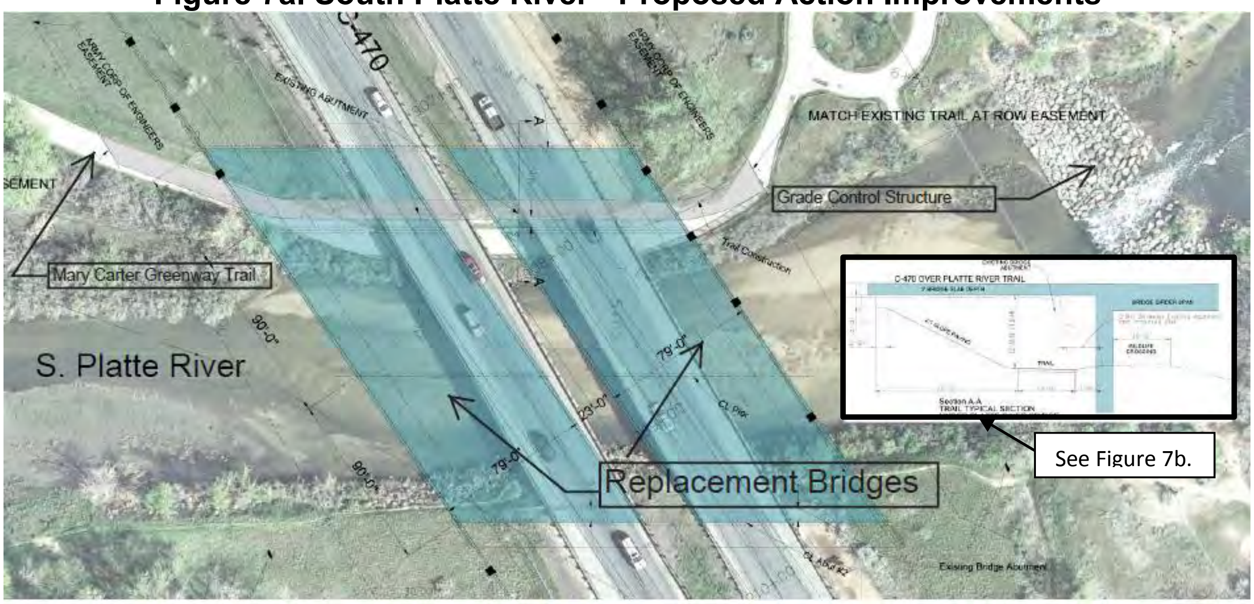
The Proposed Action includes the replacement of the two bridge structures with longer and wider structures. The existing two-pier structures will be replaced with two-pier structures with spans of 50, 90 and 90 feet with concrete abutments and sloping concrete or riprap protection. The new bridges will be skewed to the river channel about 30 degrees, similar to the existing structures.

Impacts to the S. Platte River floodplain were evaluated using a HEC-RAS hydraulic model to determine No Action and Proposed Action water surface profiles at the crossing. This analysis showed that the 500-year/100-year floodplain rises about 0.6 feet at the downstream face of the west bound Proposed Action bridge due to the flow remaining in a sub-critical flow condition at the proposed wider bridge span and the widening of the bridge in the downstream direction. The water surface quickly transitions to a level lower than the No-Action water surface about 70 feet upstream of the downstream face of the proposed west bound bridge. This rise is contained with public right-of-way and will not have any negative environment impacts. At the upstream face of the proposed east bound bridge the Proposed-Action water surface was calculated to be about 0.8 feet lower than the No-Action alternative. The regulatory floodplain boundary is shown upstream of C-470; however, there are no FIRM cross sections or Base Flood Elevations upstream of C-470. Therefore, a direct comparison to regulatory floodplain elevations was not completed.

The expected water surface lowering, upstream of the highway, is due to lengthening of the replacement bridges to accommodate improvements to the Mary Carter Greenway regional trail that crosses the project along the west bank of the S. Platte River. Proposed Action improvements provide increased clearances for trail use by raising the highway profile, lowering the trail profile and reducing the thickness of the bridge section over the trail. All of the proposed improvements are contained within the C-470 easement. The longer bridges and wider trail section will increase conveyance in the upper portion of the floodplain channel section, but will not change the main channel section, which carries most of the releases from the Chatfield Reservoir without encroachment onto the trail.

Figure 7a shows a plan view of the proposed replacement bridges relative to the existing bridges and river and **Figure 7b** shows a typical cross section of the bridge at the trail crossing. The No-Action and Proposed Action floodplain limits and the results of the hydraulic analysis are provided in Appendix B1 and the hydraulic model is provided on the enclosed disk. There will be **Minimal Encroachment** at this crossing.

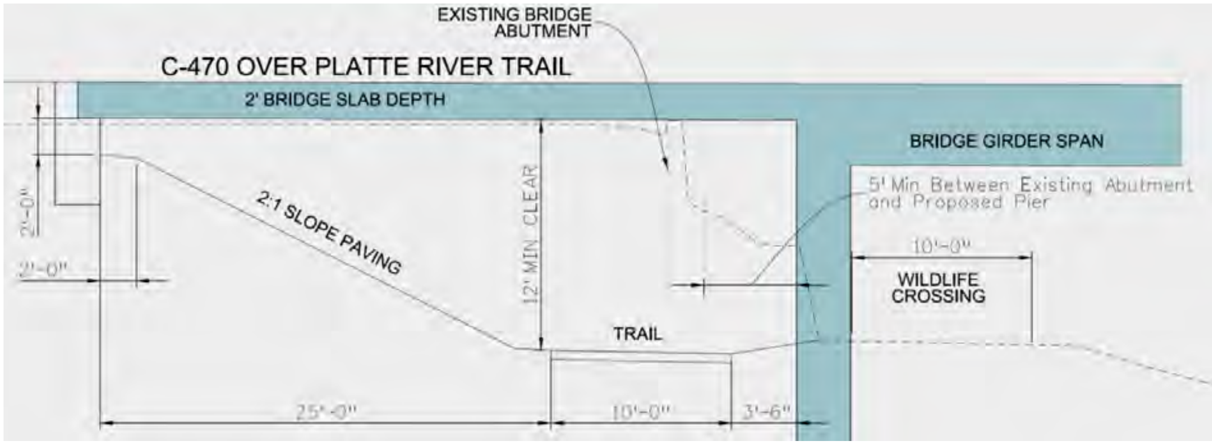
Figure 7a. South Platte River - Proposed Action Improvements



3.3.2 Potential Risks Associated With the Proposed Action

Potential risks for adversely affecting the regulatory floodplain at this crossing are limited and some reduction to flooding levels is expected. The floodplain will be somewhat wider toward the west under the new bridges, but will be lower and narrower outside of the C-470 easement upstream. There are no insurable structures adjacent to this location that would be affected by changes to the floodplain, and no increase in threats to public health and safety are expected.

Figure 7b. South Platte River 1 - Proposed Action Improvements
Mary Carter Greenway Typical Trail Section



3.3.3 Potential Impacts on Natural and beneficial Floodplain Values

Natural and beneficial floodplain values include fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aqua culture, forestry, natural moderation of floods, water quality maintenance, groundwater discharge, etc. Due to the existing downstream grade control structure and hardened channel banks, changes to the natural environment at this crossing will only result from construction of the bridge piers, that will replace the existing piers, and minor grading adjacent to the trail realignment. By maintaining the main channel configuration, potential impacts on the Natural and Beneficial Floodplain values at this location have been greatly reduced or eliminated.

3.3.4 The Support of Probable Incompatible Floodplain Development

Potential impacts are located under and immediately around the bridge crossing. Land adjacent to the crossing is publically owned parkland and there is no anticipation that the Proposed Action will create developable space or promote development within the FEMA floodplain.

3.3.5 Measures to Restore and Preserve Natural and Beneficial Floodplain Values

Measures that can be implemented to restore, preserve, and enhance the floodplain values include the implementation of temporary and permanent stormwater BMP's. Temporary BMPs will be implemented during construction, and the project will include the construction of permanent BMPs and peak flow reduction facilities within the South Platte River basin to comply with stormwater management permit requirements. These improvements related to the Proposed Action will improve the water quality of runoff to the river. The Proposed Action will also provide a planned wildlife crossing that improves the ability of wildlife to move along the river corridor.

3.3.6 Potential Concerns

The UDFCD is currently restudying the South Platte River floodplain. When available, the results of this analysis should be incorporated into the final Proposed Action design to confirm the results of the hydraulic analysis based on the preliminary design.

3.4 Dad Clark Gulch

Dad Clark Gulch crosses C-470 between Lucent Boulevard and South Broadway and enters McLellan Reservoir about one-quarter mile downstream of C-470.

3.4.1 Floodplain and Impact Description

Where C-470 crosses Dad Clark Gulch an existing 12’x6’ RCBC and 36” RCP outlet convey runoff from two upstream storage facilities that are interconnected. The facilities have been constructed to reduce peak developed runoff rates to below historic rates, while providing water quality to the runoff coming from Dad Clark Gulch before it reaches McClellan Reservoir, which is a potable drinking water supply reservoir. Drainage report documents for the regional facility indicate that the existing culvert crossing at C-470 appears to be adequate to convey an estimated 100-year discharge of 1,283 cfs.

The floodplain associated with Dad Clark Gulch has been designated by FEMA as Zone A. The installation of proposed retaining walls with the C-470 widening improvements will prevent impacts to the existing floodplain and the existing outlet works; therefore, **No Encroachment** into the floodplain will occur at this location.

3.4.2 Potential Risks Associated With the Proposed Action

Although the roadway will be widened in this portion of the project, the roadway embankment will be contained by proposed retaining walls and the existing culvert will not be extended. Therefore, there are no potential risks due to the Proposed Action.

3.4.3 Potential Impacts on Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aqua culture, forestry, natural moderation of floods, water quality maintenance, groundwater discharge, etc. Due to the installation of the retaining walls, grading impacts will be eliminated. Potential impacts on the Natural and Beneficial Floodplain values at this location have been eliminated.

3.4.4 The Support of Probable Incompatible Floodplain Development

The Proposed Action does not create developable space or promote development within the floodplain, which is located on publicly owned land.

3.4.5 Measures to Restore and Preserve Natural and Beneficial Flood Plain Values

Measures that can be implemented to restore, preserve, and enhance the floodplain values with construction include the implementation of temporary and permanent stormwater BMPs. The project will address potential impacts during construction and the existing water quality facility adjacent to the project will provide water quality treatment for the Proposed Action.

3.4.6 Potential Concerns

There are no identified concerns regarding the Proposed Action and the floodplain at this location.

3.5 Big Dry Creek

C-470 crosses the main branch of Big Dry Creek approximately 0.9 miles west of Colorado Boulevard.

3.5.1 Floodplain and Impact Description

At this location two 41.5' wide x 128' long single span bridges with sloping riprap-lined earth abutments have been constructed to convey C-470 traffic over the channel. **Figure 8** shows the downstream side of this crossing.

Information provided by FEMA FIRM Map No. 08035C0041 and the FIS study for Douglas County indicate that this portion of Big Dry Creek is designated as a FEMA Zone AE floodplain, with a peak 100-year discharge of 2,950 cfs produced from a watershed approximately 11.2 square miles in size.

Due to upstream development and stream degradation, the channel bottom (thalweg) of Big Dry Creek has changed since the original bridge was designed and constructed. This is typical for alluvial streams in the Denver area. The current streambed has been stabilized with grade control structures downstream and upstream of the crossing, therefore, no further degradation of the channel is expected and the floodplain should remain stable. The expansion of the existing bridge will maintain the same span and channel section, but will be increased in width to accommodate the increased width of C-470. This will extend the roadway embankment upstream and downstream within the floodplain. The extended embankment will be smoothly transitioned into the existing embankment to avoid abrupt changes and hydraulic losses. **Minimal Encroachment** into the regulatory floodplain is expected to occur at this location.

Figure 8. Downstream Side of Existing Bridge at Big Dry Creek

3.5.2 Potential Risks Associated With the Proposed Action

As discussed previously, encroachments to the upstream and downstream embankment slopes as a result of widening of the structure could result in a minor increase of floodplain elevations. Any increase of the floodplain elevation would occur on the upstream adjacent property, which is used for open space, and a golf course where no insurable structures are located and no increase in threats to public health and safety are expected.

3.5.3 Potential Impacts on Natural and beneficial Floodplain Values

The only potential impacts to natural and beneficial floodplain values would result from minor encroachments to widen the bridge upstream and downstream within existing highway right-of-way. These improvements would involve a limited portion of the channel above the normal high water level and could be constructed with minimal or no impacts on the adjacent floodplain.

3.5.4 The Support of Probable Incompatible Floodplain Development

The Proposed action does not modify the floodplain in a manner that would support incompatible floodplain development. The adjacent property is already fully developed and includes open space and a golf course.

3.5.5 Measures to Restore and Preserve Natural and Beneficial Flood Plain Values

Measures that can be implemented to restore, preserve, and enhance the floodplain values include the implementation of temporary BMPs during construction and permanent stormwater BMPs in other portions of the project. Vegetation that is disturbed by the project will be restored.

3.6 Willow Creek

C-470 crosses Willow Creek approximately 0.5 miles west of Yosemite Blvd.

3.6.1 Floodplain and Impact Description

Runoff reaching this location is conveyed north under the roadway by triple 12’x12’ reinforced concrete box culverts. As shown in the **Figure 9** photo, the westerly culvert also functions to convey pedestrian traffic. This culvert will be extended upstream with the proposed widening of C-470. The culvert will not be extended downstream. The length of the extended culvert will be limited by the construction of a retaining wall to stay within the available right-of-way.

The adjacent floodplain has been designated as a Zone A. At the limit of the detailed FIS, downstream of this location, a 100-year flow rate of 2,419 cfs was used. However, this value was based on land uses at the time of the study (September 30, 2005). Drainage basin studies completed since the FIS have included estimates of flow resulting from completed and proposed upstream development. The Outfall Systems Planning Study (OSPS), CH2M Hill, February 2010, estimated a future flow of 4,236 cfs at County Line Rd. and the flow profile (Figure B-8) from that study shows that the 100-year flow at C-470 is estimated to be about 3,500 cfs.

The OSPS proposed a regional detention pond on Willow Creek just upstream of C-470 that would reduce the 100-year flow. However, based on conversations with City of Lone Tree engineers, this improvement is not likely to be constructed. Therefore, the potential impact of the Proposed-Action was evaluated based on the undetained future land use condition 100-year flow of 3,500 cfs.

A preliminary hydraulic analysis was completed to evaluate the potential impact of the encroachment on the floodplain. A hydraulic model received from the UDFCD was modified to show the Proposed Action improvements. It was assumed that the existing culvert section and slope will be extended upstream to match the existing creek bottom. Based on the 100-year flow rate of 3,500 cfs and the preliminary design for the culvert extension, the analysis showed a potential increase of 0.3 feet in the 100-year water surface from the pre-project to the post-project conditions immediately upstream of the extended culvert. However, this estimated increase in water surface elevation is eliminated within a few hundred feet upstream of the culvert. The results of the hydraulic analysis for the No-Action and Proposed Action conditions are provided in Appendix B2 and the hydraulic model is provided on the enclosed disk. Floodplain regulations allow for an increase of up to 1.0 feet in Zone A floodplains. Therefore, **Minimal Encroachment** is expected from the Proposed Action at this crossing.

Figure 9. Upstream Side of Existing Culvert at Willow Creek Crossing

3.6.2 Potential Risks Associated With the Proposed Action

The upstream segment of Willow Creek that is potentially impacted from the Proposed Action is within publically owned land being used as open space, there are no insurable structures that could be affected and no increase in threats to public health and safety are expected.

3.6.3 Potential Impacts on Natural and Beneficial Floodplain Values

Improvements required by the Proposed Action will require that a short section of Willow Creek, that is currently open channel, will be within the extended box culvert and roadway embankment fill adjacent to the box culvert will also encroach into the creek. The area affected by this encroachment is small, but will need to be covered under a floodplain development permit and other environmental permits, as needed.

3.6.4 The Support of Probable Incompatible Floodplain Development

Potential impacts are located immediately adjacent to the existing roadway facilities primarily within the C-470 right-of-way. The Proposed Action would not create developable space or promote development within the regulatory floodplain. The land adjacent to the floodplain is publicly owned open space and is not expected to be developed.

3.6.5 Measures to Restore and Preserve Natural and Beneficial Flood Plain Values

Measures that can be implemented to restore, preserve, and enhance the floodplain values include the implementation of temporary and permanent stormwater BMPs. Water quality improvements constructed with the project will provide benefits to the downstream system. The stabilization of the embankment adjacent to the stream will reduce erosion and downstream sedimentation. The disturbance of vegetation due to construction of the culvert extension will be mitigated by revegetation of the disturbed areas.

4.0 Conclusions

The drainageways with floodplains that cross the project have either Zone A, approximate floodplains, or Zone AE, detailed study floodplains. The type of floodplain for each of the drainageways is as follows:

- Massey Draw – Zone A
- S. Platte River – Zone AE
- Dad Clark Gulch – Zone A
- Big Dry Creek – Zone AE
- Willow Creek – Zone A

Potential impacts to Massey Draw and Dad Clark Gulch were avoided because retaining walls will be used to avoid extending existing cross culverts. Therefore, there will be **No Encroachment** into these floodplains.

Potential impacts to the S. Platte River floodplain were evaluated using a hydraulic model (See Appendix B1) to determine No Action and Proposed Action conditions. This analysis showed that the 100/500-year water surface just downstream of the proposed, wider bridge may rise about 0.6 feet and the 100/500-year water surface upstream of the crossing will be lowered about 0.8 feet. The minor rise in the downstream water surface is due to the widening of the bridge section and the change in flow regime due to the longer bridge span. The lowering is due to the lengthening of the replacement bridges to accommodate improvements to the Mary Carter Greenway regional trail that crosses the project along the west bank of the S. Platte River.

Proposed Action improvements provide increased clearances for trail uses by raising the highway profile, lowering the trail profile and reducing the bridge section over the trail. The longer bridges and wider trail section increase the conveyance of the upper portion of the floodplain section under the proposed bridges, but do not affect the main channel section, which carries most of the releases from Chatfield Reservoir without overtopping the trail. The planned wildlife crossing included in the longer bridge span section will improve wildlife movement along the river corridor.

All of the improvements are contained within the C-470 easement; therefore, there are no impacts beyond the easement limits. Therefore, there will be **Minimal Encroachment** at this crossing.

The replacement of the bridges over Big Dry Creek will maintain the current span and will not reduce the channel section through the bridge. The widening of the bridge section will require minor encroachment into the upstream and downstream floodplain adjacent to the roadway embankment, but will have only **Minimal Encroachment** at this crossing.

The extension of the existing culvert at Willow Creek upstream was evaluated using a hydraulic model (See Appendix B2) resulted in an increase of 0.3 feet during the 100-year flood. However, this rise immediately upstream of the extended culvert will be eliminated within a few hundred feet of the culvert entrance. Also, the Willow Creek drainageway is located within publically owned land being used as open space that will not be developed. Therefore, there will be **Minimal Encroachment** into this floodplain.

The project will be designed to minimize impacts and where they are unavoidable, to limit them by the restoration of disturbed areas. There are no insurable structures adjacent to the drainageways that may be placed at greater risk due to potential impacts to floodplains and no changes to the floodplain will provide additional opportunity for incompatible development.

Therefore, the Proposed Action will have **No Encroachment** or **Minimal Encroachment** on the floodplains that cross or are located adjacent to the Study Area.

References

Arapahoe County Stormwater Management Manual, Revised July 5, 2011.

Arapahoe County Land Development Code, June 30, 2010.

Colorado Department of Transportation Drainage Design Manual, dated 2004
City of Littleton Zoning Ordinance, Revised 6-11-1992.

Douglas County Storm Drainage Design and Technical Criteria Manual, Amended July 8, 2008.

Douglas County Zoning Resolution, dated March 10, 1999.

Home Rule Charter and Code of the City of Lone Tree, Colorado, dated 2004.

Federal Emergency Management Agency, Flood Insurance Study, Arapahoe County, Colorado and Incorporated Areas, Volume 1 and 4 of 4, December 17, 2010.

Federal Emergency Management Agency, Flood Insurance Study, Douglas County, Colorado Unincorporated Areas, Volume 1 and 2 of 3, September 30, 2005.

Flood Insurance Rate Map Panel(s) 28, 33, 34, 36, and 41 of 495 Douglas County Colorado, Revised September 30, 2005.

Federal Emergency Management Agency, Flood Insurance Study, Jefferson County, Colorado and Incorporated Areas, Volume 1 of 7, June 17, 2003.

Flood Insurance Rate Map Panel(s) 0415E Jefferson County Colorado and Incorporated Areas, Revised by LOMRs, Effective February 19 2008, and Effective March 23, 2009.

Flood Insurance Rate Map Panel 433 of 725 Arapahoe County Colorado and Incorporated Areas, Revised December 17, 2010.

Jefferson County Storm Drainage Design & Technical Criteria, adopted March 24, 2009.

Jefferson County Zoning Resolution, Adopted August 27-2013.

Master Plan of Drainage Addendum Dad Clark Gulch, by Nolte and Associates, Revised September 1997.

National Environmental Policy Act Manual, Section 9.5, Floodplains, Colorado Department of Transportation, October, 2014.

Urban Drainage and Flood Control District, Electronic Data Management Maps.

APPENDIX A – FLOODPLAIN MAPS

This appendix contains copies of FEMA FIRMs for each of major drainageways crossing the project.

Map A1: **Massey Draw**: FEMA FIRM Map No. 08059c0415E Revised by LOMR Effective Feb 19 2008

Map A2: **South Platte River**: FEMA FIRM Map No. 08005C0433K, Revised December 17, 2010

Map A3: **Dad Clark Gulch**: FEMA FIRM Map No. 08005C0036F, Effective September 30, 2005

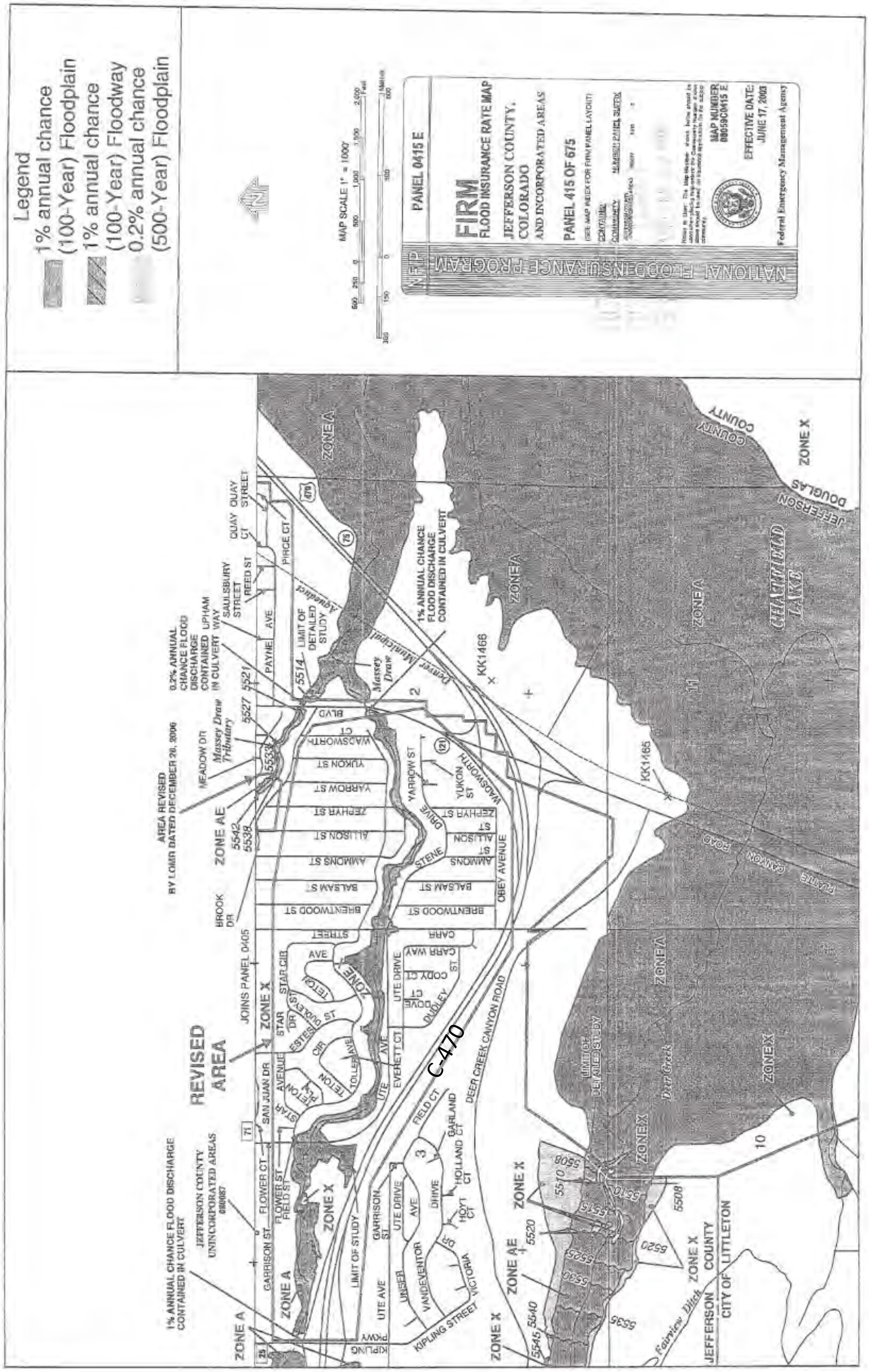
Map A4: **Big Dry Creek**: FEMA FIRM Map No. 08005C0033F, Effective September 30, 2005

Map A5: **Big Dry Creek**: FEMA FIRM Map No. 08005C0041F, Effective September 30, 2005

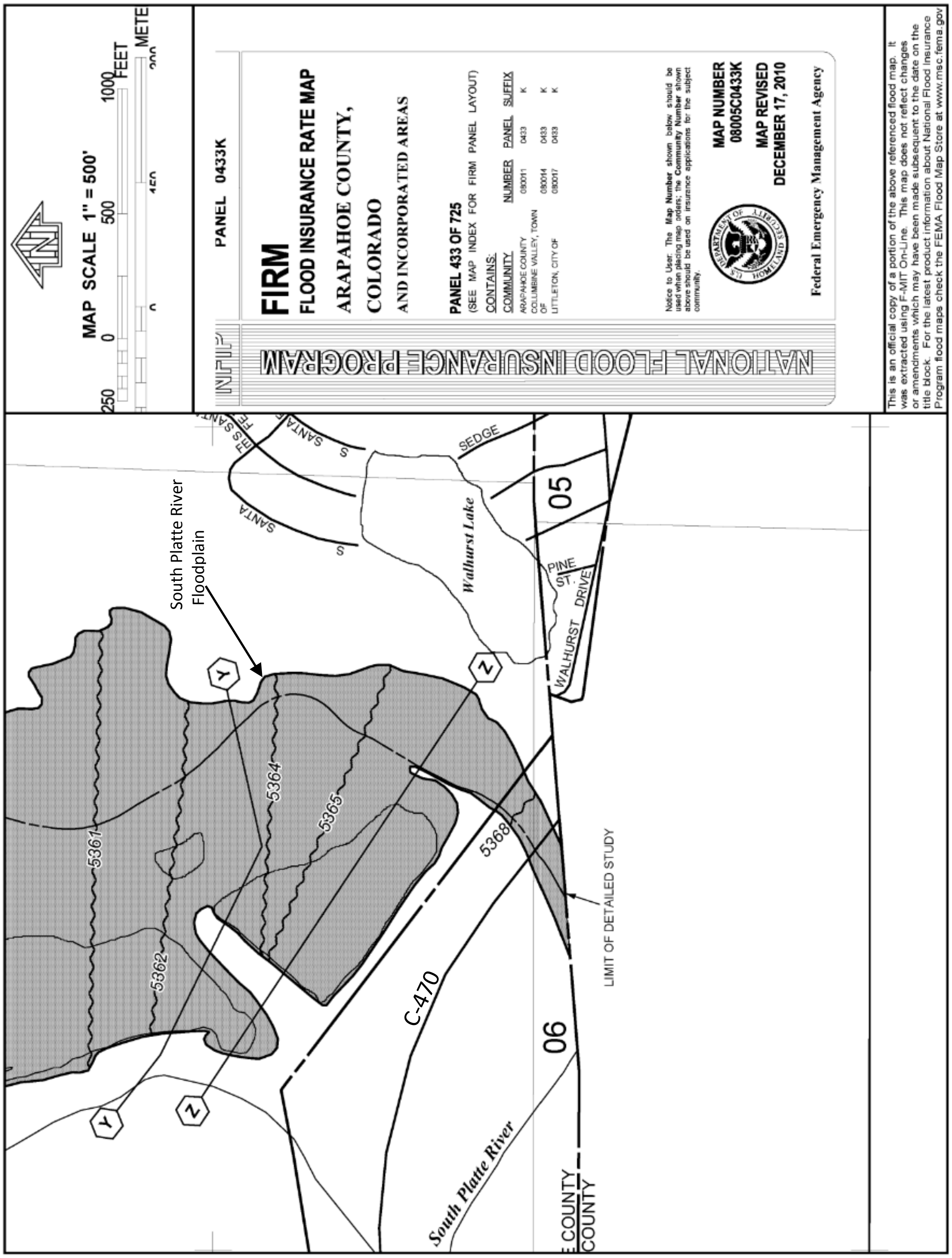
Map A6: **Willow Creek**: FEMA FIRM Map No. 08005C0034F, Effective September 30, 2005

Map A7: **Willow Creek**: FEMA FIRM Map No. 08005C0042F, Effective September 30, 2005

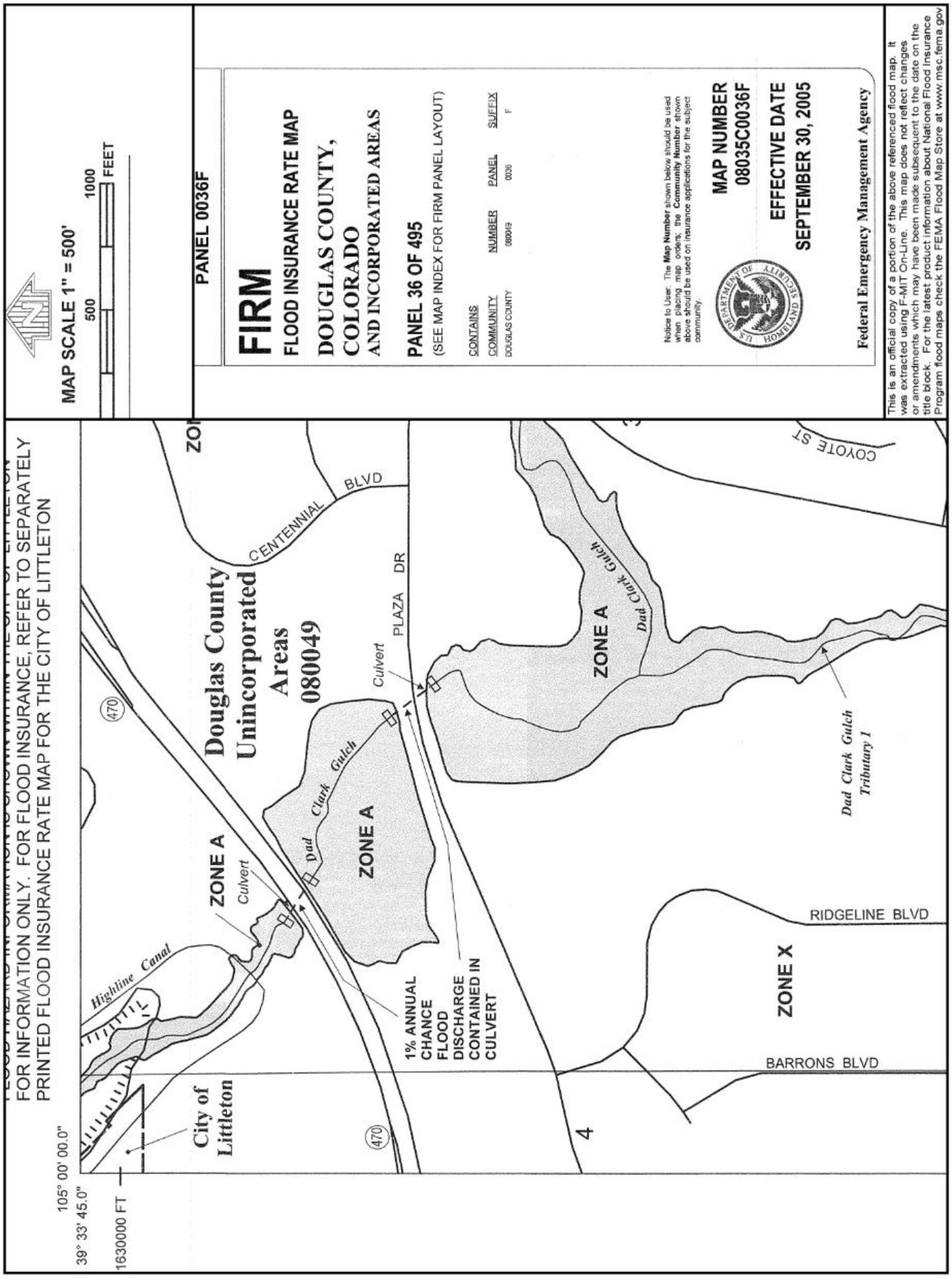
Map A1- Massey Draw



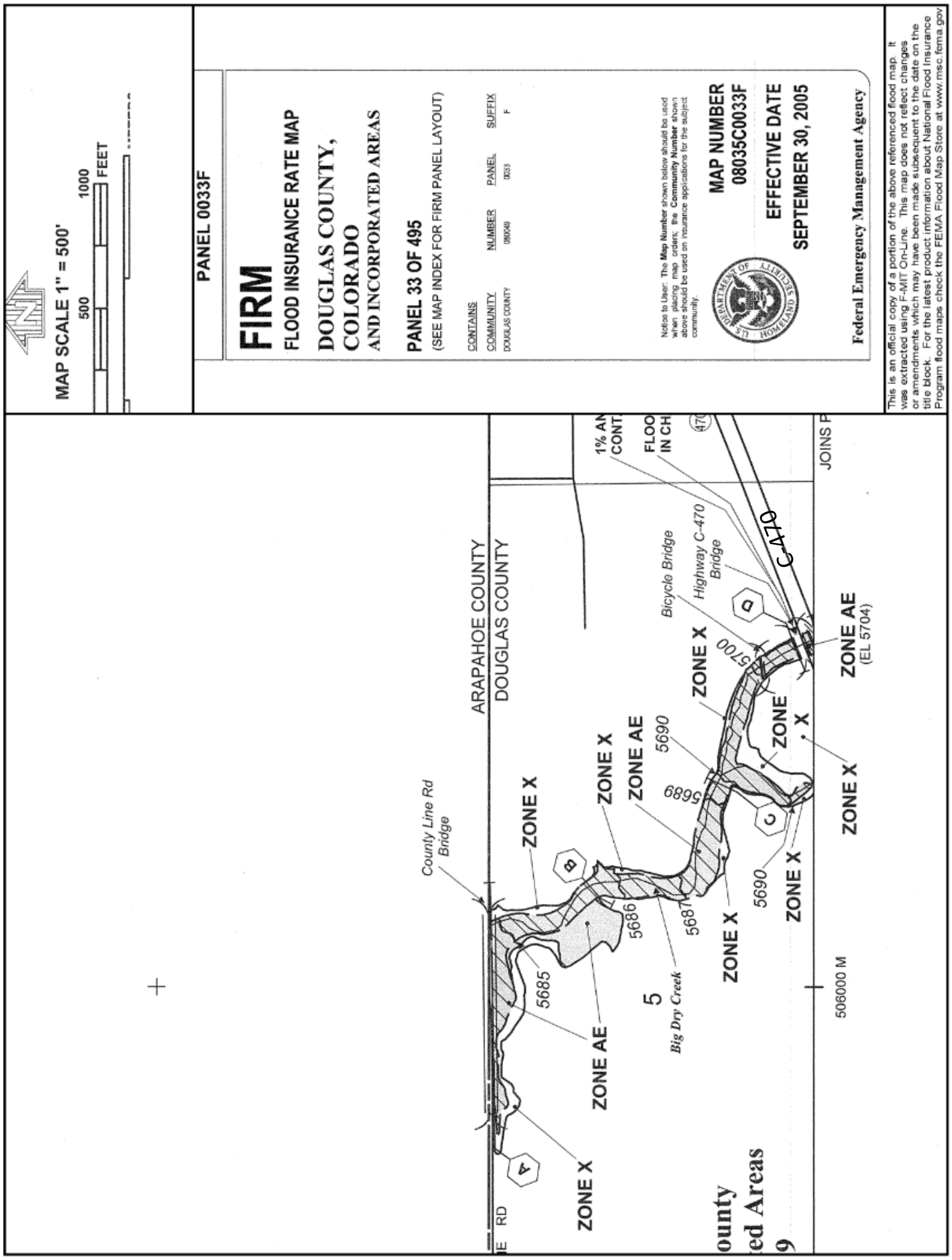
Map A2- South Platte River



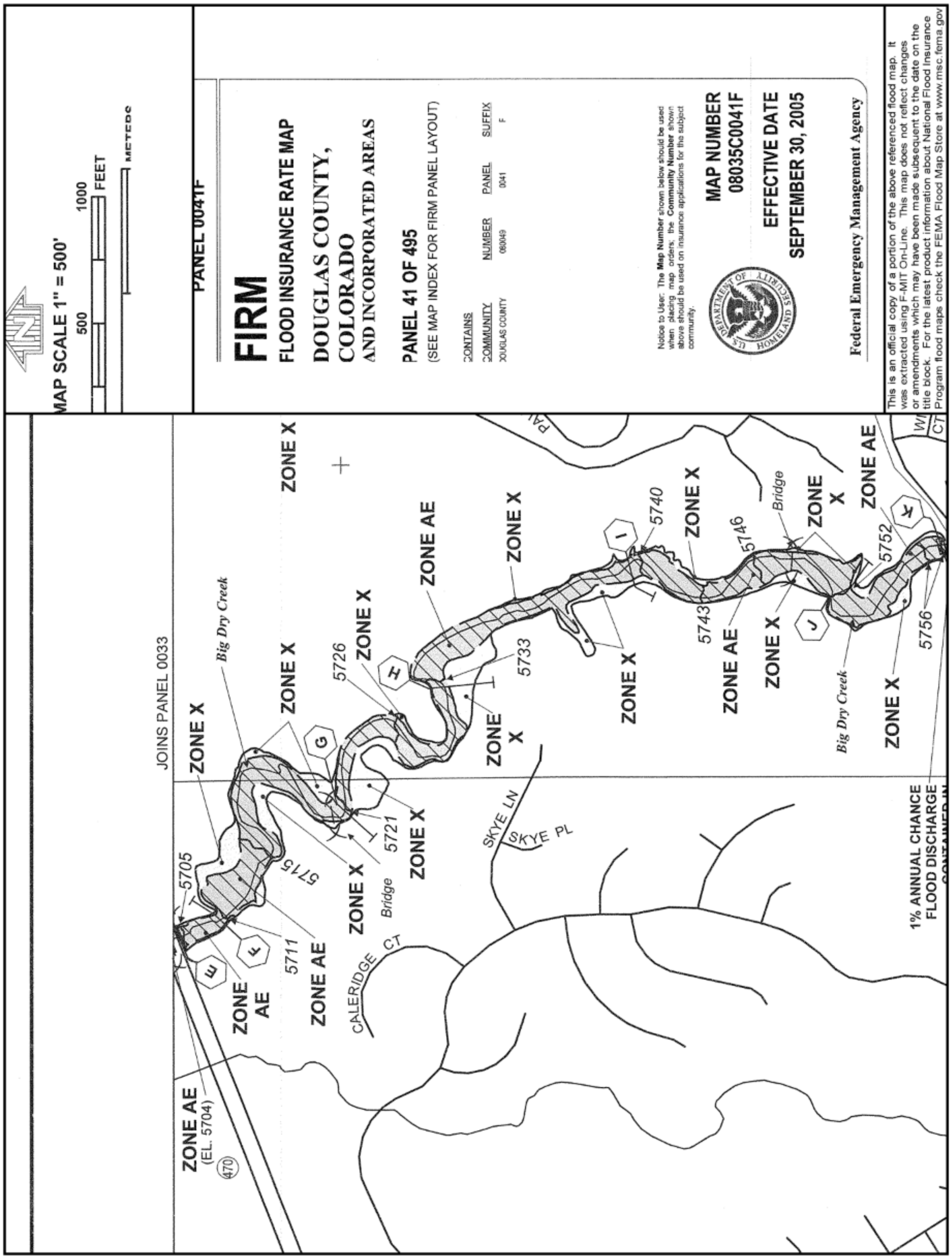
Map A3- Dad Clark Gulch



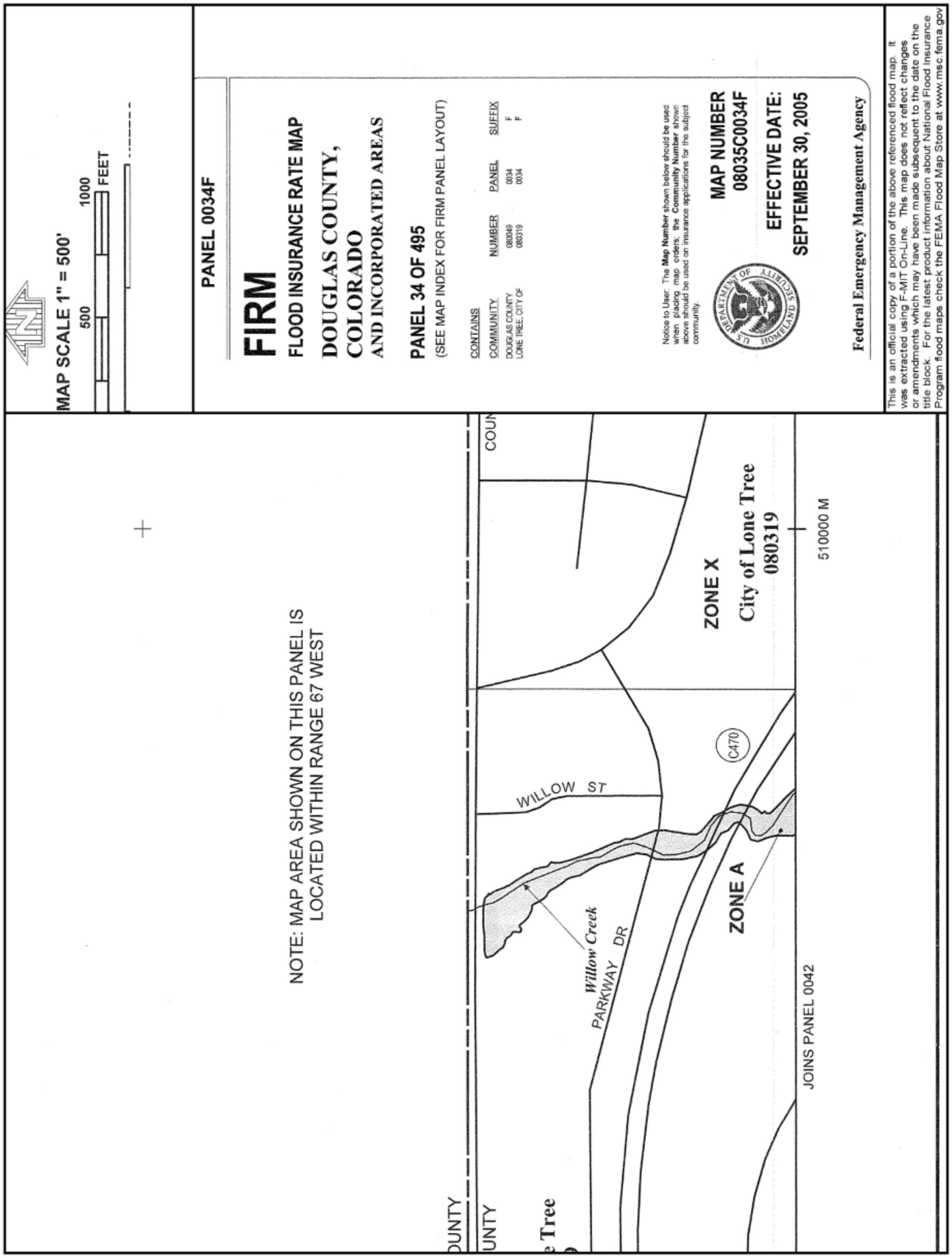
Map A4- Big Dry Creek



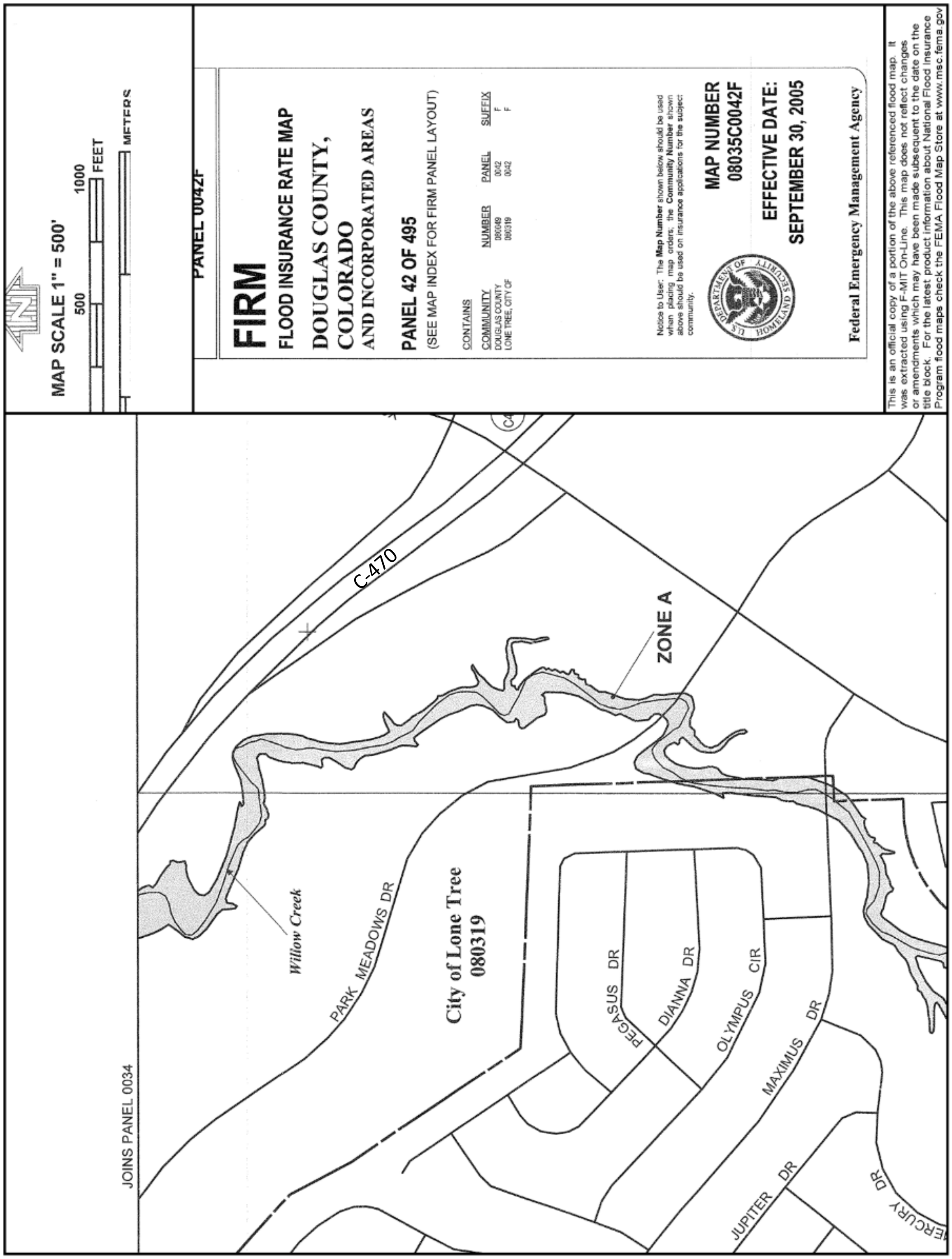
Map A5- Big Dry Creek



Map A6- Willow Creek



Map A7- Willow Creek



APPENDIX B – HYDRAULIC ANALYSES

Appendix B1 - South Platte River Bridge

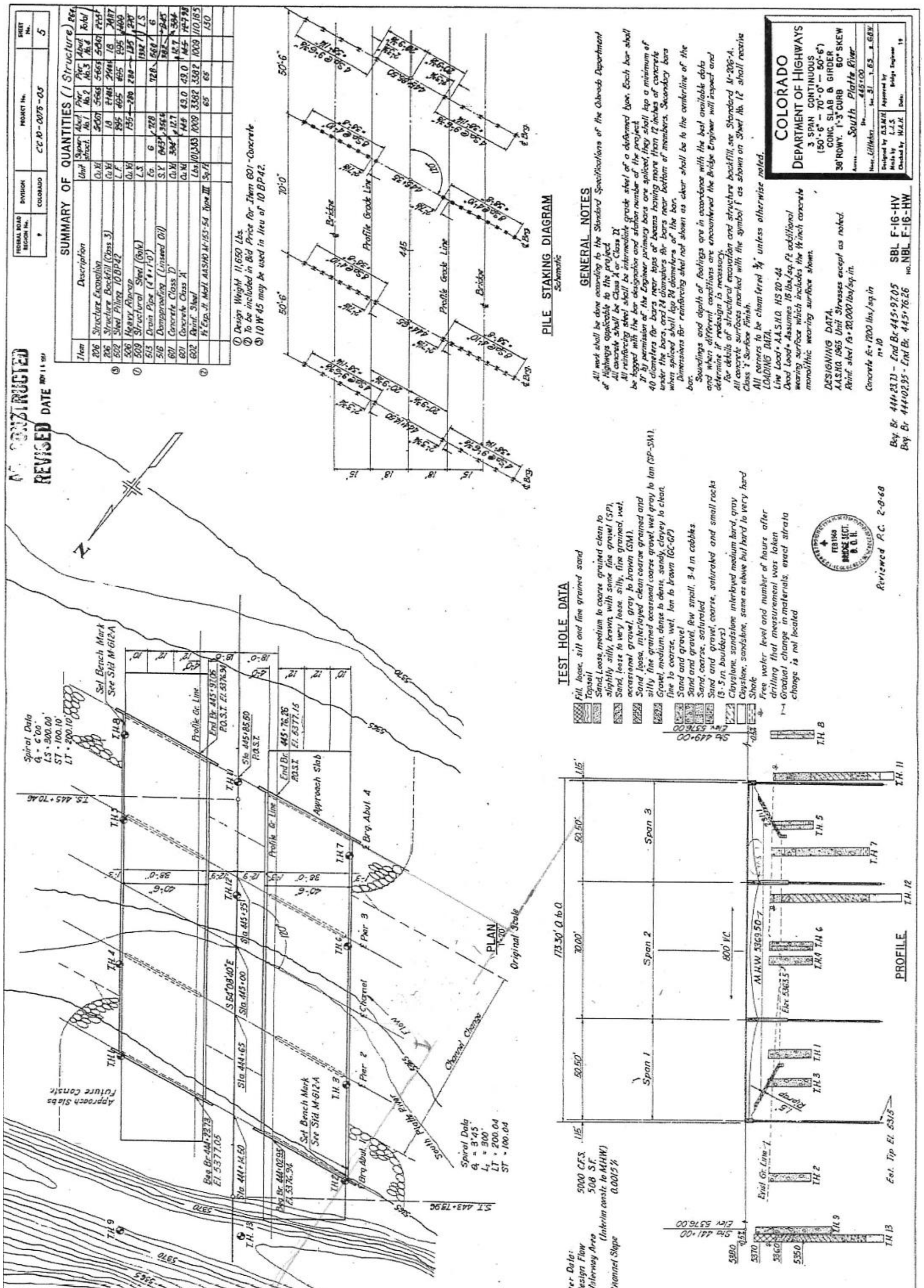
Appendix B2 - Willow Creek Culvert Extension

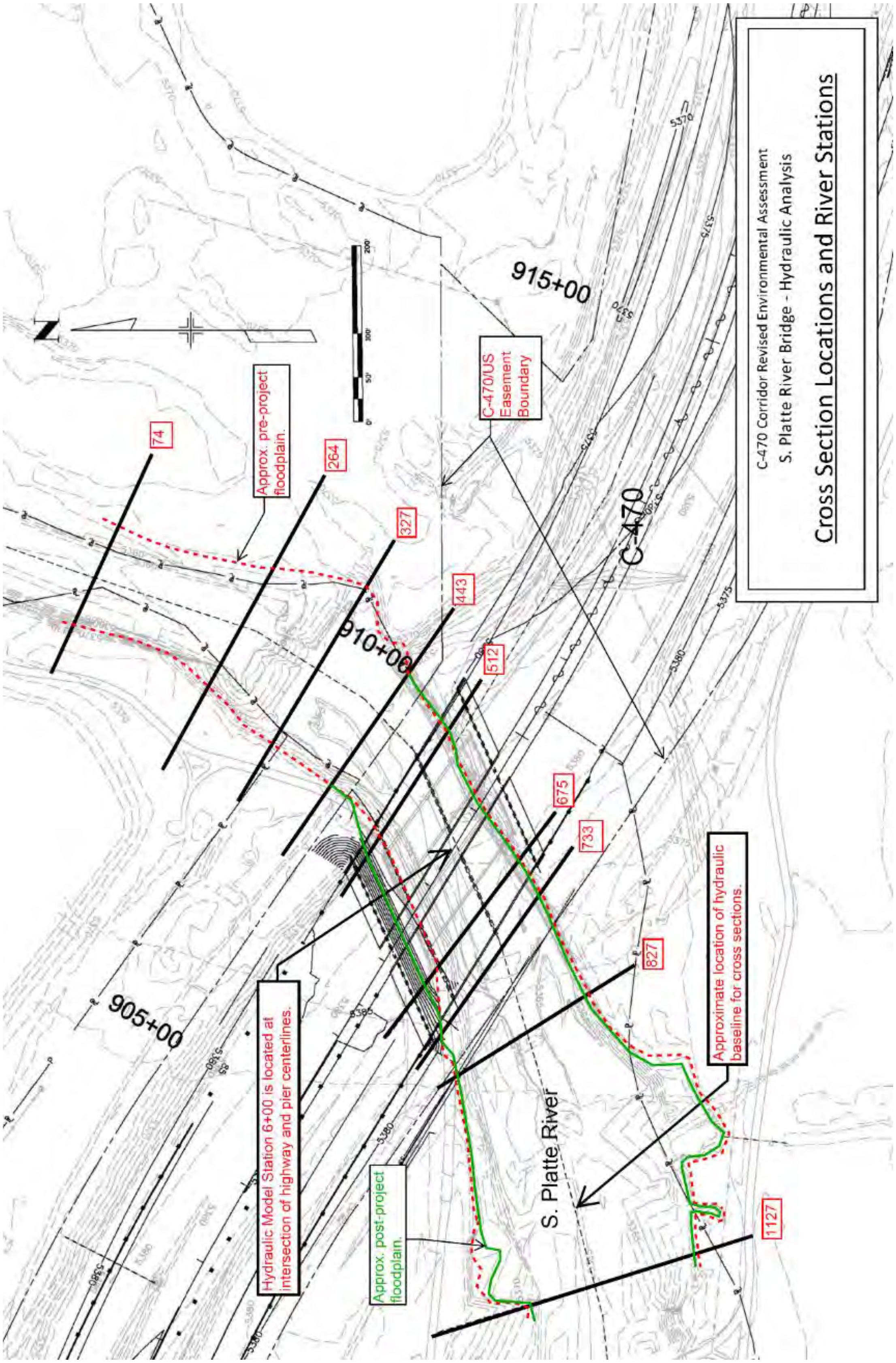
Appendix B1

South Platte River Bridge

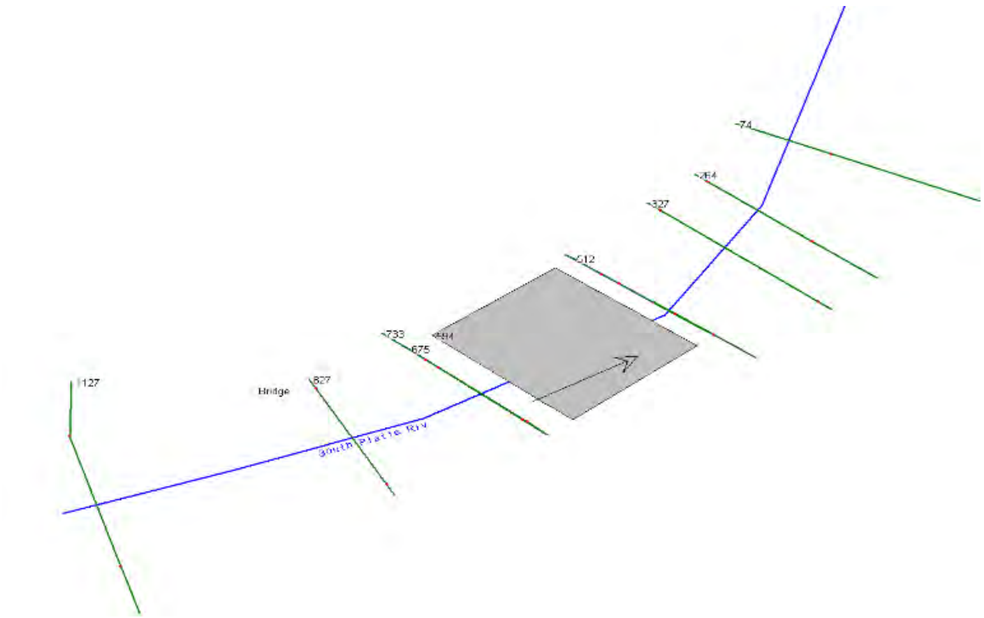
Hydraulic Analysis Data

S. Platte River Bridge
Existing Bridge As-Built

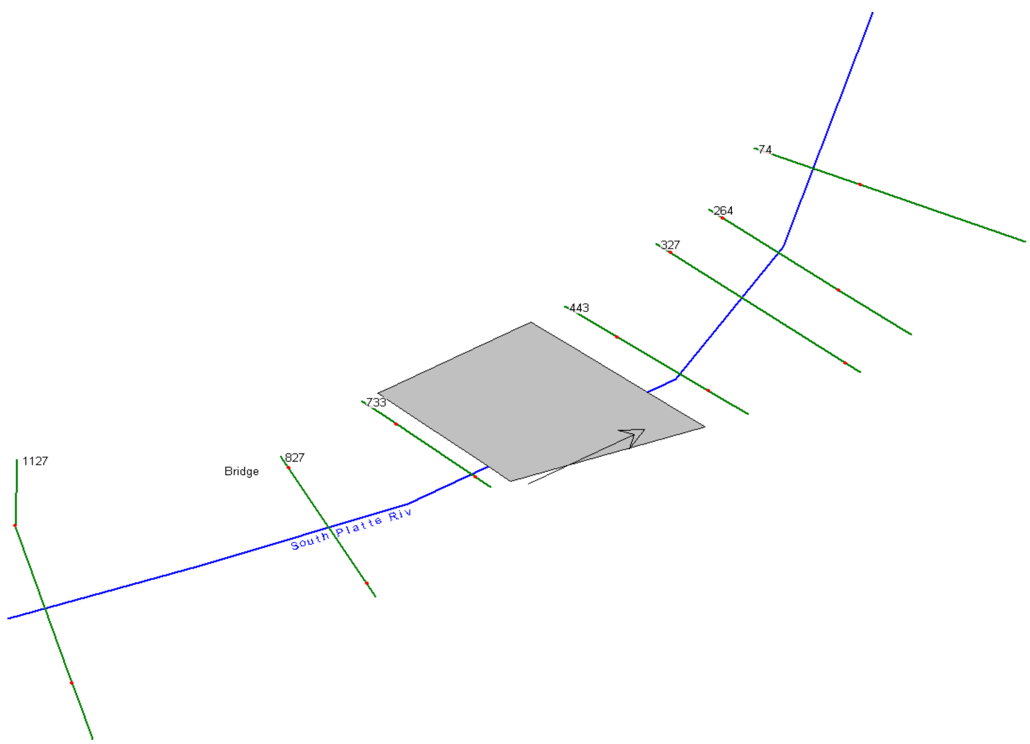

SUMMARY OF QUANTITIES
PILE STAKING DIAGRAM
GENERAL NOTES
TEST HOLE DATA
PLAN
PROFILE
COLORADO
DEPARTMENT OF HIGHWAYS
SBL F-16-HV
NBL F-16-HW


C-470 Corridor Revised Environmental Assessment
S. Platte River Bridge - Hydraulic Analysis
Cross Section Locations and River Stations
Approx. pre-project floodplain.
C-470/US Easement Boundary
Hydraulic Model Station 6+00 is located at intersection of highway and pier centerlines.
Approx. post-project floodplain.
Approximate location of hydraulic baseline for cross sections.
S. Platte River
C-470
905+00
910+00
915+00
74
264
327
443
512
675
733
827
1127

S. Platte River Bridge
Hydraulic Plan Cross-Section Locations
No Action & Proposed Action Alternatives

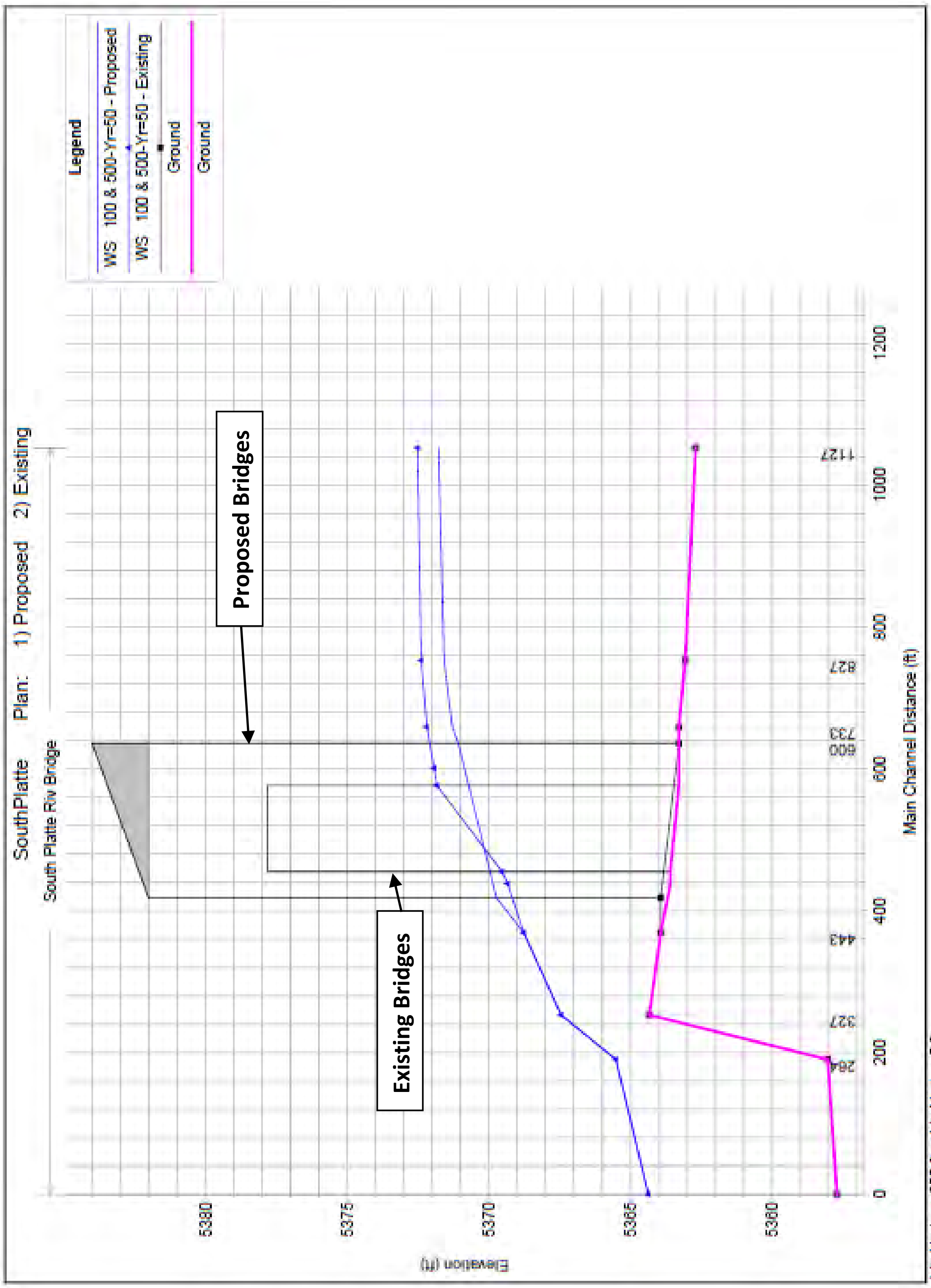


No Action

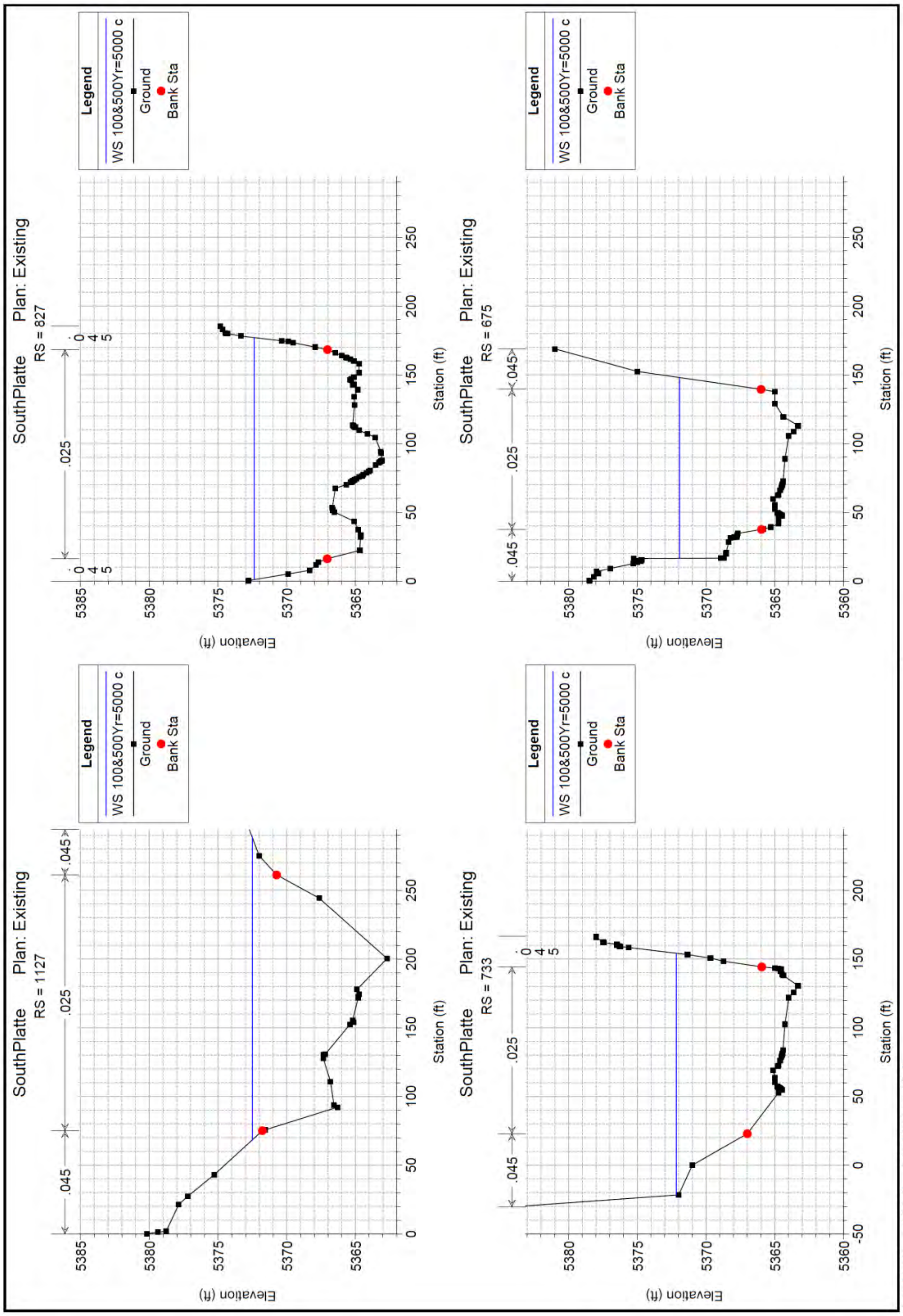


Proposed Action

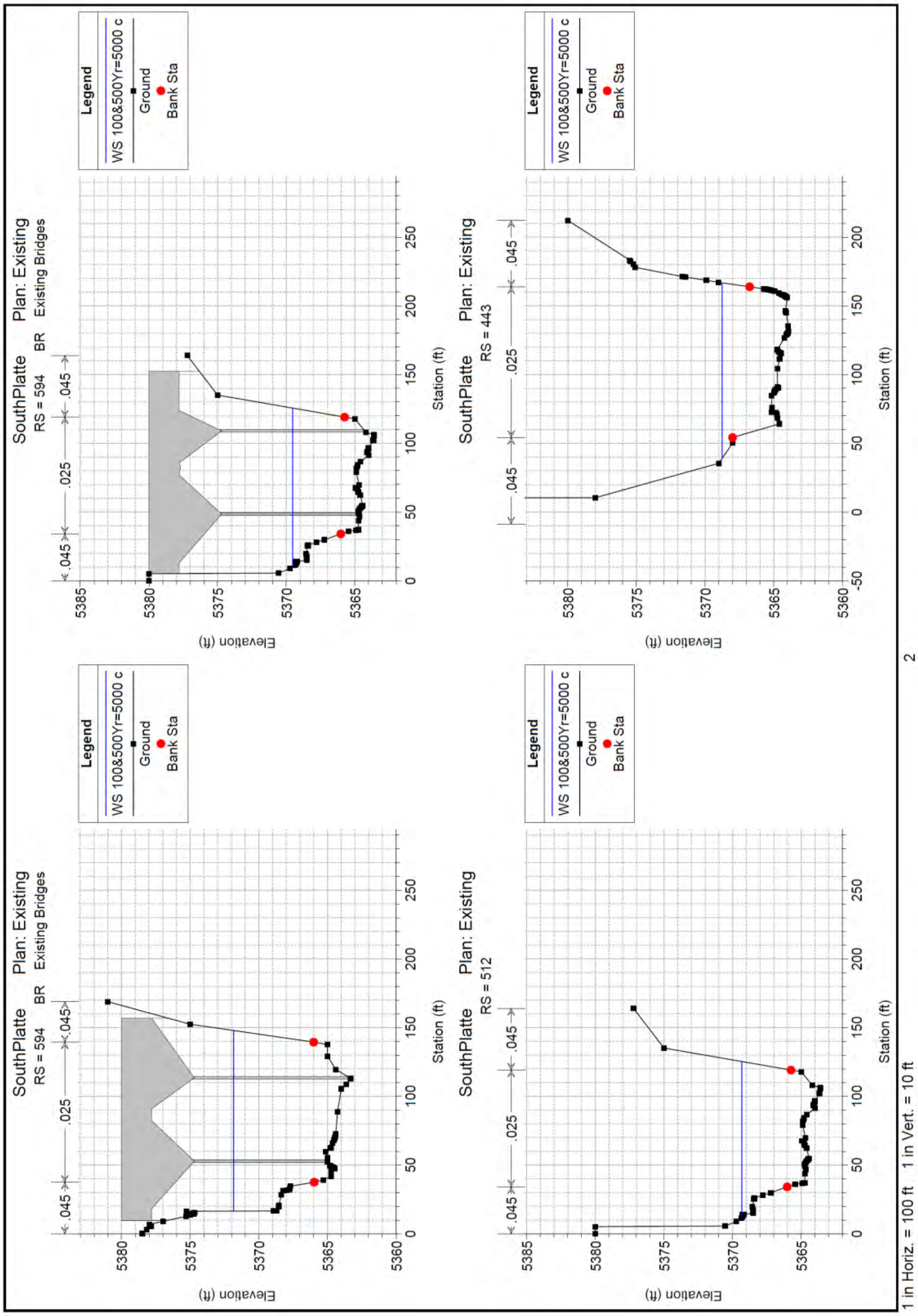
S. Platte River Bridge
Hydraulic Profiles
No Action & Proposed Action Alternatives


SouthPlatte Plan: 1) Proposed 2) Existing
South Platte Riv Bridge
Legend
WS 100 & 500-Yr=50 - Proposed
WS 100 & 500-Yr=50 - Existing
Ground
Ground
Proposed Bridges
Existing Bridges
Elevation (ft)
Main Channel Distance (ft)
1 in Horiz. = 200 ft 1 in Vert. = 5 ft

S. Platte River Bridge
Hydraulic Cross Sections
No Action Alternative

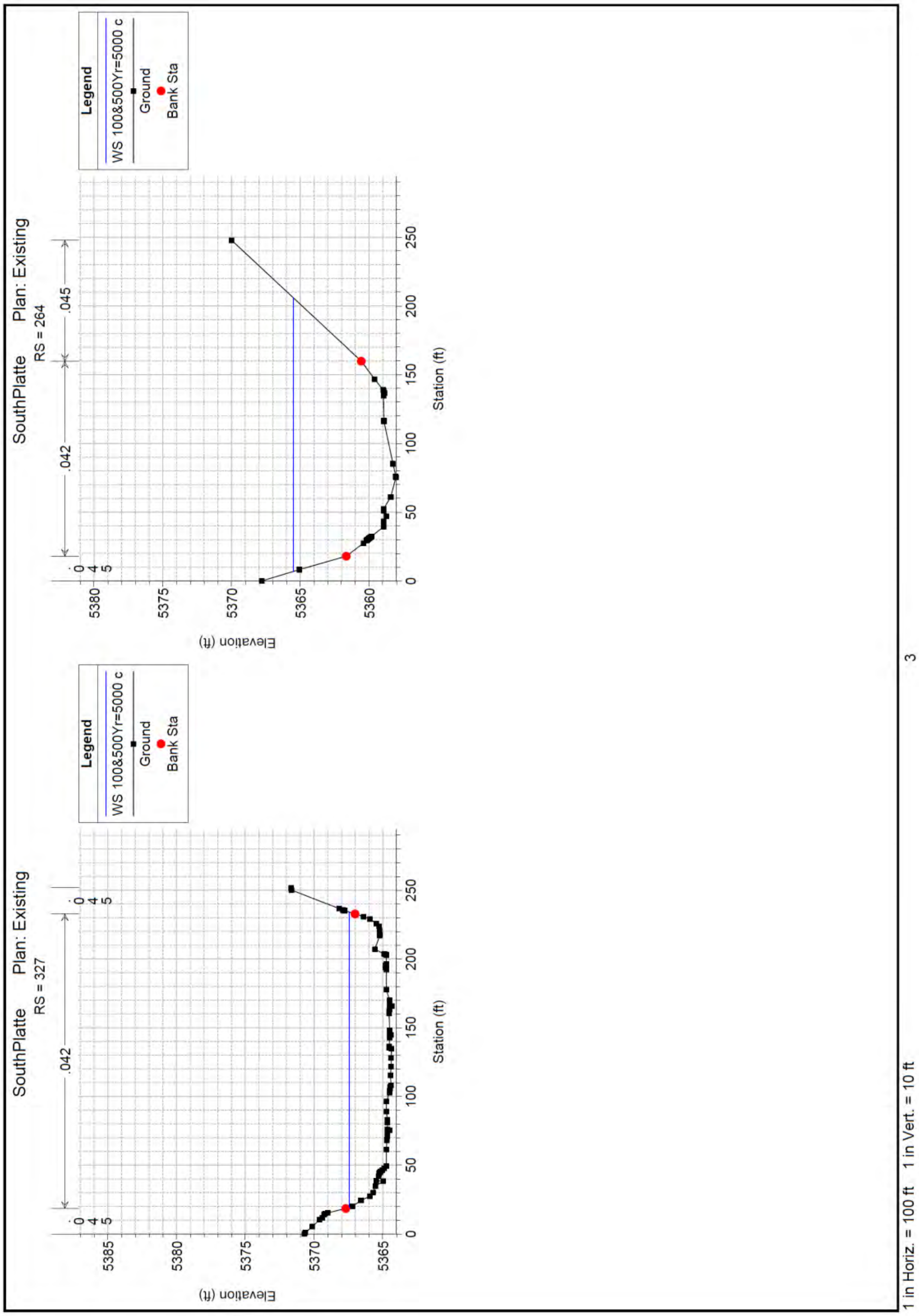

SouthPlatte Plan: Existing
RS = 1127
SouthPlatte Plan: Existing
RS = 827
SouthPlatte Plan: Existing
RS = 733
SouthPlatte Plan: Existing
RS = 675
Legend
WS 100&500Yr=5000 c
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 10 ft

S. Platte River Bridge
Hydraulic Cross Sections
No Action Alternative



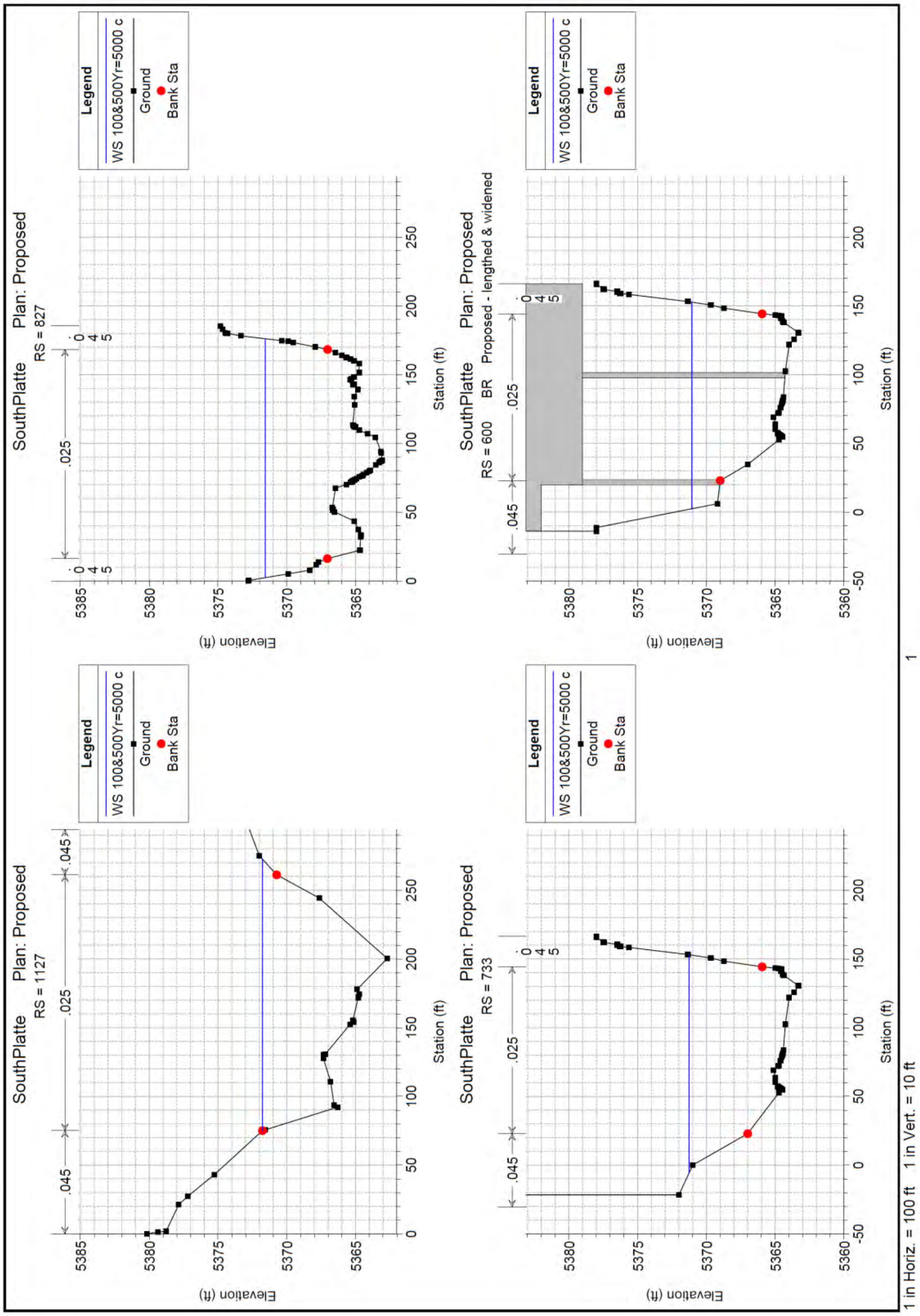
S. Platte River Bridge
Hydraulic Cross Sections

No Action Alternative



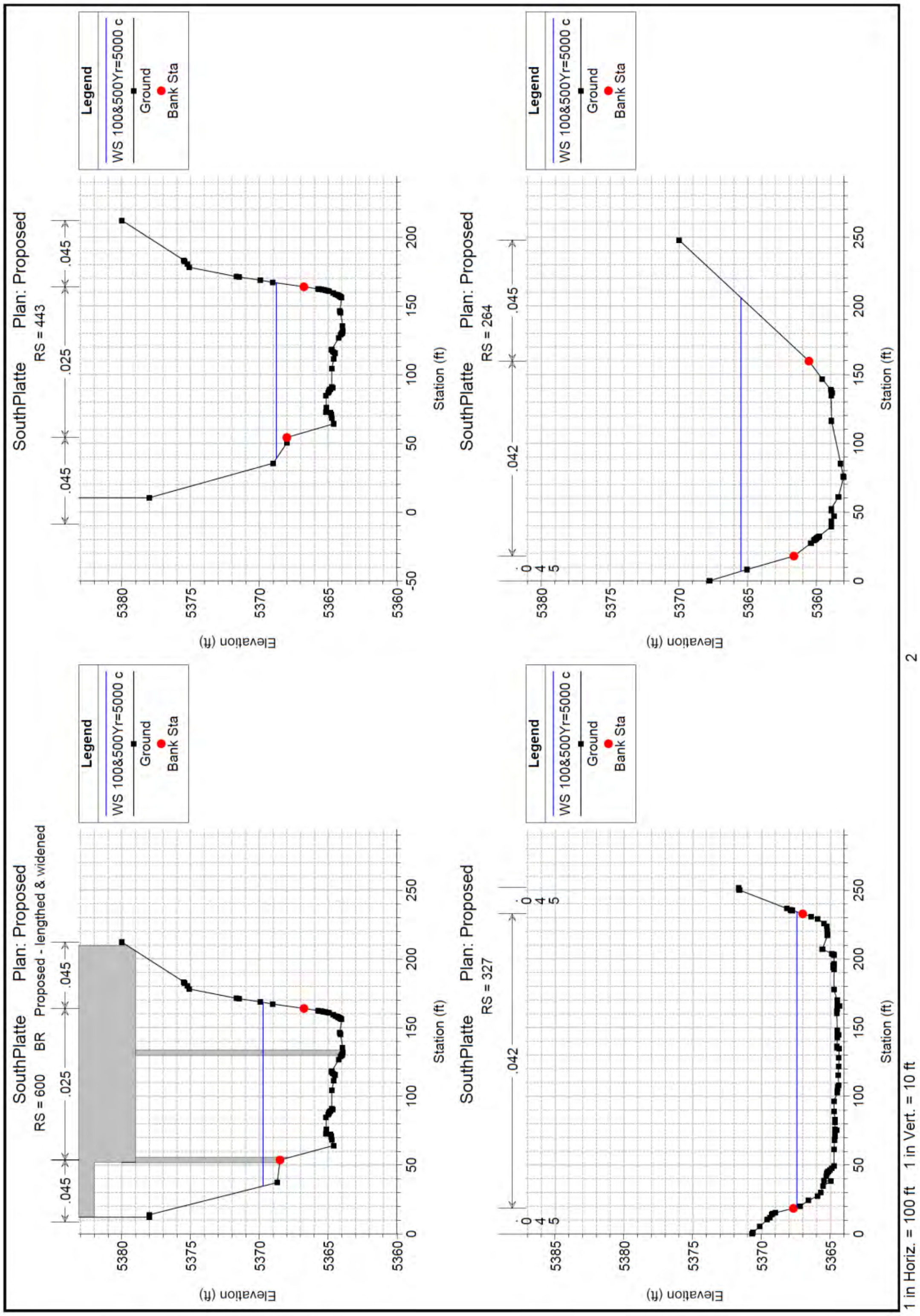
S. Platte River Bridge

Hydraulic Cross Sections
Proposed Action Alternative



S. Platte River Bridge
Hydraulic Cross Sections

Proposed Action Alternative



S. Platte River Bridge
Hydraulic Data
No Action & Proposed Action Alternatives

HEC-RAS River: South Platte Riv Reach: Bridge Profile: 100 & 500-Yr=50

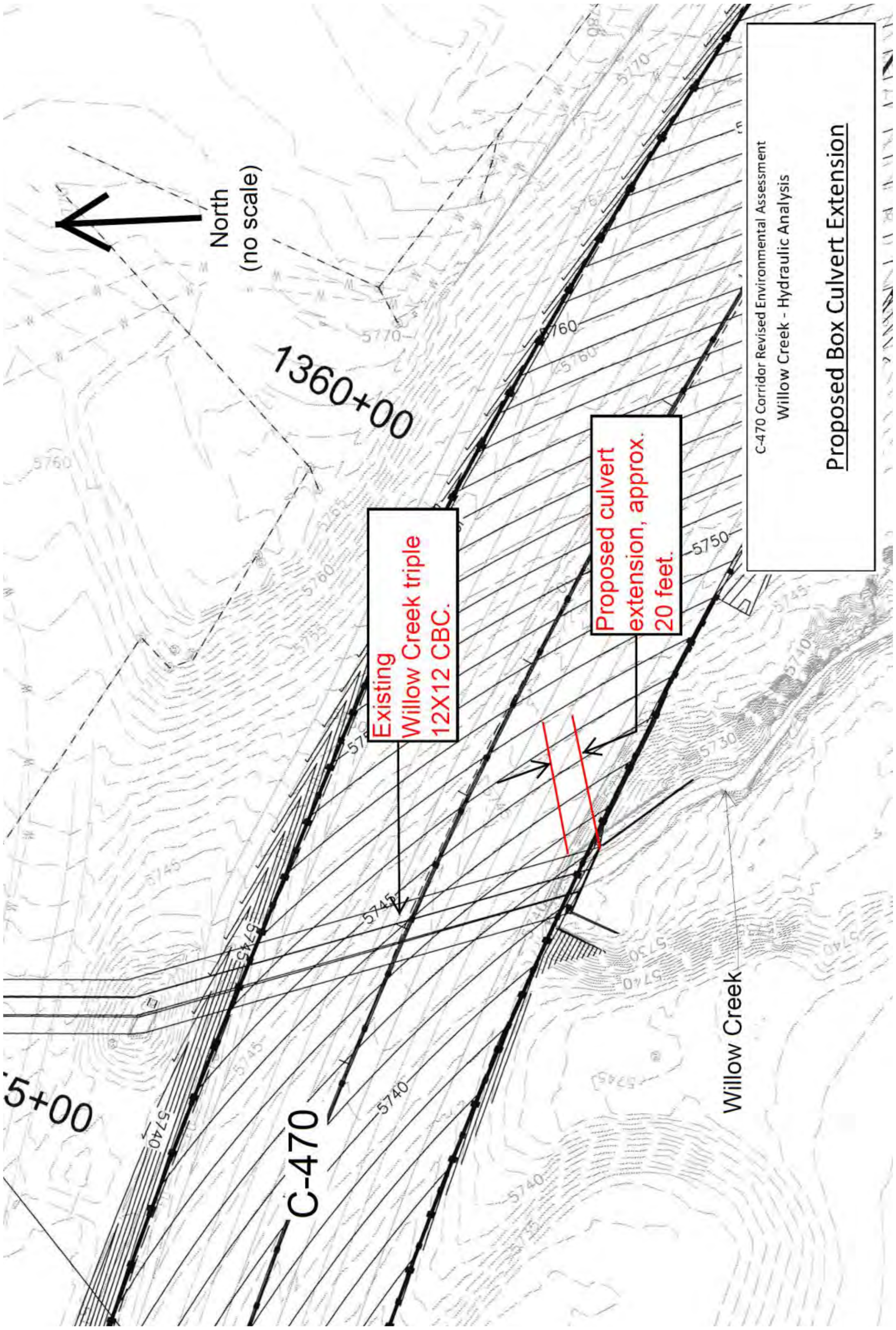
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Ch Sta L (ft)	Ch Sta R (ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)
Bridge	74	100 & 500-Yr=50	Existing	5000.00	5357.71	5364.36	15.37	114.77	8.45	727.76	262.09
Bridge	74	100 & 500-Yr=50	Proposed	5000.00	5357.71	5364.36	15.37	114.77	8.45	727.76	262.09
Bridge	264	100 & 500-Yr=50	Existing	5000.00	5358.04	5365.51	17.97	159.85	5.08	1054.39	199.19
Bridge	264	100 & 500-Yr=50	Proposed	5000.00	5358.04	5365.51	17.97	159.85	5.08	1054.39	199.19
Bridge	327	100 & 500-Yr=50	Existing	5000.00	5364.33	5367.45	18.51	232.72	9.11	549.17	214.94
Bridge	327	100 & 500-Yr=50	Proposed	5000.00	5364.33	5367.45	18.51	232.72	9.11	549.17	214.94
Bridge	443	100 & 500-Yr=50	Existing	5000.00	5363.93	5368.77	54.24	163.90	11.27	452.24	127.77
Bridge	443	100 & 500-Yr=50	Proposed	5000.00	5363.93	5368.77	54.24	163.90	11.27	452.24	127.77
Bridge	512	100 & 500-Yr=50	Existing	5000.00	5363.59	5369.33	34.19	119.08	12.06	444.03	113.24
Bridge	594 BR D	100 & 500-Yr=50	Existing	5000.00	5363.59	5369.54	34.19	119.08	12.05	447.11	111.27
Bridge	594 BR U	100 & 500-Yr=50	Existing	5000.00	5363.32	5371.83	37.53	139.43	6.63	819.51	127.41
Bridge	600 BR D	100 & 500-Yr=50	Proposed	5000.00	5363.95	5369.73	53.69	163.90	9.51	544.57	125.70
Bridge	600 BR U	100 & 500-Yr=50	Proposed	5000.00	5363.29	5371.07	22.93	144.25	6.86	766.80	142.32
Bridge	675	100 & 500-Yr=50	Existing	5000.00	5363.29	5371.93	37.53	139.43	6.33	862.13	131.55
Bridge	733	100 & 500-Yr=50	Existing	5000.00	5363.29	5372.18	22.93	144.25	5.36	1022.94	175.92
Bridge	733	100 & 500-Yr=50	Proposed	5000.00	5363.29	5371.29	22.93	144.25	6.14	871.36	159.20
Bridge	827	100 & 500-Yr=50	Existing	5000.00	5363.07	5372.38	16.13	168.30	4.36	1202.70	176.09
Bridge	827	100 & 500-Yr=50	Proposed	5000.00	5363.07	5371.58	16.13	168.30	4.91	1061.49	173.81
Bridge	1127	100 & 500-Yr=50	Existing	5000.00	5362.70	5372.52	75.08	261.15	4.24	1199.70	220.48
Bridge	1127	100 & 500-Yr=50	Proposed	5000.00	5362.70	5371.77	75.08	261.15	4.81	1044.24	197.40

Appendix B2

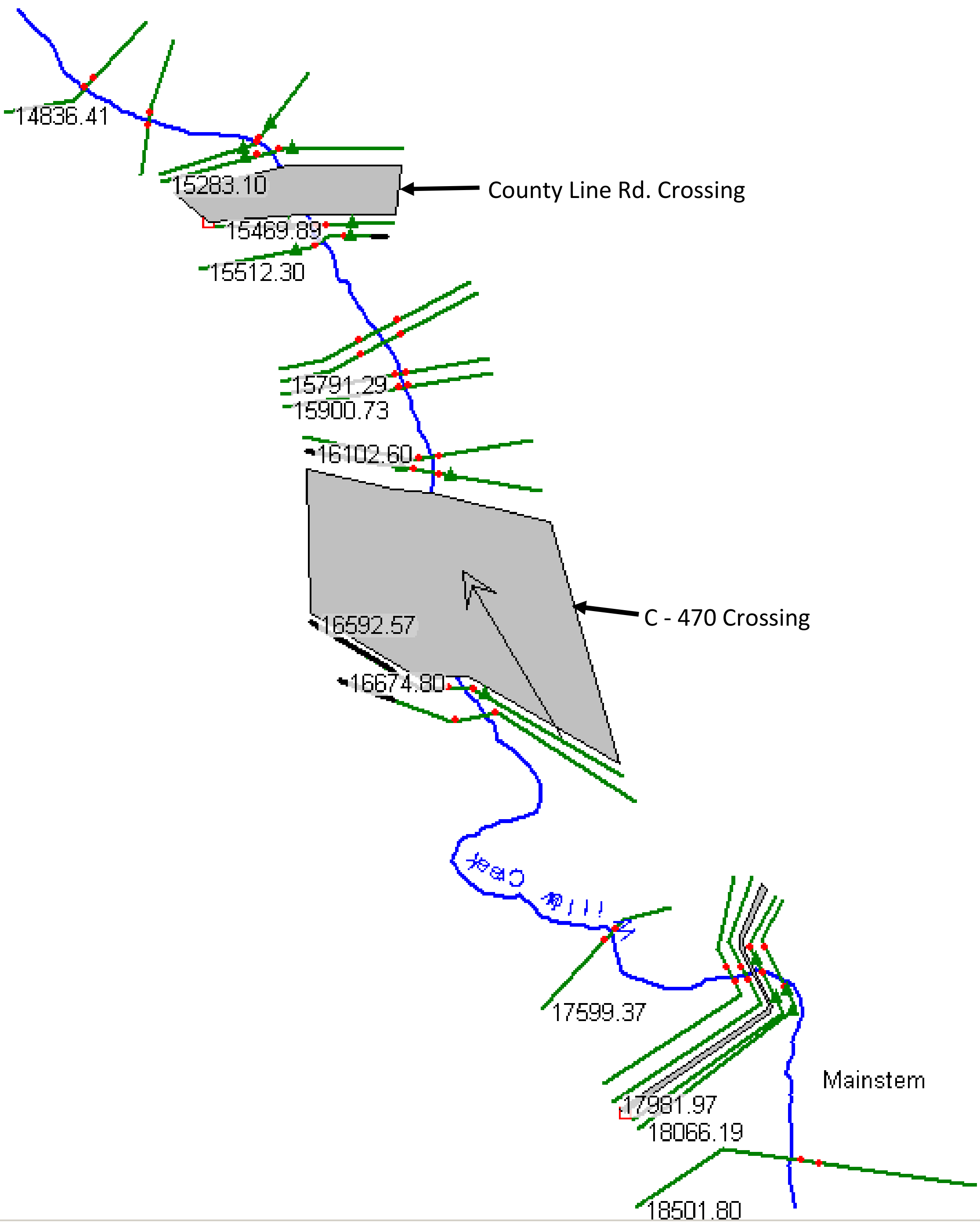
Willow Creek Culvert Extension

Hydraulic Analysis Data

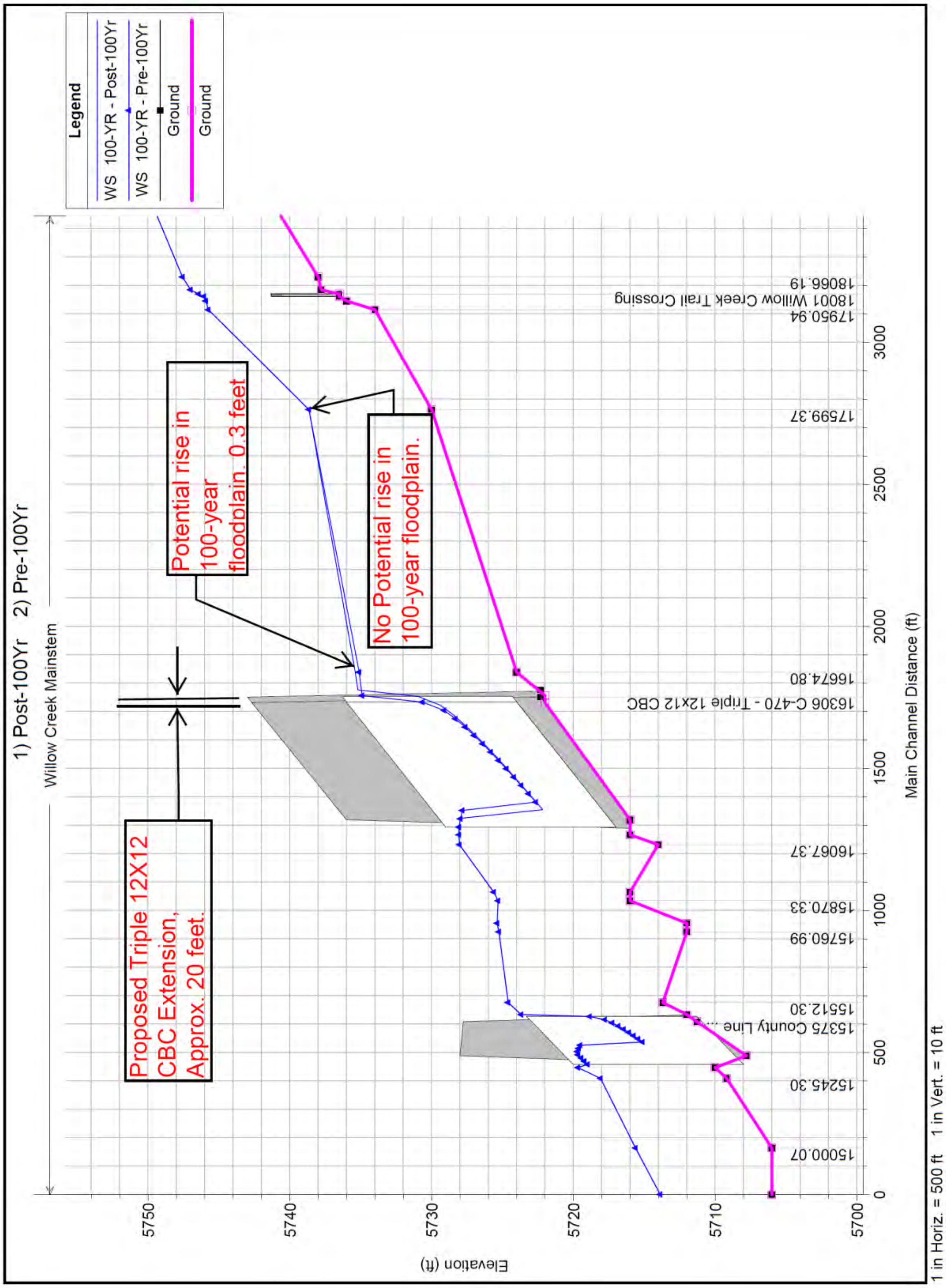
Willow Creek Culvert Extension
Plan View of Culvert Location
No Action & Proposed Action Alternatives


C-470 Corridor Revised Environmental Assessment
Willow Creek - Hydraulic Analysis
Proposed Box Culvert Extension
North
(no scale)
1360+00
Existing
Willow Creek triple
12X12 CBC.
Proposed culvert
extension, approx.
20 feet.
C-470
Willow Creek

Willow Creek Culvert Extension
Hydraulic Plan Cross-Section Locations
No Action & Proposed Action Alternatives

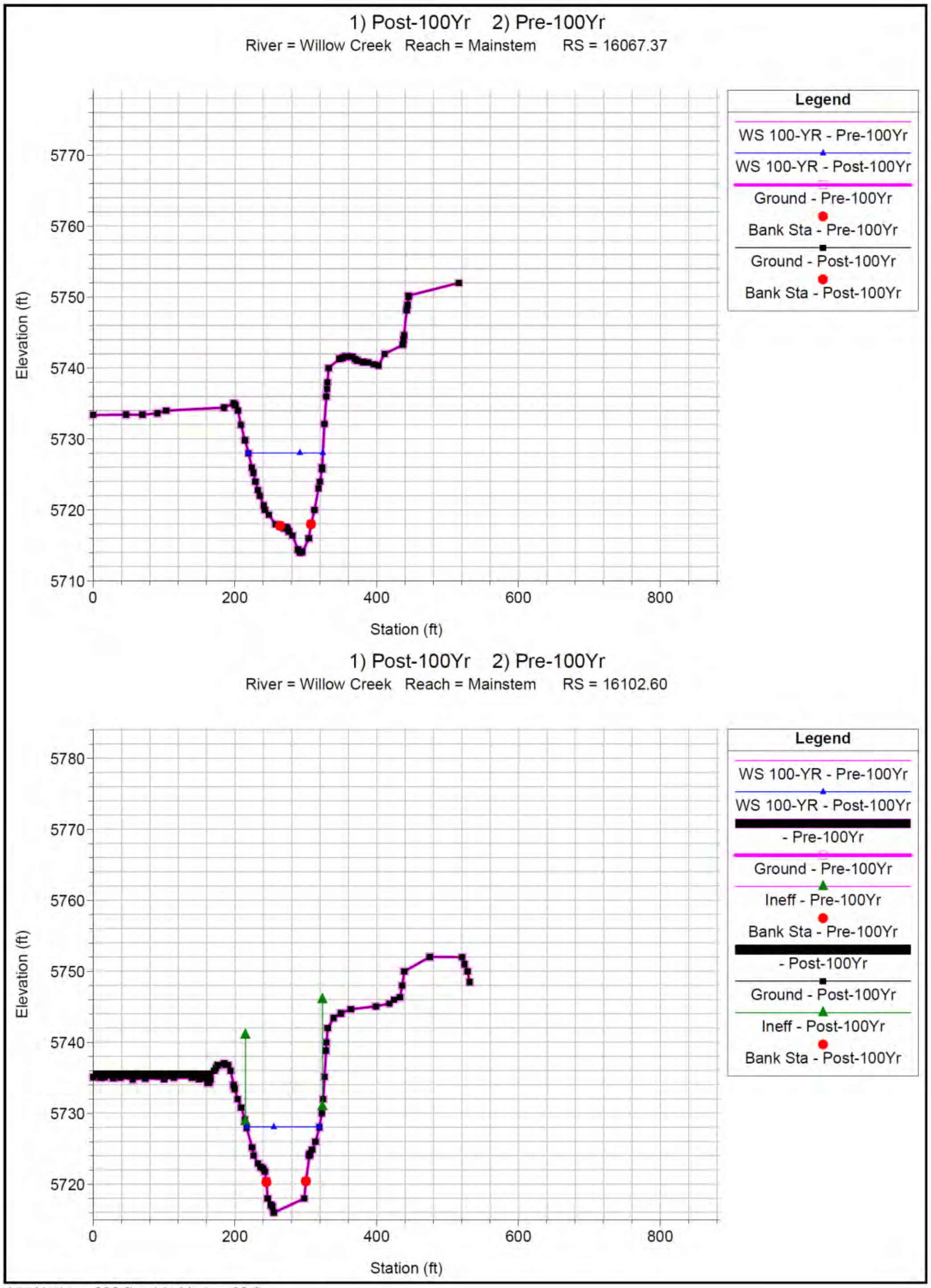


Willow Creek Culvert Extension
Hydraulic Profiles
No Action & Proposed Action Alternatives



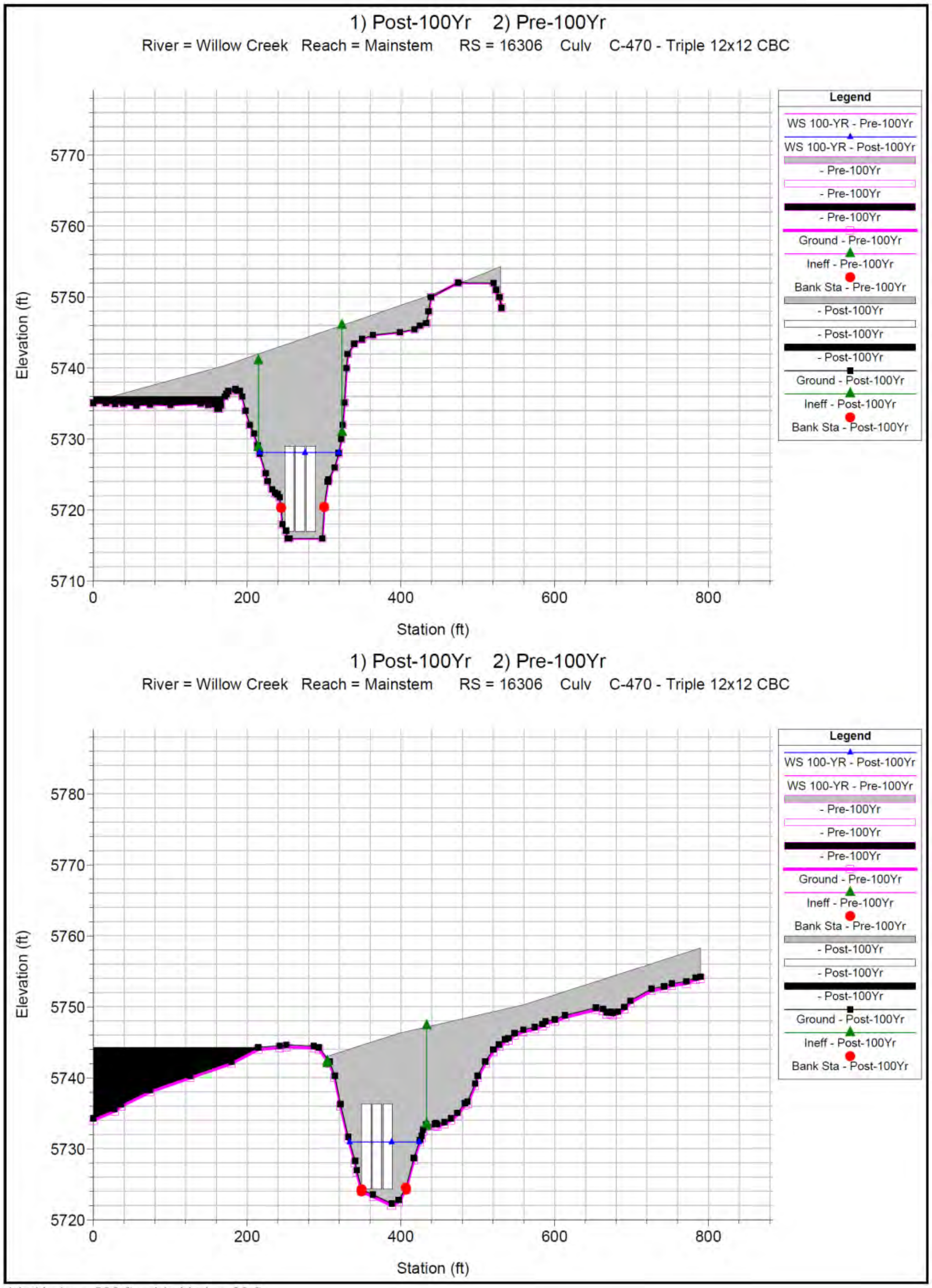
1) Post-100Yr 2) Pre-100Yr
Willow Creek Mainstem
Legend
WS 100-YR - Post-100Yr
WS 100-YR - Pre-100Yr
Ground
Ground
Proposed Triple 12X12 CBC Extension, Approx. 20 feet.
Potential rise in 100-year floodplain, 0.3 feet
No Potential rise in 100-year floodplain.
15000.07
15245.30
15375 County Line
15512.30
15760.99
15870.33
16067.37
16306 C-470 - Triple 12x12 CBC
16674.80
17599.37
17950.94
18001 Willow Creek Trail Crossing
18066.19
Elevation (ft)
5700
5710
5720
5730
5740
5750
Main Channel Distance (ft)
0
500
1000
1500
2000
2500
3000
1 in Horiz. = 500 ft 1 in Vert. = 10 ft

Willow Creek Culvert Extension
Selected Hydraulic Cross Sections
No Action and Proposed Action Alternatives



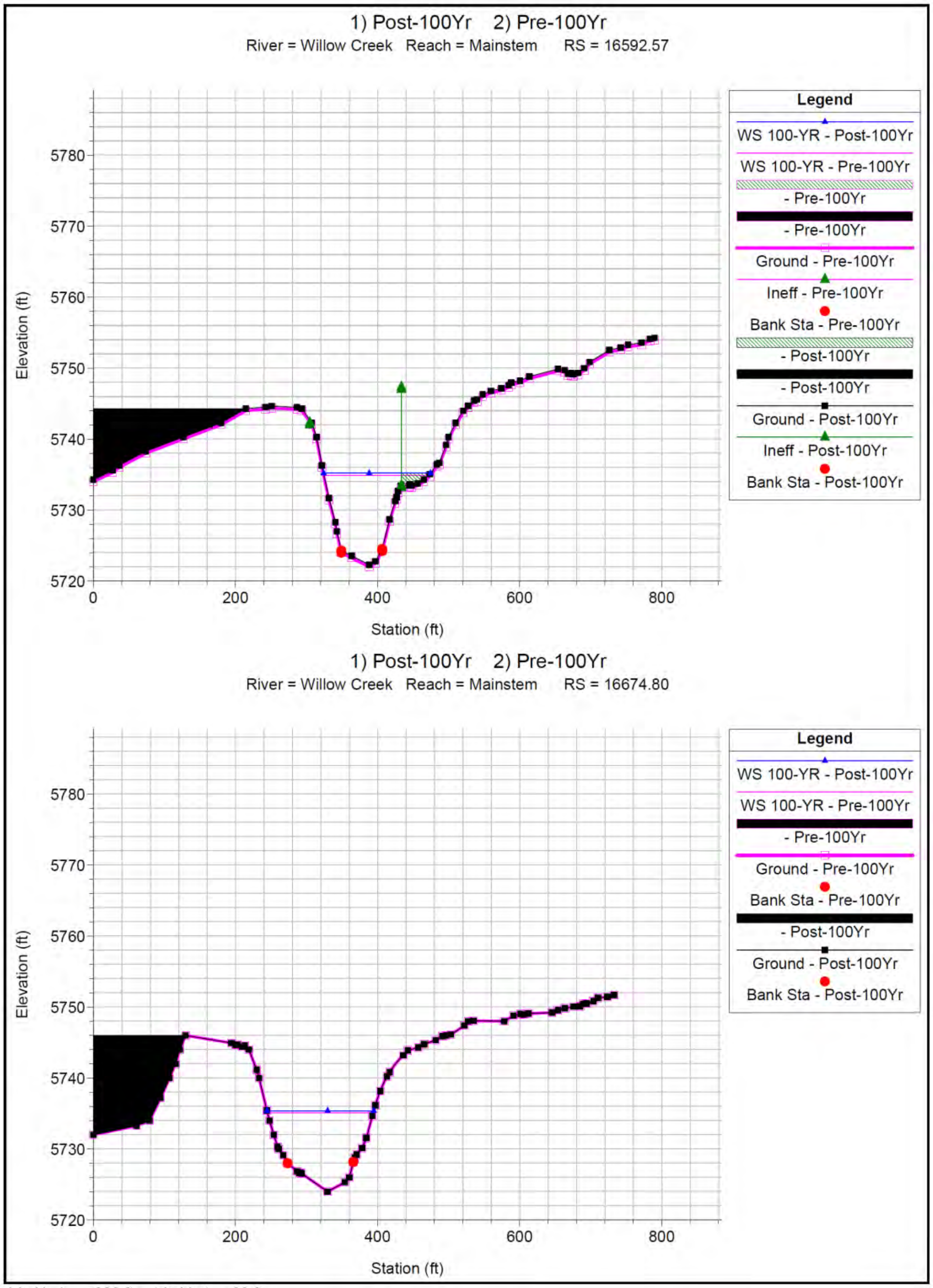
1 in Horiz. = 200 ft 1 in Vert. = 20 ft

Willow Creek Culvert Extension
Selected Hydraulic Cross Sections
No Action and Proposed Action Alternatives



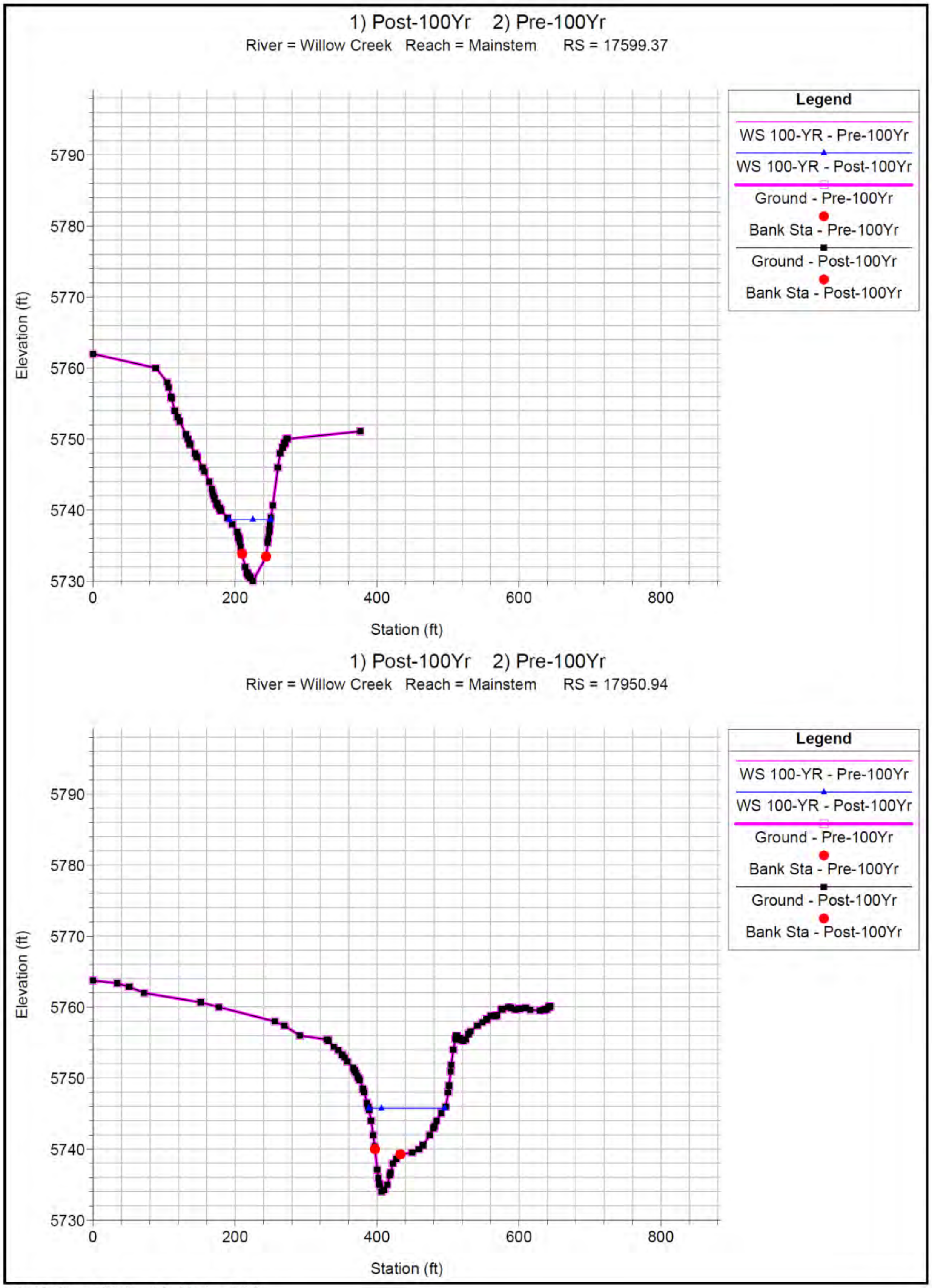
1 in Horiz. = 200 ft 1 in Vert. = 20 ft

Willow Creek Culvert Extension
Selected Hydraulic Cross Sections
No Action and Proposed Action Alternative



1 in Horiz. = 200 ft 1 in Vert. = 20 ft

Willow Creek Culvert Extension
Selected Hydraulic Cross Sections
No Action Alternative



1 in Horiz. = 200 ft 1 in Vert. = 20 ft

Willow Creek Culvert Extension
Hydraulic Data
No Action & Proposed Action Alternative

HEC-RAS River: Willow Creek Reach: Mainstem Profile: 100-YR

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Ch Sta L	Ch Sta R	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Mainstem	14836.41	100-YR	Post-100Yr	4236.00	5706.00	5713.87	179.46	208.48	8.88	688.68	156.56
Mainstem	14836.41	100-YR	Pre-100Yr	4236.00	5706.00	5713.87	179.46	208.48	8.88	688.68	156.56
Mainstem	15000.07	100-YR	Post-100Yr	4236.00	5706.00	5715.61	107.52	132.11	8.49	755.16	153.07
Mainstem	15000.07	100-YR	Pre-100Yr	4236.00	5706.00	5715.61	107.52	132.11	8.49	755.16	153.07
Mainstem	15245.30	100-YR	Post-100Yr	4236.00	5709.19	5718.08	230.93	242.35	12.48	446.63	100.95
Mainstem	15245.30	100-YR	Pre-100Yr	4236.00	5709.19	5718.08	230.93	242.35	12.48	446.63	100.95
Mainstem	15283.10	100-YR	Post-100Yr	4236.00	5710.00	5719.68	221.07	270.33	6.84	699.69	128.17
Mainstem	15283.10	100-YR	Pre-100Yr	4236.00	5710.00	5719.68	221.07	270.33	6.84	699.69	128.17
Mainstem	15375	100-YR	Post-100Yr	4236.00							
Mainstem	15375	100-YR	Pre-100Yr	4236.00							
Mainstem	15469.89	100-YR	Post-100Yr	4236.00	5712.00	5723.68	198.87	218.09	9.22	680.02	166.01
Mainstem	15469.89	100-YR	Pre-100Yr	4236.00	5712.00	5723.68	198.87	218.09	9.22	680.02	166.01
Mainstem	15512.30	100-YR	Post-100Yr	4236.00	5713.69	5724.60	249.50	316.00	4.37	1081.57	195.50
Mainstem	15512.30	100-YR	Pre-100Yr	4236.00	5713.69	5724.60	249.50	316.00	4.37	1081.57	195.50
Mainstem	15760.99	100-YR	Post-100Yr	3500.00	5712.00	5725.25	187.88	283.05	4.80	730.17	97.83
Mainstem	15760.99	100-YR	Pre-100Yr	3500.00	5712.00	5725.25	187.88	283.05	4.80	730.17	97.83
Mainstem	15791.29	100-YR	Post-100Yr	3500.00	5712.00	5725.37	188.93	289.14	4.87	718.84	91.17
Mainstem	15791.29	100-YR	Pre-100Yr	3500.00	5712.00	5725.37	188.93	289.14	4.87	718.84	91.17
Mainstem	15870.33	100-YR	Post-100Yr	3500.00	5716.00	5725.31	255.62	282.52	10.45	425.60	77.94
Mainstem	15870.33	100-YR	Pre-100Yr	3500.00	5716.00	5725.31	255.62	282.52	10.45	425.60	77.94
Mainstem	15900.73	100-YR	Post-100Yr	3500.00	5716.00	5725.62	262.65	283.44	12.15	374.68	67.81
Mainstem	15900.73	100-YR	Pre-100Yr	3500.00	5716.00	5725.62	262.65	283.44	12.15	374.68	67.81
Mainstem	16067.37	100-YR	Post-100Yr	3500.00	5714.01	5728.03	263.81	307.33	4.56	926.09	104.75
Mainstem	16067.37	100-YR	Pre-100Yr	3500.00	5714.01	5728.03	263.81	307.33	4.56	926.09	104.75
Mainstem	16102.60	100-YR	Post-100Yr	3500.00	5716.00	5728.07	244.44	300.21	5.09	784.26	102.96
Mainstem	16102.60	100-YR	Pre-100Yr	3500.00	5716.00	5728.07	244.44	300.21	5.09	784.26	102.96
Mainstem	16306	100-YR	Post-100Yr	3500.00							
Mainstem	16306	100-YR	Pre-100Yr	3500.00							
Mainstem	16592.57	100-YR	Post-100Yr	3500.00	5722.30	5735.20	349.03	406.53	4.16	977.32	150.51
Mainstem	16592.57	100-YR	Pre-100Yr	3500.00	5722.00	5734.90	349.03	406.53	4.16	977.29	150.51
Mainstem	16674.80	100-YR	Post-100Yr	3500.00	5724.00	5735.38	273.32	365.87	3.39	1148.56	150.37
Mainstem	16674.80	100-YR	Pre-100Yr	3500.00	5724.00	5735.11	273.32	365.87	3.51	1107.00	148.83
Mainstem	17599.37	100-YR	Post-100Yr	3500.00	5730.00	5738.65	210.03	243.86	13.62	287.04	58.73
Mainstem	17599.37	100-YR	Pre-100Yr	3500.00	5730.00	5738.65	210.03	243.86	13.62	287.04	58.73
Mainstem	17950.94	100-YR	Post-100Yr	3500.00	5734.00	5745.74	397.10	433.04	7.04	622.14	106.89
Mainstem	17950.94	100-YR	Pre-100Yr	3500.00	5734.00	5745.74	397.10	433.04	7.04	622.14	106.89
Mainstem	17981.97	100-YR	Post-100Yr	3500.00	5736.00	5745.92	457.45	490.50	8.18	550.71	106.93
Mainstem	17981.97	100-YR	Pre-100Yr	3500.00	5736.00	5745.92	457.45	490.50	8.18	550.71	106.93
Mainstem	18001 BR D	100-YR	Post-100Yr	3500.00	5736.51	5746.05	454.17	490.50	9.08	467.60	107.71
Mainstem	18001 BR D	100-YR	Pre-100Yr	3500.00	5736.51	5746.05	454.17	490.50	9.08	467.60	107.71
Mainstem	18001 BR U	100-YR	Post-100Yr	3500.00	5736.51	5746.43	489.28	557.04	7.68	524.94	123.14
Mainstem	18001 BR U	100-YR	Pre-100Yr	3500.00	5736.51	5746.43	489.28	557.04	7.68	524.94	123.14
Mainstem	18021.40	100-YR	Post-100Yr	3500.00	5737.78	5747.00	496.29	557.04	6.01	688.70	158.22
Mainstem	18021.40	100-YR	Pre-100Yr	3500.00	5737.78	5747.00	496.29	557.04	6.01	688.70	158.22
Mainstem	18066.19	100-YR	Post-100Yr	3500.00	5738.00	5747.56	494.49	594.39	3.46	1201.38	221.18
Mainstem	18066.19	100-YR	Pre-100Yr	3500.00	5738.00	5747.56	494.49	594.39	3.46	1201.38	221.18
Mainstem	18501.80	100-YR	Post-100Yr	3500.00	5743.33	5751.20	371.34	405.35	13.55	291.02	59.20
Mainstem	18501.80	100-YR	Pre-100Yr	3500.00	5743.33	5751.20	371.34	405.35	13.55	291.02	59.20

Right-of-Way Technical Report

For the C-470 Corridor Revised Environmental Assessment

May 2015

Submitted to:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted by:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

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1.0 INTRODUCTION

This Right-of-Way Technical Report examines potential impacts to private property ownership as the result of proposed improvements to Colorado State Highway 470 (C-470) in the southwestern part of the Denver metropolitan area.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in **Figure 1**. In 2013, the Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) initiated a Revised Environmental Assessment (EA) for the 13-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the 2014 Revised EA differs slightly from the Express Lanes (EL) alternative identified in the previous EA that was approved by CDOT and FHWA in 2006.

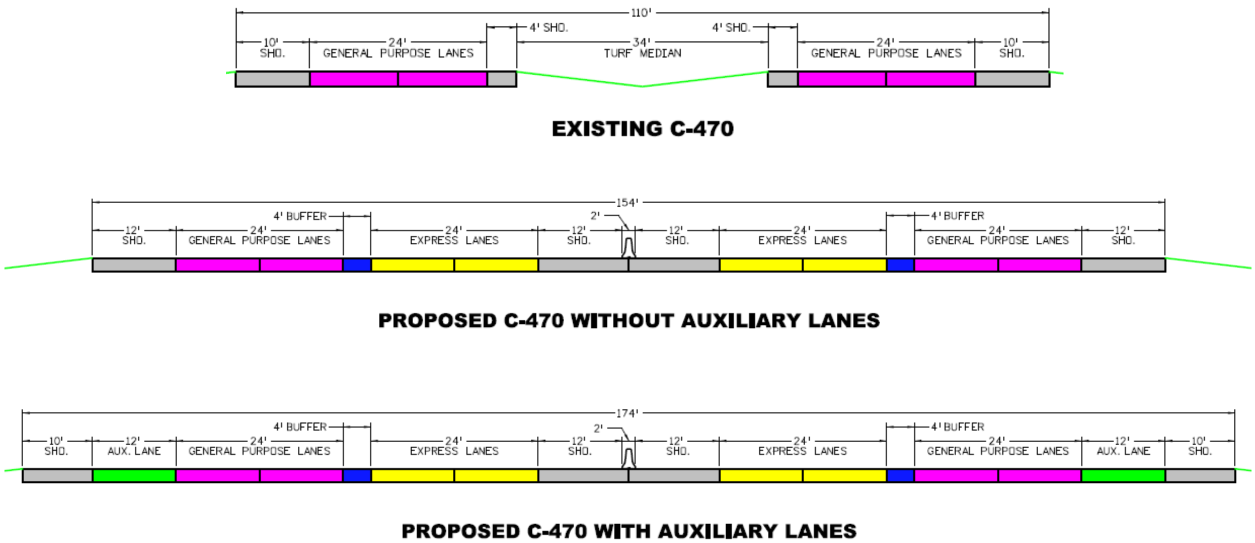
Figure 1
C-470 Corridor and Surrounding Vicinity

1.1 Project Description

The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged, but would receive maintenance as needed to maintain the safety and functionality of the existing four-lane freeway.

The Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications. The existing and proposed typical cross sections are shown below in **Figure 2**.

Figure 2
Existing and Proposed C-470 Typical Cross Sections



1.2 Right-of-Way Approach

The land upon which a highway is constructed, together with any related ramps, medians, shoulders, and adjacent land interests owned for highway-related purposes, is termed “right-of-way.” If additional land is needed by the Colorado Department of Transportation (CDOT) for transportation improvements, the right-of-way is purchased from the affected, abutting property owners.

In some cases where homes or businesses are on the land needed for transportation improvements, the properties must be acquired in their entirety. Where this occurs, the displacement of residents or businesses from the property results in relocation impacts. In most other cases, it is possible to acquire a lesser portion of the property while still leaving the remaining land viable for its existing or planned use.

The right-of-way acquisitions and relocations were analyzed in part by using the guidance of FHWA Technical Advisory Report T6640.8A.

2.0 AFFECTED ENVIRONMENT

2.1 Related Plans and Policies

Electronic right-of-way maps and parcel information was gathered from Arapahoe County, Douglas County, and Jefferson County, beginning in the summer of 2013 and concluding in the fall of 2014. The project team joined these three right-of-way files together, overlaid the file onto the C-470 project area, and rectified the assessor based ownership mapping with recorded CDOT and local agency right of way plans. The resulting map defined the existing ownership map for the alternatives.

2.2 Description of Existing Conditions

Built over twenty years ago, C-470 is located in the southwestern quadrant of the Denver metropolitan region, having portions in Jefferson County, Douglas County, and Arapahoe County. The highway traverses from Kipling Parkway to I-25, providing a major east-west facility for users in the area. For much of the corridor, the existing C-470 right-of-way is 300 feet wide. Typically, this width is adequate for freeway lanes, medians, paved shoulders, and landscaping areas. Near interchanges, where additional lanes are located for on and off ramps, the C-470 right-of-way is sufficient to accommodate existing ramps, but this right-of-way would not be adequate in all cases where a different geometric configuration is proposed.

Land use along the C-470 Corridor is mostly made up of a mix of residential, commercial, and undeveloped open land. Chatfield State Park, as well as other local parks, is located at the western end of the Corridor, mixed with dense residential populations. The middle stretch is where most of the residential units are located, spotted with several commercial units throughout. At the eastern end of the Corridor, commercial property is located on both sides of the highway, with residential property extending behind the commercial units to the north and to the south.

Approximately 124 acres of the defined project area lie upon the United States Army Corps of Engineers (USACE) property. The USACE allows CDOT the use of this land under the terms of an easement, which is also approximately 300 feet wide. The USACE first created this easement in 1971, incorporating a total of 315 acres. The easement language has been modified only twice in the past 34 years to make minor corrections for clarity.

Recent developments have been active adjacent to the corridor, and the existing ownership mapping is current as of March 2015. Additional build-out of Highlands Ranch is expected further off the C-470 Corridor Environmental Assessment Right-of-Way and Relocations Corridor, but will not impact the right-of-way assessment for the Proposed Action.

3.0 ENVIRONMENTAL CONSEQUENCES

3.1 Methodology for Impact Evaluation

Relevant data was collected for the C-470 Corridor including aerial photographs, county parcel maps, CDOT right of way maps, local entity surveys, and railroad right of way maps.

Next, a field inspection was performed, noting the lay out of the land and specific geographical features for all locations along the Corridor. The number of parcels and approximate acreage of impact was determined. These totals were broken down by land use types, including residential and commercial. The types of roadway improvements to occur at each of these locations were noted.

3.2 ROW Impacts of the No-Action Alternative

The No Action Alternative would require no additional right-of-way or relocations within the study area for the C-470 Corridor.

3.3 ROW Impacts of the Proposed Action

The Proposed Action would have right-of-way impacts affecting 38 adjacent land parcels, as indicated in **Table 1**. CDOT would acquire six parcels totaling 3.48 acres as new right-of-way, including two total acquisitions and four partial acquisitions. These are the only two total acquisitions needed, and since both are vacant parcels, no business or residential relocations would be needed.

The Proposed Action would result in acquisition of permanent easements from 13 other parcels. These easements total 31.46 acres, and would affect between two percent and 19 percent of the area of the respective parcels. The majority of permanent easements are due to water quality cooperation with local agencies, as the local agencies are allowing CDOT to drain the highway right-of-way to the existing ponds. In return, CDOT will modify the ponds to provide water quality treatment that will benefit both CDOT and the local agency.

The most common right-of-way impact under the Proposed Action would be temporary easements affecting a very small portion (e.g., one to five percent) of an affected parcel. An estimated 19 temporary easements totaling 8.1 acres would be needed.

Temporary easements are acquired where access is needed to an owner's property only during construction, sometimes for utility relocation or water quality purposes. If any property is altered within a temporary easement during construction, CDOT restores the property condition or (more typically) compensates the owner for the damage. Typically, permanent physical modifications such as grade changes are not allowed within temporary easement areas.

Between Wadsworth Boulevard and Santa Fe Drive, all Proposed Action work has been designed to stay within the existing USACE easement. However, all roadway changes within the easement will require USACE approval, especially the replacement of the C-470 bridges over the South Platte River.

4.0 MITIGATION

Right-of-way acquisition will comply with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended, and the Uniform Relocation Act Amendments of 1987 (Public Law 100-17), which contain specific requirements that govern the manner in which a government entity acquires private property for public use. The purpose of this act is to provide a uniform policy for fair and equitable treatment of persons and businesses displaced as a result of federal and federally assisted programs. The law is designed to ensure just compensation for all acquired properties and to minimize impacts on current owners and tenants.

Although no relocations are anticipated for this project, CDOT will continue to advise persons of the acquisition process throughout project development relative to the impact on their residence or business location. Right-of-way information will be available, along with experienced personnel to meet with impacted property owners and tenants, and explain the program throughout the project development process.

Pamphlets and brochures describing the acquisition program are available at all C-470 Corridor public meetings, or by calling CDOT. Meetings and discussions with owners and tenants can be scheduled at any time either as a small group or individually.

Continuous communication with the impacted property owners and their tenants will be necessary to keep them advised of project funding and schedules. Adequate lead time for the right-of-way acquisition process will need to be planned and programmed into the project schedule. CDOT is committed to ensuring adequate time is available to accomplish the steps necessary to negotiate the purchase of the required property rights needed to build the project.

5.0 SUMMARY

The conclusions of this report were based on a thorough analysis of the most current right-of-way information available. Impact lines were continuously refined to minimize right-of-way impacts to the greatest extent possible, and will be refined further throughout final design. The figures given in this report are subject to change during the final design stage.

No structures will be impacted by the right-of-way acquisitions, but there will be minor effects to landscaping around commercial buildings. Continuous communication with affected parcel owners will be maintained to ensure a proactive process for right-of-way acquisition.

Figure 1
Location of Right-of-Way Impacts

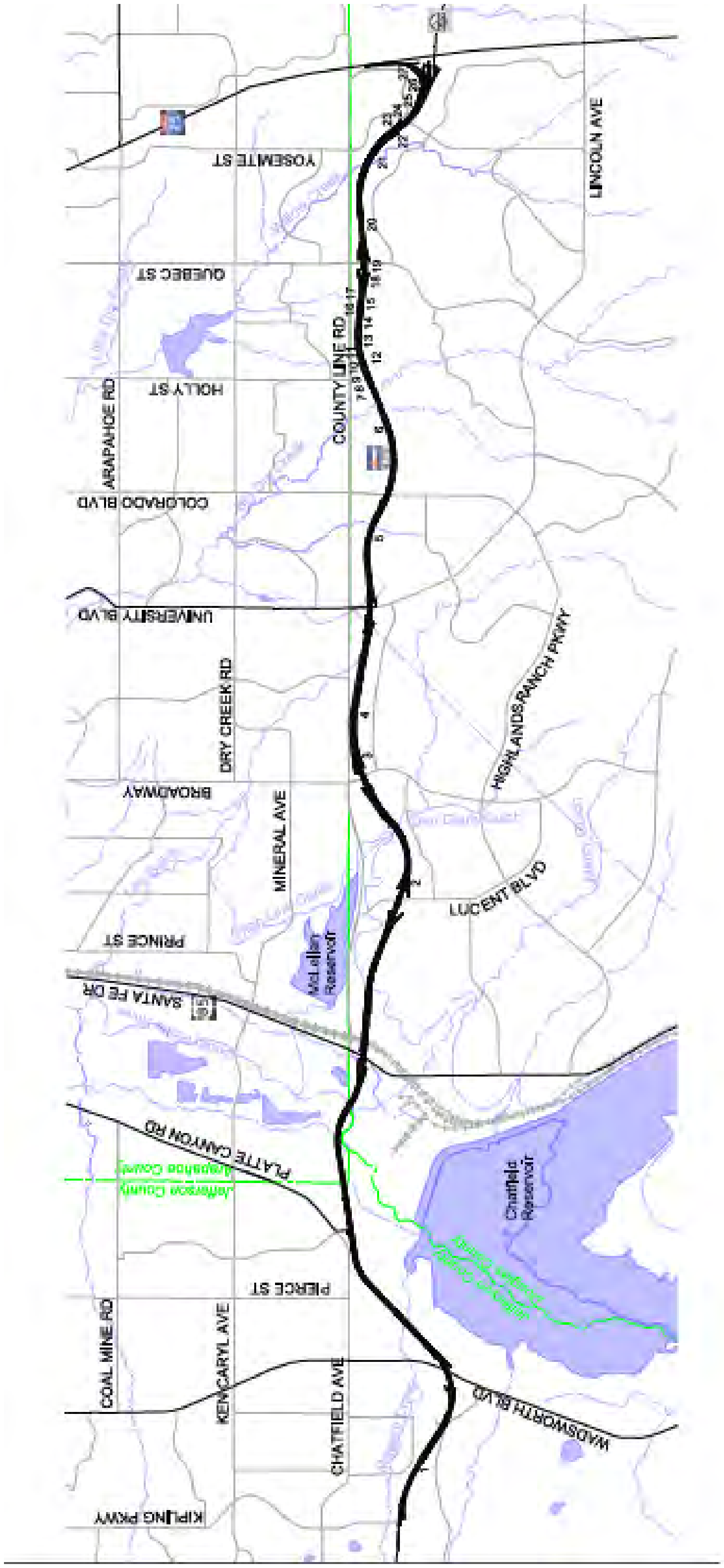


Table 1
Right-of-Way Impacts of the Proposed Action
(listed from west to east across the project area)

ROW Exhibit #	Current Land Use	Size of Total Parcel (acres)	Size of Parcel Impact (acres)			% of Parcel	For Water Qual.
			Acquisition	Easement			
				Permanent	Temporary		
1	vacant	18.05	0.74			4%	0.74
2	vacant	1.33		1.33		100%	1.33
3	vacant	13.96		12.88		92%	12.88
4	vacant	7.77		7.77		100%	7.77
5	commercial	13.48		0.76		6%	
6	vacant	3.47		3.47		100%	3.47
7	vacant	2.90		0.24		10%	
8	vacant	18.32			5.88	32%	5.88
9	vacant (2 easements)	3.26		1.31/0.91		69%	
10	vacant	26.51		1.06		2%	
11	vacant (2)	13.82			0.27/7.71	58%	
14	park land**	3.31			0.18	7%	
16	commercial	0.55			0.03	3%	
17	commercial	1.73			0.05	4%	
18	commercial	1.90			0.08	3%	
19	commercial	1.40			0.04	1%	
20	apartments	36.15			0.39		
21	soccer field**	1.95			0.12	6%	
22	vacant	1.51	0.08			5%	
23	vacant	1.64	0.09			5%	
24	commercial	4.09			0.03	1%	
25	commercial	3.63			0.05	1%	
27	commercial	2.96			0.08	3%	
28	commercial	2.48			0.02	1%	
29	commercial	14.78		0.10		1%	
31	vacant (2)	8.89		1.48	0.18	19%	
32	vacant	9.58	0.04			<1%	
33	C-470 ramp	2.18	2.18			100%	
34	C-470 ramp	0.35	0.35			100%	
35	commercial	1.51		0.11		7%	
36	detention pond	3.00			0.13	4%	
37	vacant (2)	0.86			0.03/0.07	12%	
38	commercial	12.54			0.07	1%	
39	commercial	14.20			0.01	<1%	
41	commercial	12.03		0.13		1%	
TOTAL ACRES			**3.48**	**31.46**	**6.33**		**30.56**
NUMBER OF PARCELS			**6**	**13**	**19**		

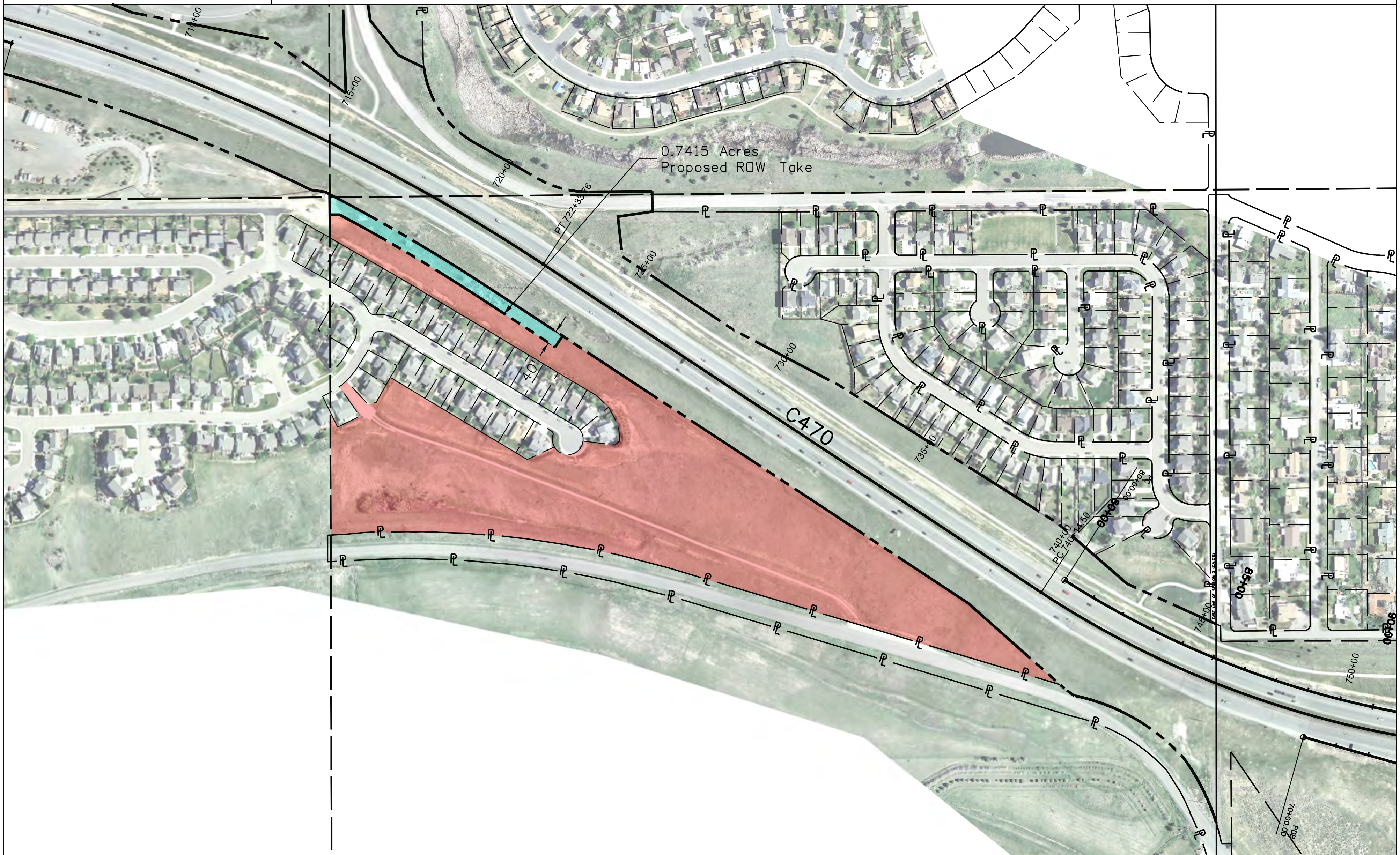
** Shaded rows indicate parcels owned by governmental or quasi-governmental entities.*
*** The parcel #13 "soccer field" temporary easement is vacant land located away from the soccer field and also not used for any recreational purpose. All impacts to commercial properties affect unused land adjacent to C-470 ROW, not developed portions of those parcels.*

ATTACHMENT:

SHEETS DEPICTING INDIVIDUAL RIGHT-OF-WAY IMPACTS

ROW Exhibit 1

Plat #: 69-034-00-001 Owner: Land Securities Investors LTD
Plat Size: 18.0851 Acres Proposed ROW Take Area: 0.7415 Acres

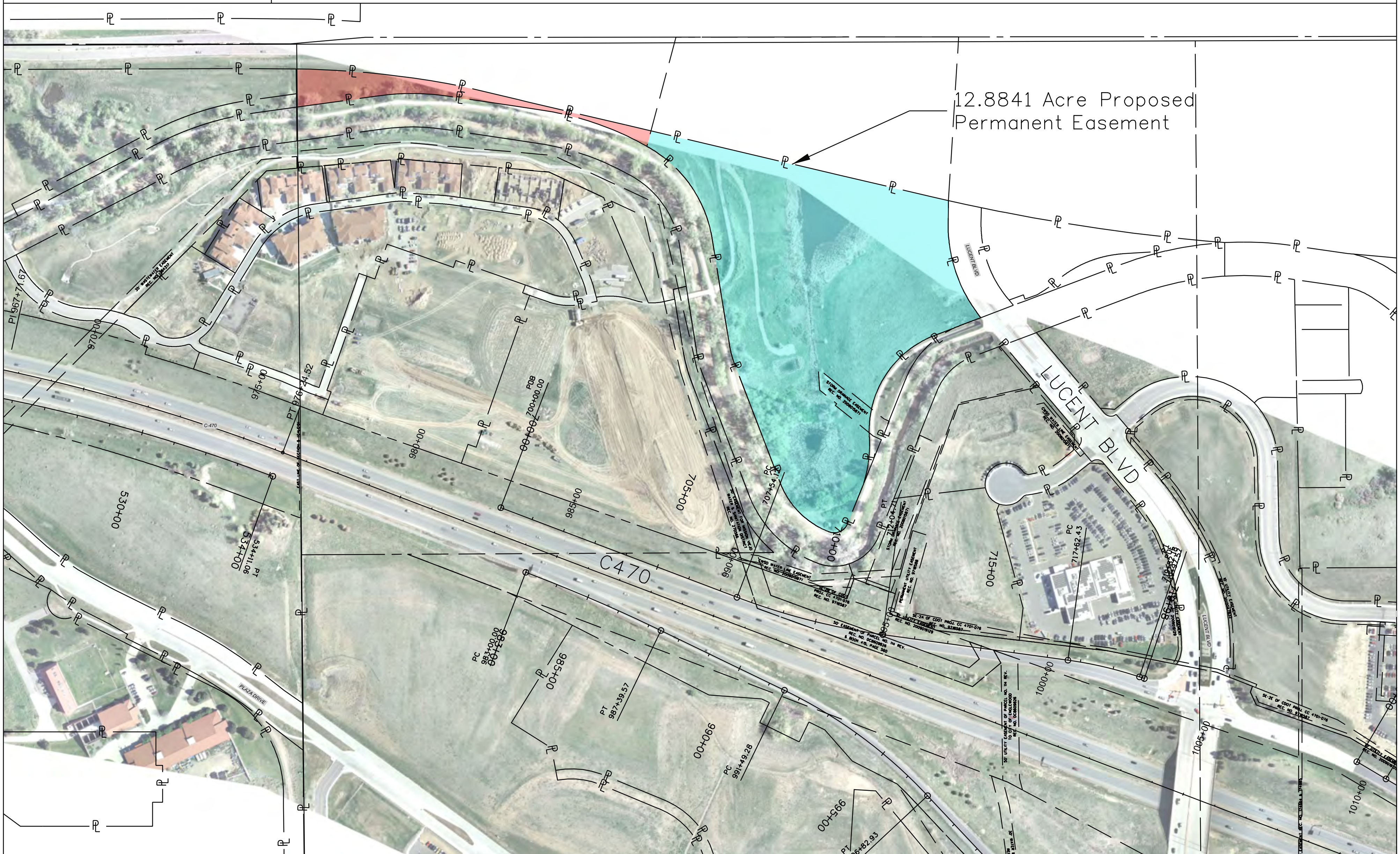


Legend
- Proposed Permanent Easement
- Existing ROW
- Proposed Temporary Easement
- Existing Property Line
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 200' 400' 800'

ROW Exhibit 3

Plat #: 222904000035 Owner: Englewood McLellan Reservoir Foundation
Plat Size: 13.9555 Acres Proposed Easement Area: 12.8841 Acres



Legend	Proposed Permanent Easement		Proposed ROW/Easement Area
	Existing ROW	Proposed Temporary Easement	Affected Plat
	Existing Property Line	Proposed ROW	

N

0' 200' 400' 800'

ROW Exhibit 4

Plat #: XXXXXXXXXXXXX Owner:

Plat Size: 7.7695 Acres Proposed Easement Area: 7.7695 Acres

Legend

Proposed Permanent Easement	Proposed ROW/Easement Area		
Existing ROW	Proposed Temporary Easement	Affected Plat	
Existing Property Line	Proposed ROW		

0' 200' 400' 800'

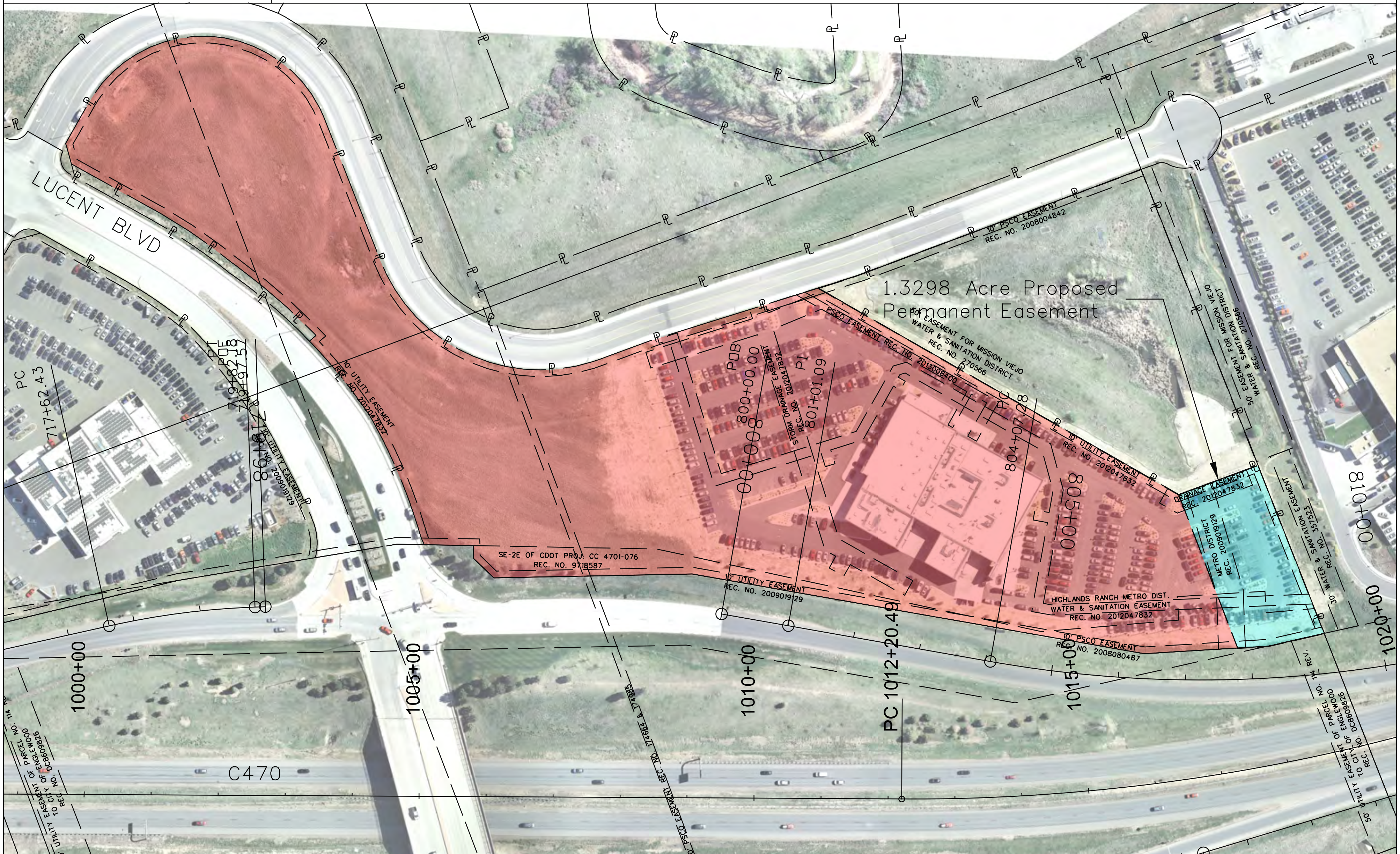
ROW Exhibit 5

Plat #: 222904104006

Plat Size: 13.4811 Acres

Owner: Englewood McLellan Reservoir Foundation

Proposed Easement Area: 0.7596 Acres



Legend

Proposed Permanent Easement

Existing ROW

Existing Property Line

Proposed Temporary Easement

Proposed ROW

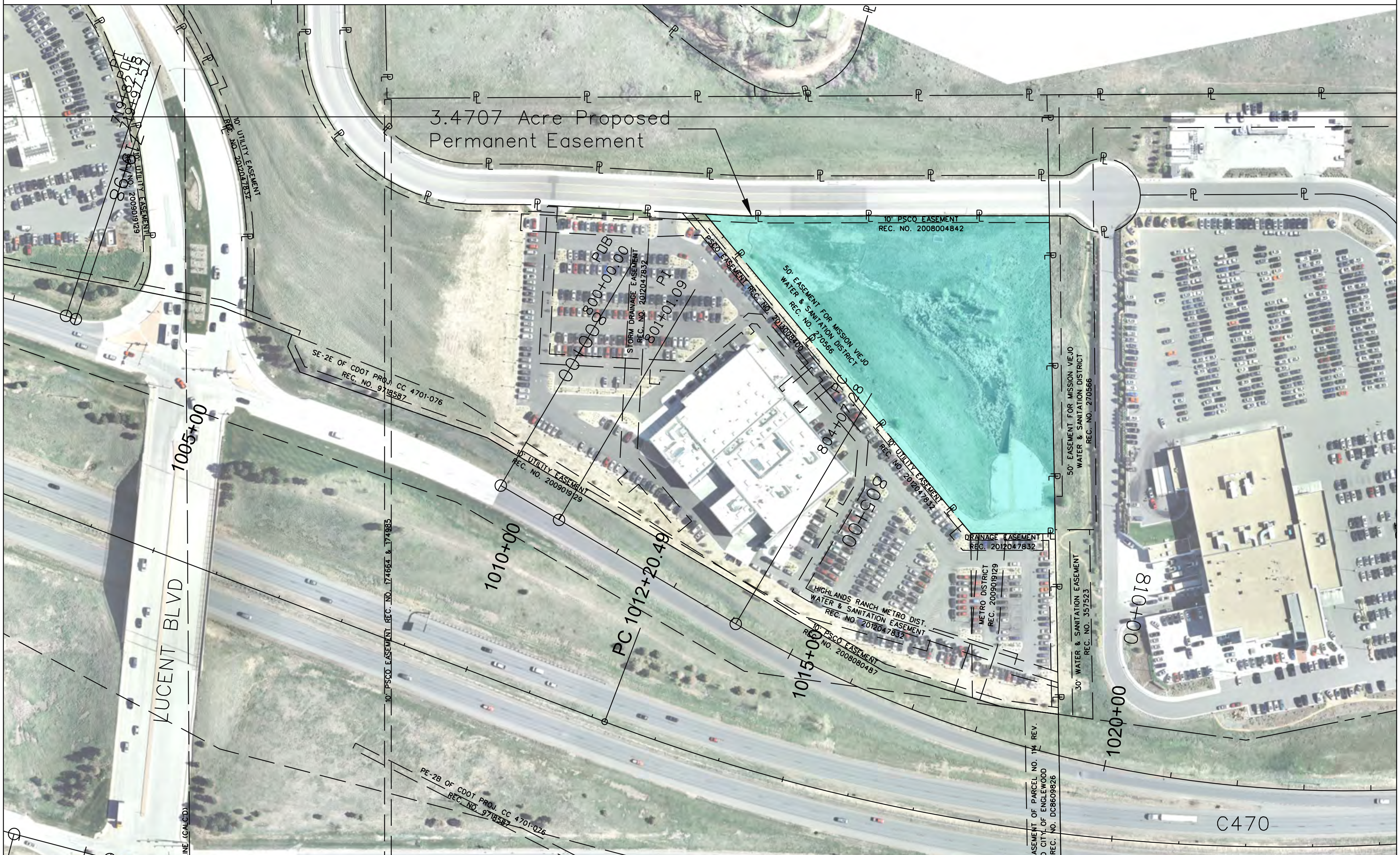
Proposed ROW/Easement Area

Affected Plat

0' 100' 200' 400'

ROW Exhibit 6

Plat #: 222904104007 Owner: Englewood McLellan Reservoir Foundation
Plat Size: 3.4707 Acres Proposed Easement Area: 3.4707 Acres



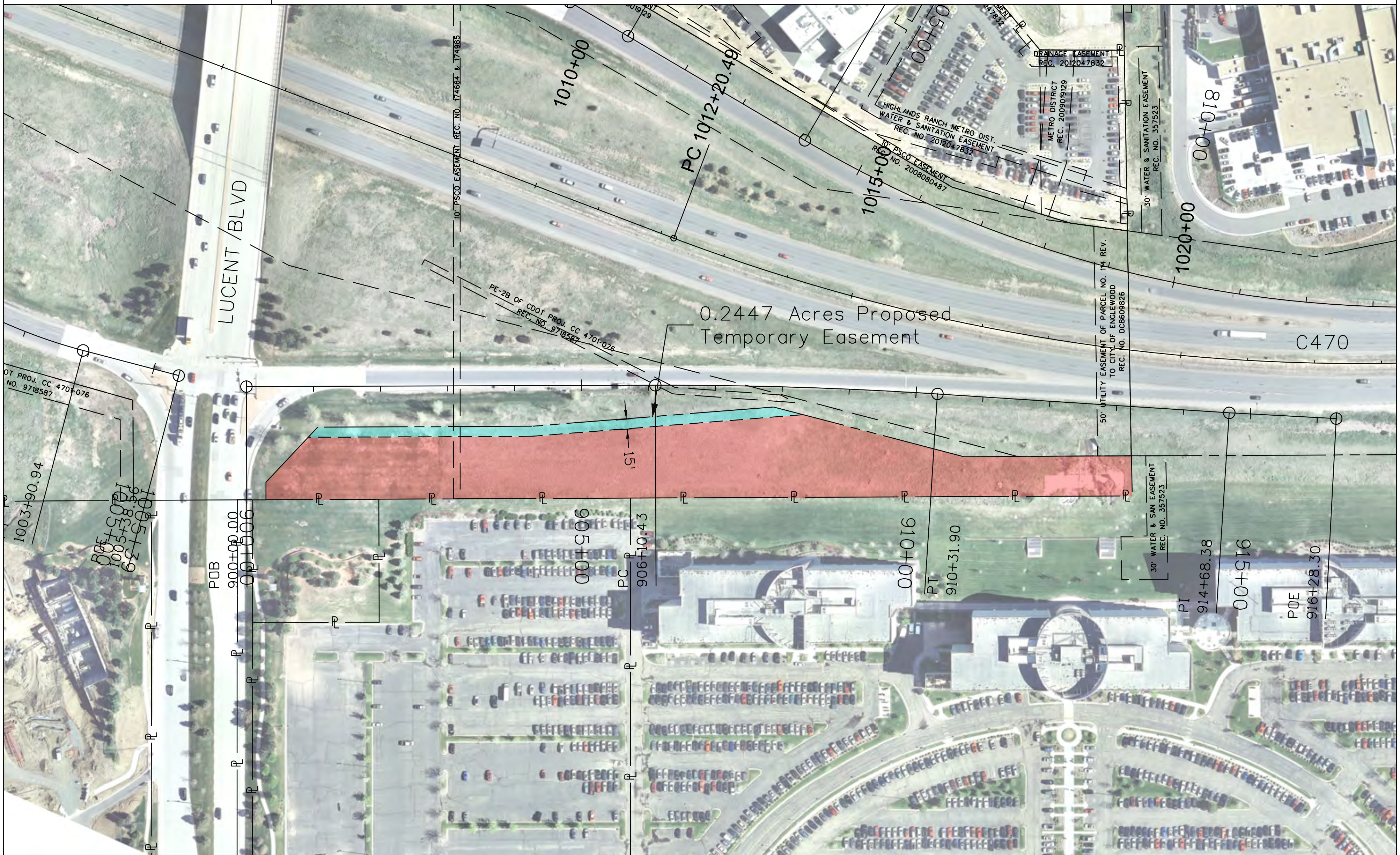
Legend
Proposed Permanent Easement
Proposed ROW/Easement Area
Existing ROW
Proposed Temporary Easement
Affected Plat
Existing Property Line
Proposed ROW

N

0' 100' 200' 400'

ROW Exhibit 7

Plat #: 222904000026 Owner: Englewood McLellan Reservoir Foundation
Plat Size: 2.8973 Acres Proposed Easement Area: 0.2447 Acres



Legend

Proposed Permanent Easement
Proposed ROW/Easement Area
Existing ROW
Proposed Temporary Easement
Affected Plat
Existing Property Line
Proposed ROW

0' 50' 100' 200'

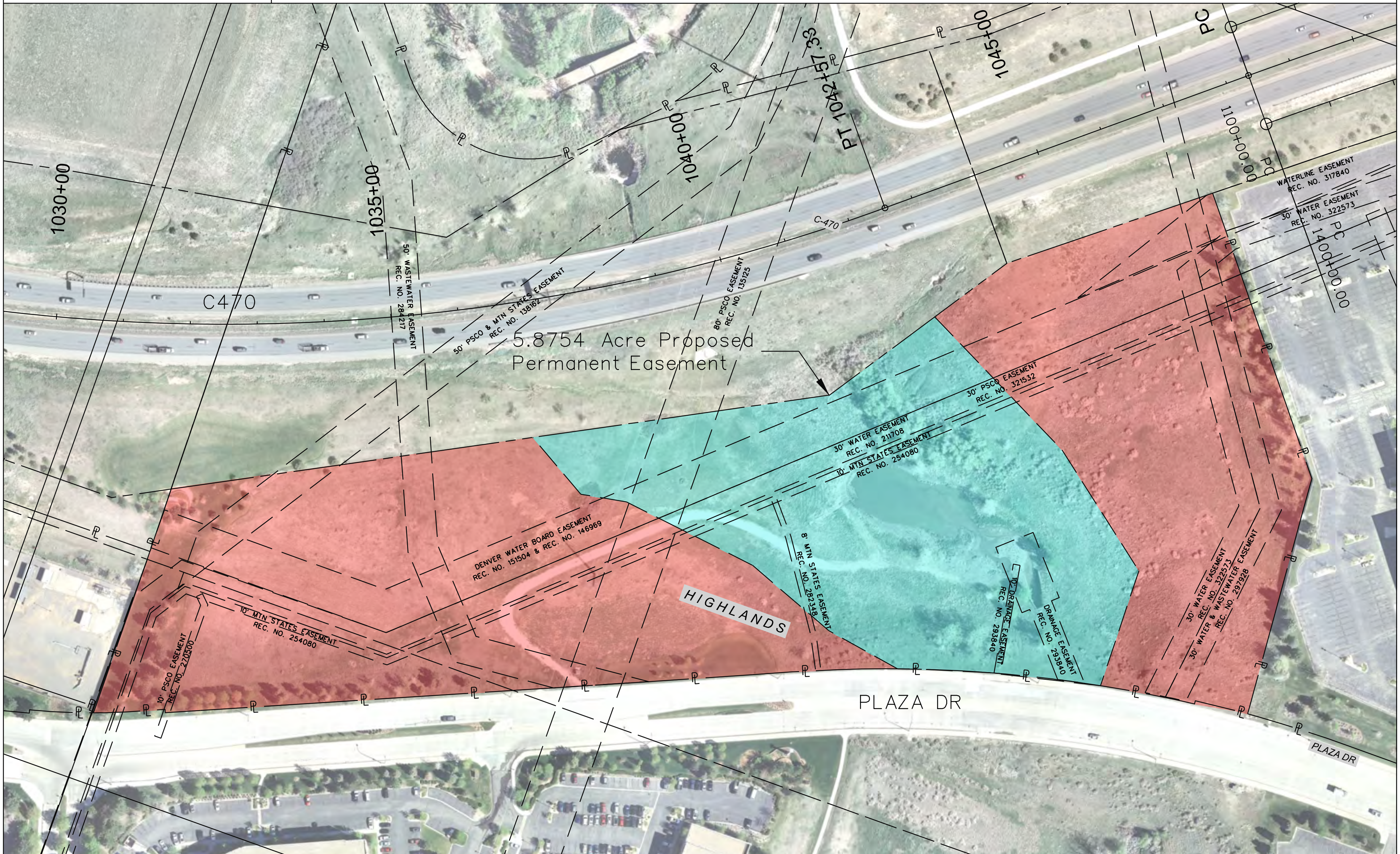
ROW Exhibit 8

Plat #: 222903207005

Plat Size: 18.3223 Acres

Owner: Highlands Ranch Metro District

Proposed Easement Area: 5.8754 Acres



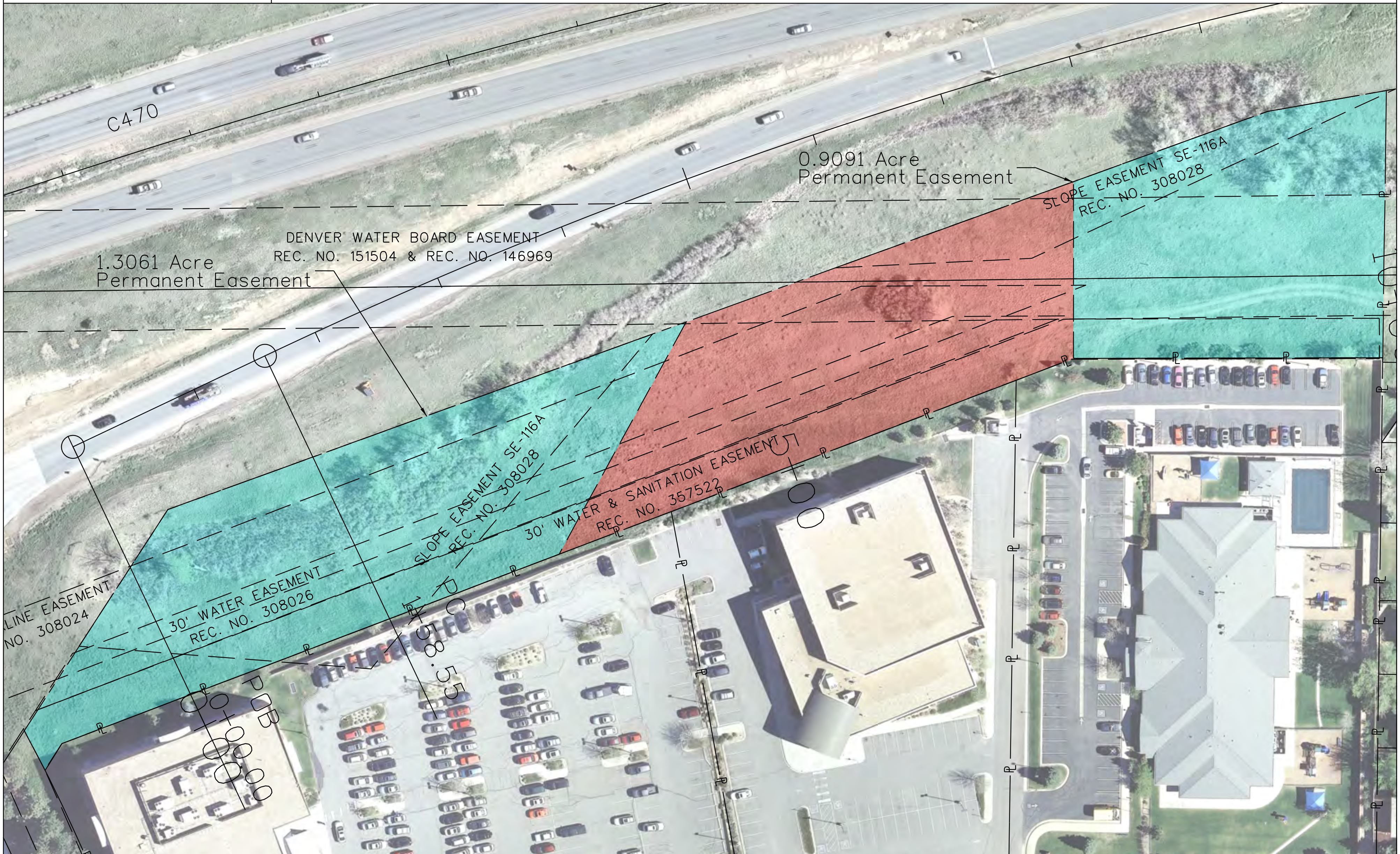
Legend

Proposed Permanent Easement	Proposed ROW/Easement Area
Existing ROW	Proposed Temporary Easement
Affected Plat	Existing Property Line
Proposed ROW	

0' 100' 200' 400'

ROW Exhibit 9

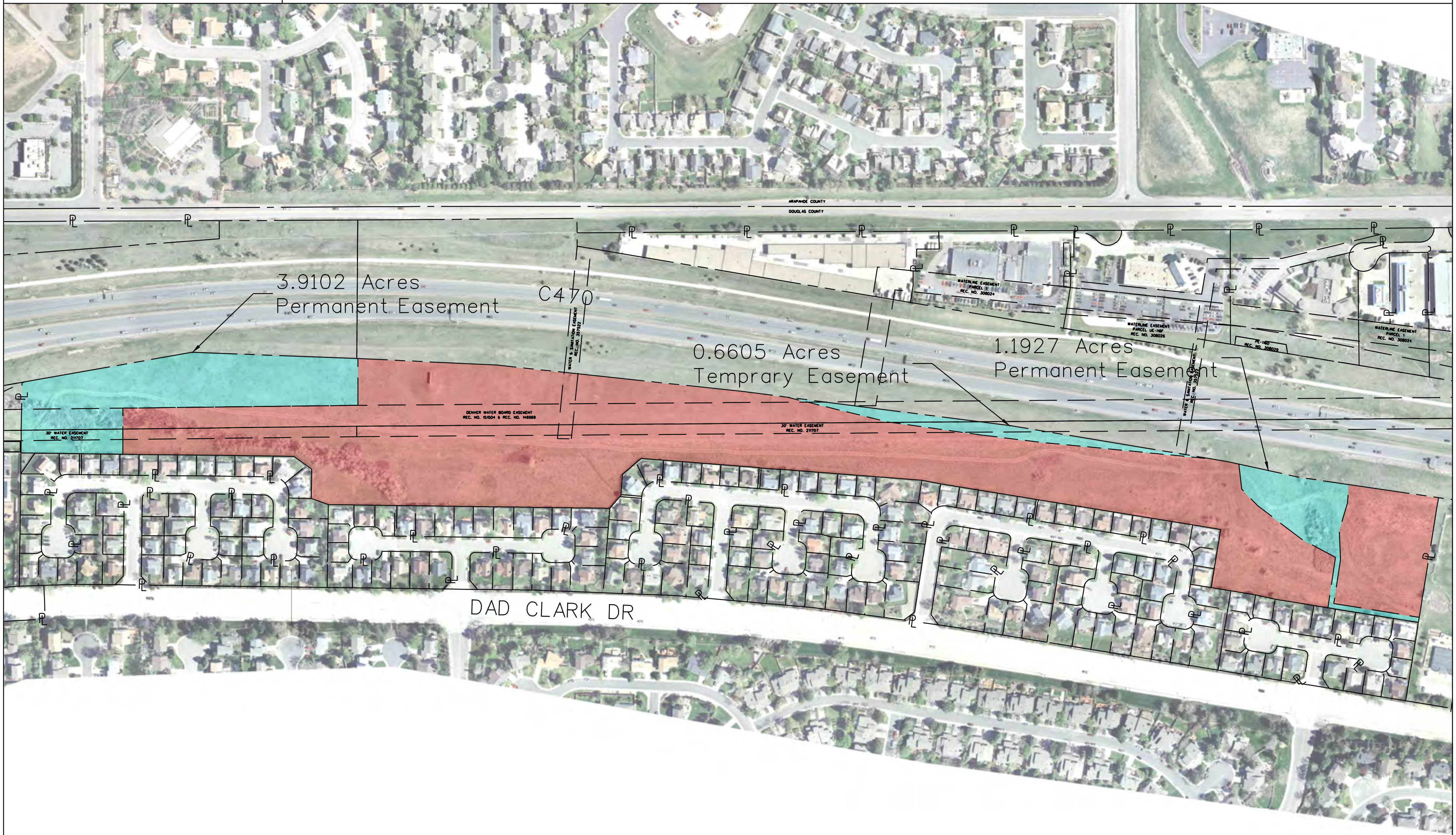
Plat #: 222903113060 Owner: Highlands Ranch Metro District
Plat Size: 3.2579 Acres Proposed Easement Area: 2.2152 Acres



Legend
Proposed Permanent Easement
Proposed ROW/Easement Area
Existing ROW
Proposed Temporary Easement
Affected Plat
Existing Property Line
Proposed ROW

0' 50' 100' 200'

ROW Exhibit 10	Plat #: 222902221138 Plat Size: 26.5099 Acres	Owner: Highlands Ranch Metro District Proposed Easement Area: 5.7634 Acres



Legend

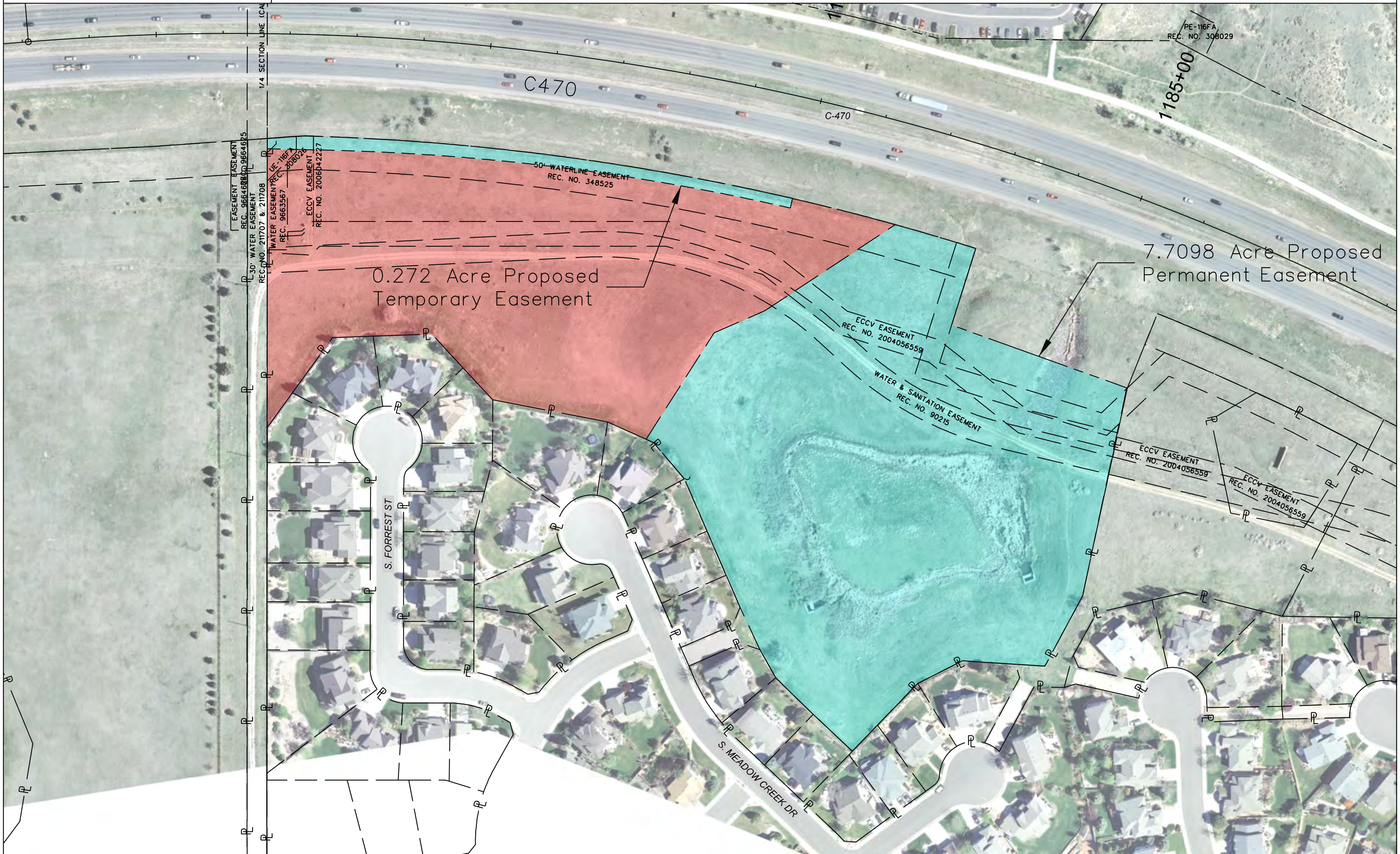
— — — —	Proposed Permanent Easement	(cyan)	Proposed ROW/Easement Area
—— – – ——	Existing ROW	(red)	Affected Plat
– – – – – – –	Proposed Temporary Easement		
—— ℗ ——	Existing Property Line		
—— – – – ——	Proposed ROW		

N

0' 200' 400' 800'

ROW Exhibit 11

Plat #: 222901111126 Owner: Highlands Ranch Metro District
Plat Size: 13.8121 Acres Proposed Easement Area: 7.9818 Acres



Legend

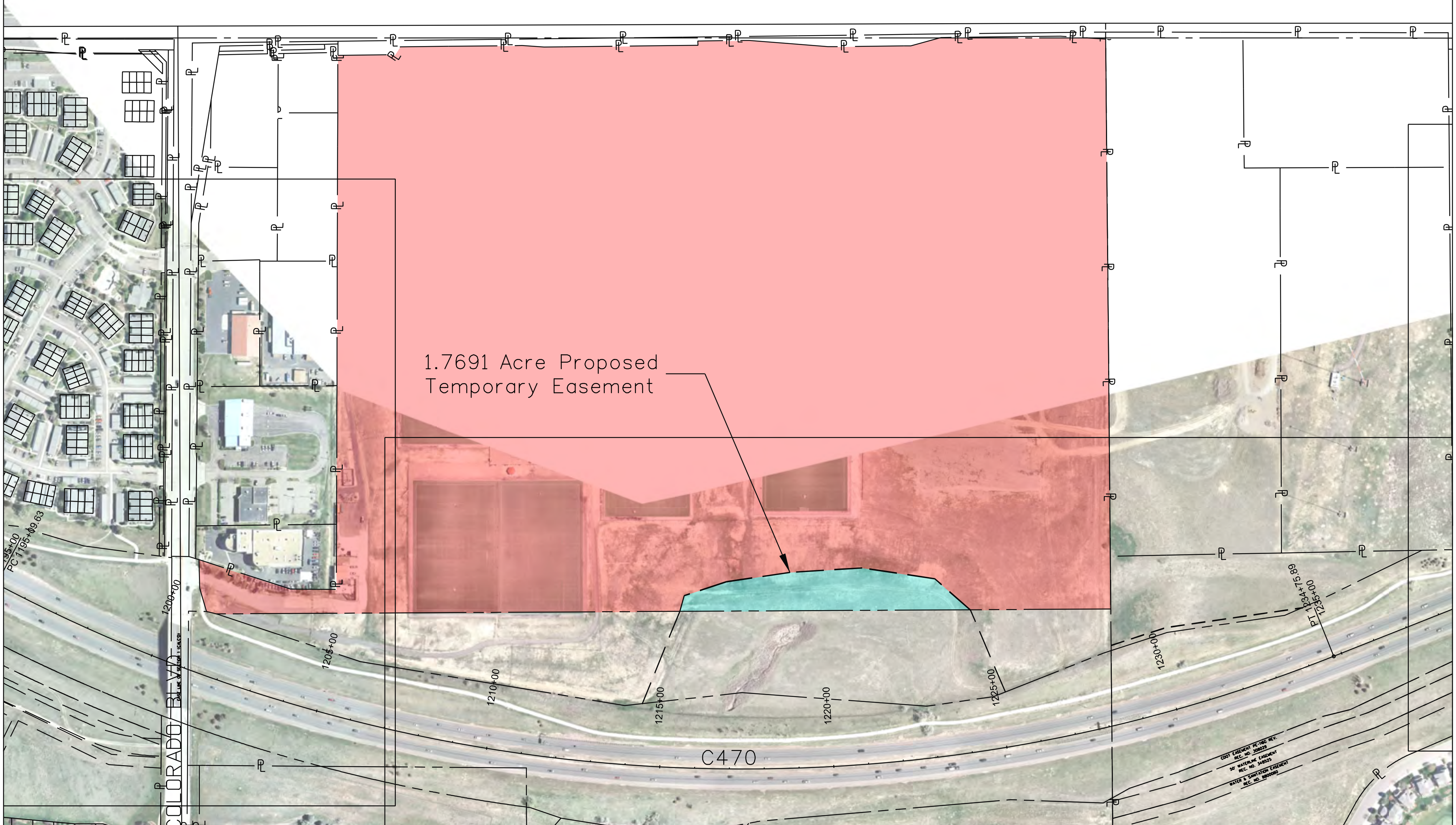
Proposed Permanent Easement	Proposed ROW/Easement Area	Existing ROW	Proposed Temporary Easement
Affected Plat	Existing Property Line	Proposed ROW	

0' 50' 100' 200'

ROW Exhibit 12

Plat #: 223106200008
Plat Size: 83.6175 Acres

Owner: Colorado Disposal Inc.
Proposed Easement Area: 1.7691 Acres



Legend

Proposed Permanent Easement

Proposed ROW/Easement Area

Existing ROW

Proposed Temporary Easement

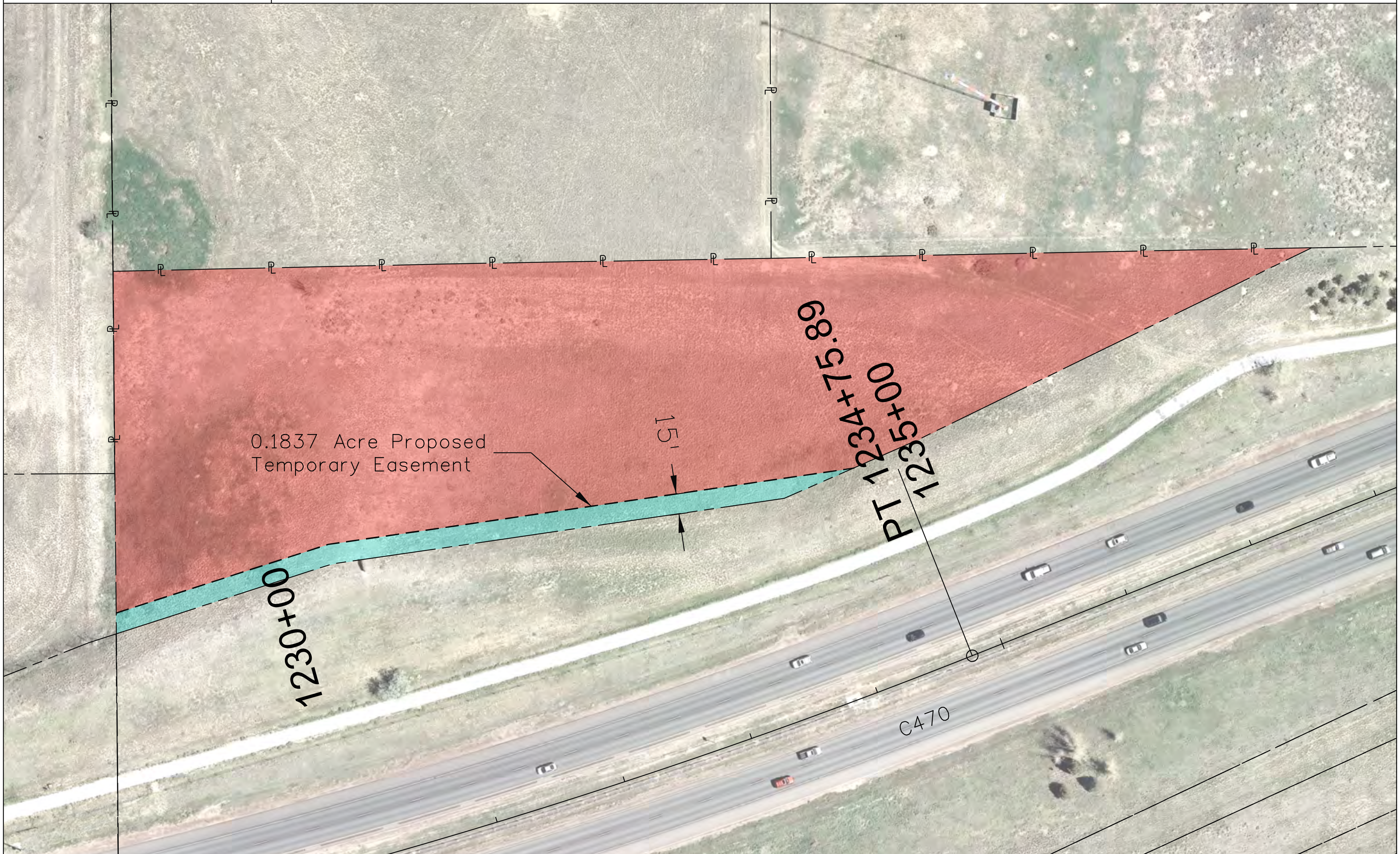
Affected Plat

Existing Property Line

Proposed ROW

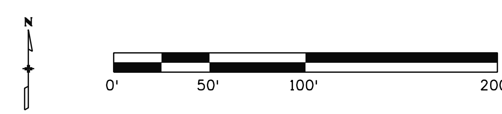
0' 200' 400' 800'

ROW Exhibit 14	Plat #: 223106100002 Plat Size: 3.3084 Acres	Owner: South Suburban Park and Recreation District Proposed Easement Area: 0.1837 Acres

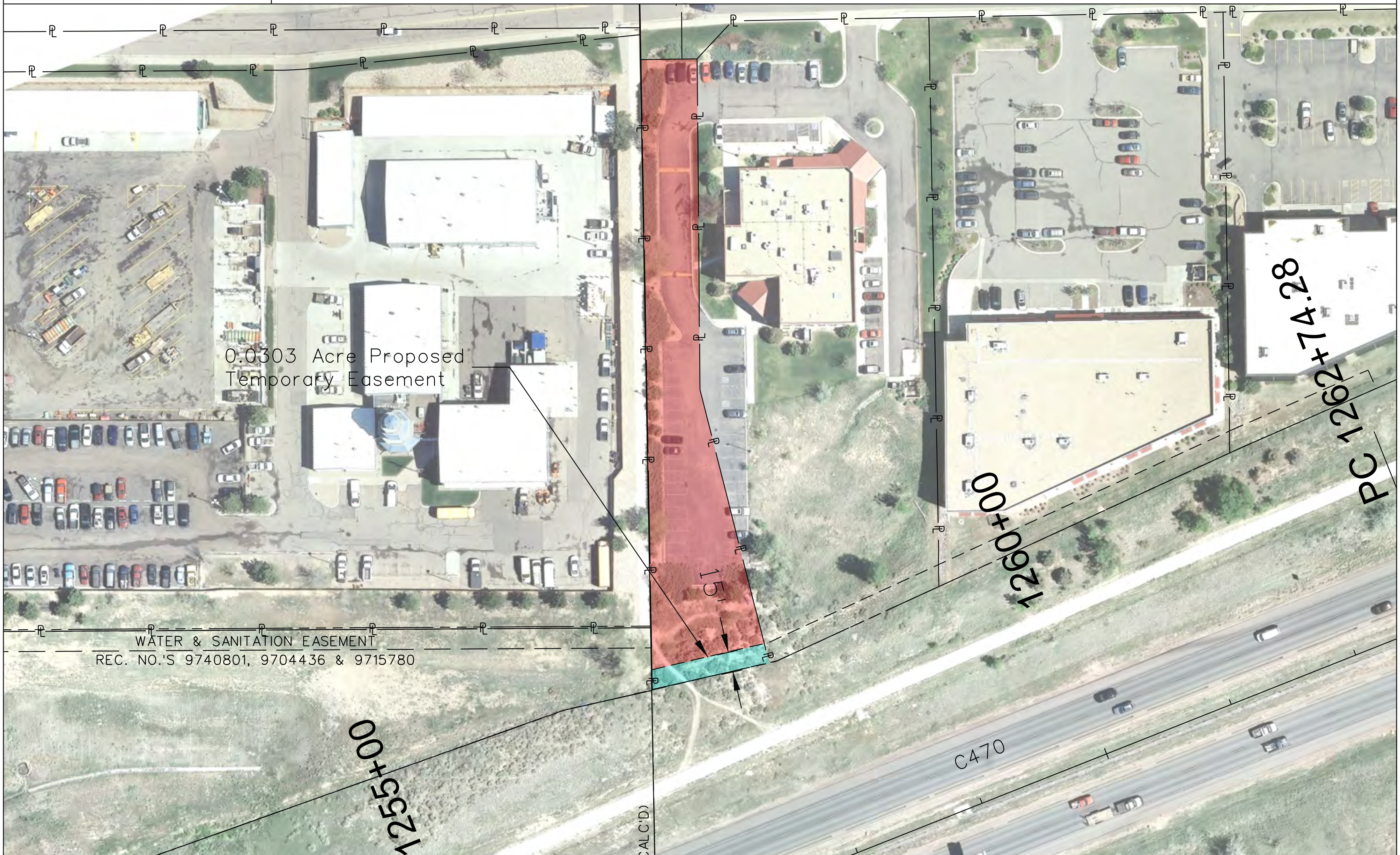


Legend

- Proposed Permanent Easement
- Existing ROW
- Existing Property Line
- Proposed Temporary Easement
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat



ROW Exhibit 16	Plat #: 223105201016 Plat Size: 0.5532 Acres	Owner: Bellview Animal Hospital LLC Proposed Easement Area: 0.0303 Acres



Legend

- Proposed Permanent Easement
- Existing ROW
- Existing Property Line
- Proposed Temporary Easement
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

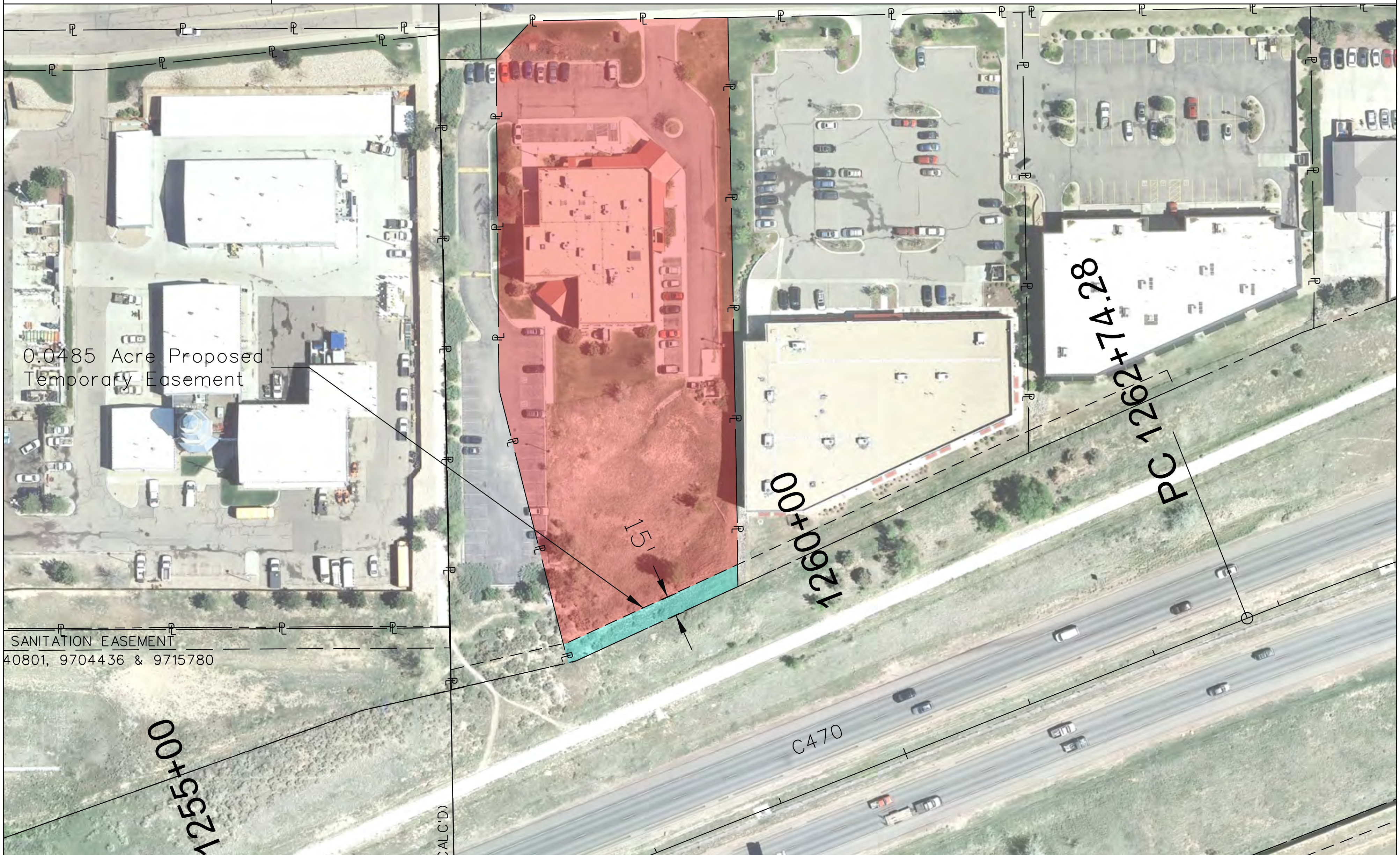
N

0' 50' 100' 200'

ROW Exhibit 17

Plat #: 223105201015
Plat Size: 1.7284 Acres

Owner: Bellview Animal Hospital LLC
Proposed Easement Area: 0.0485 Acres

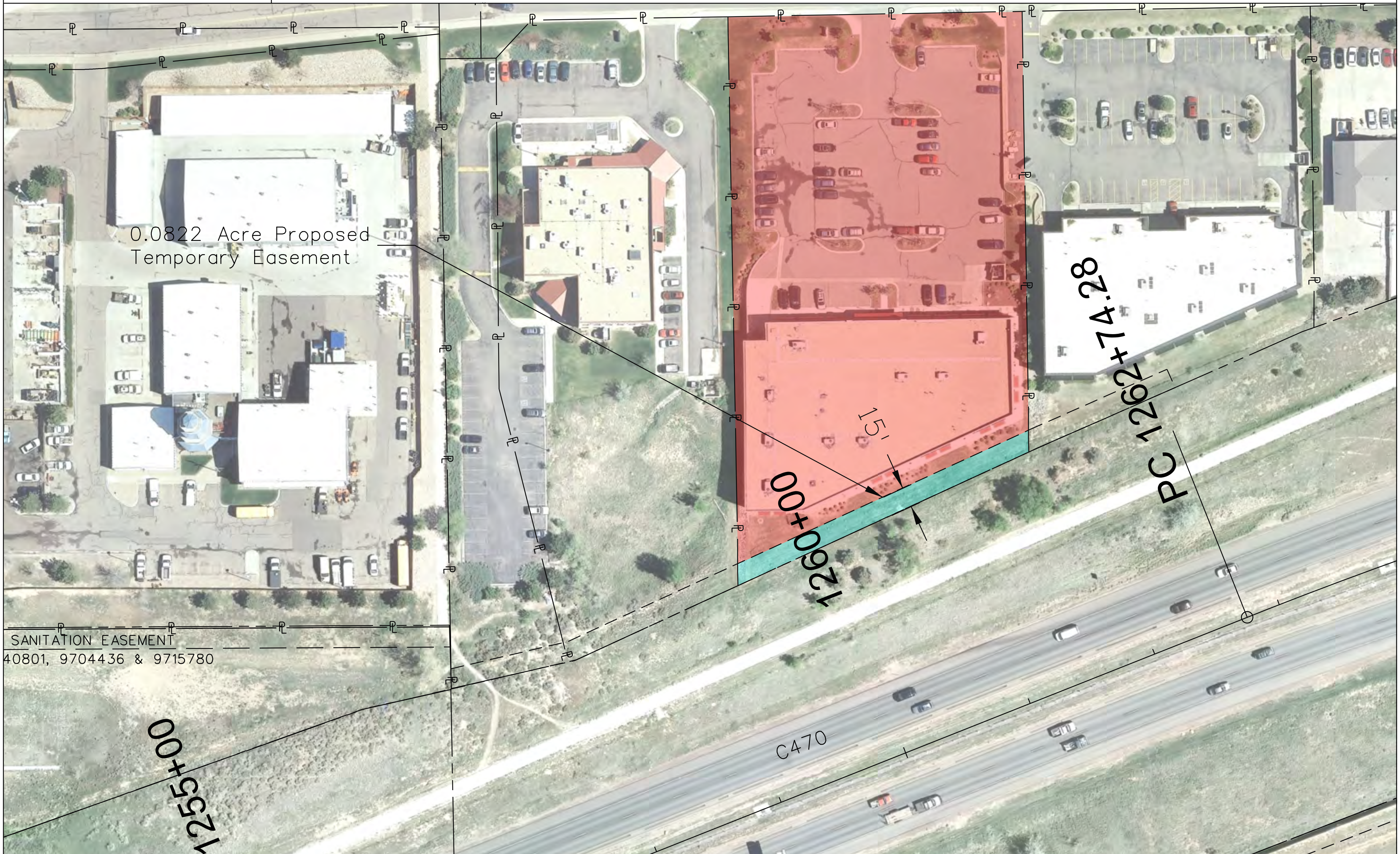


Legend

— — — —	Proposed Permanent Easement	(cyan)	Proposed ROW/Easement Area
—— — — ——	Existing ROW	— — — — — —	Proposed Temporary Easement
(red)	Affected Plat	—— P ——	Existing Property Line
——— — — — ———	Proposed ROW		

ROW Exhibit 18

Plat #: 223105201014 Owner: G & D LLC
Plat Size: 1.8958 Acres Proposed Easement Area: 0.0822 Acres



Legend

Proposed Permanent Easement
Proposed ROW/Easement Area
Existing ROW
Proposed Temporary Easement
Affected Plat
Existing Property Line
Proposed ROW

0' 50' 100' 200'

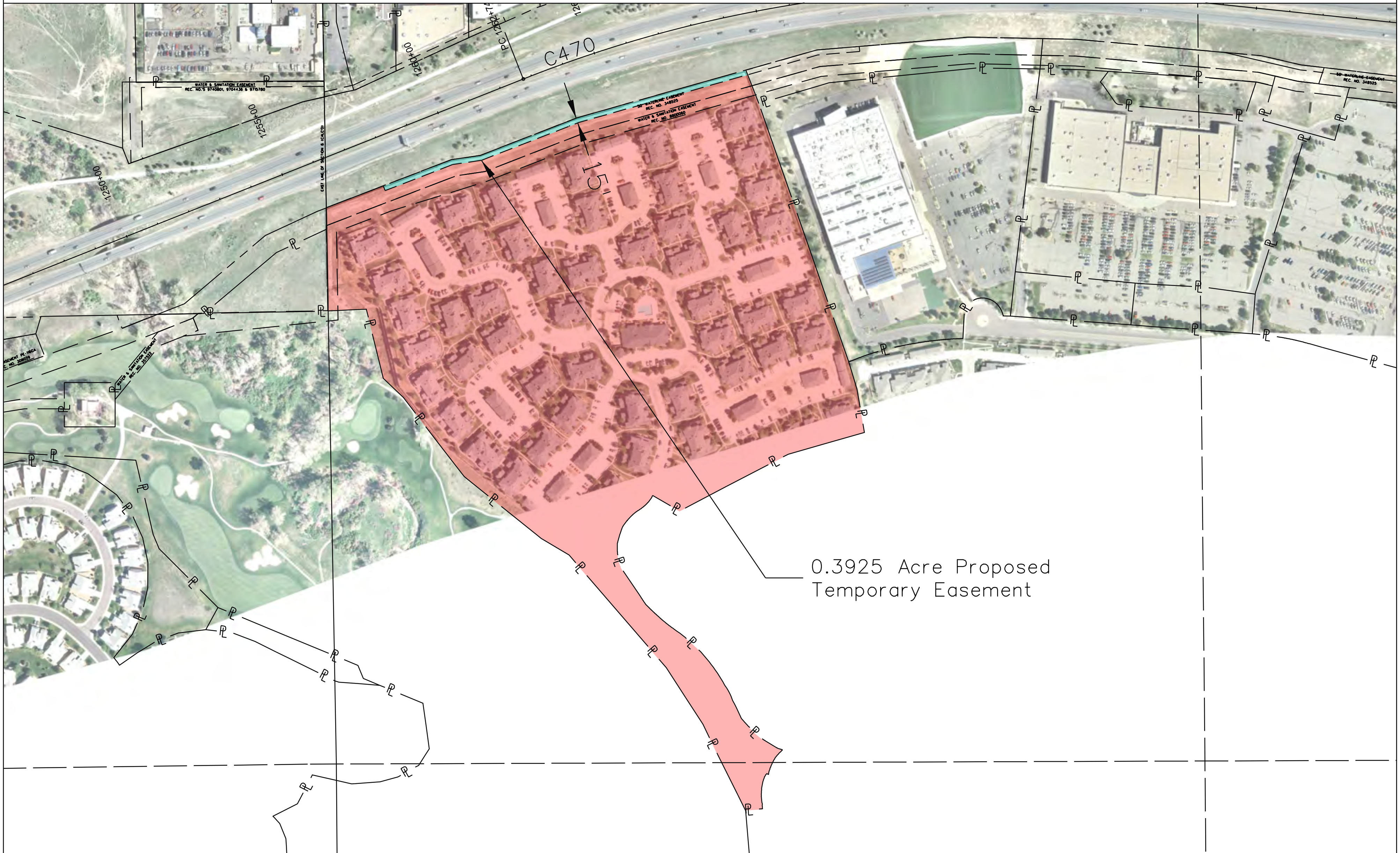
ROW Exhibit 19	Plat #: 223105201013 Plat Size: 1.4006 Acres	Owner: Lommen and Maloney LLC Proposed Easement Area: 0.0400 Acres

Legend
Proposed Permanent Easement
Proposed ROW/Easement Area
Existing ROW
Proposed Temporary Easement
Affected Plat
Existing Property Line
Proposed ROW

N
0' 50' 100' 200'

ROW Exhibit 20

Plat #: 223105204014 Owner: T C Palomino Green River LLC
Plat Size: 36.1494 Acres Proposed Easement Area: 0.3925 Acres



Legend

Proposed Permanent Easement

Proposed ROW/Easement Area

Existing ROW

Proposed Temporary Easement

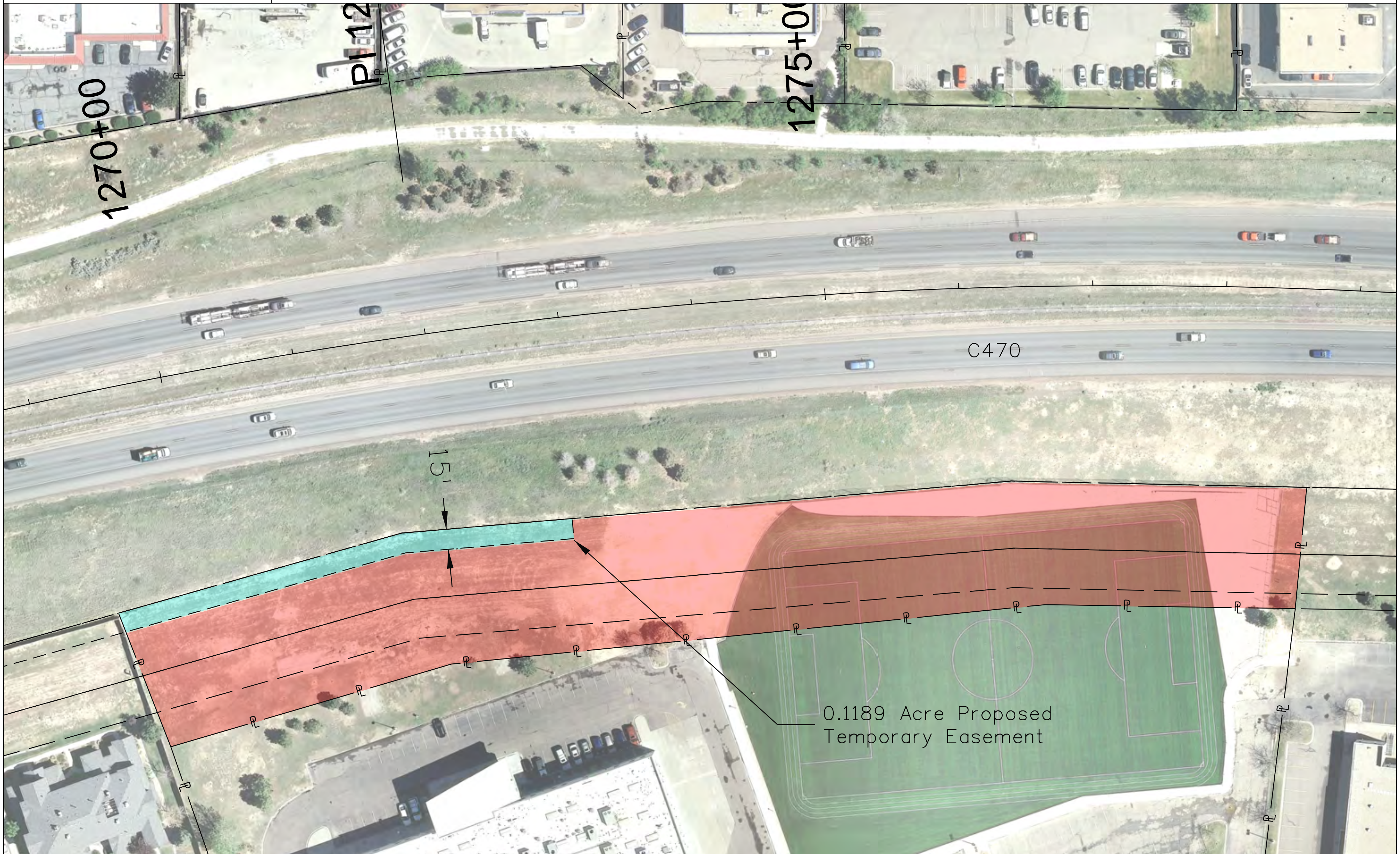
Affected Plat

Existing Property Line

Proposed ROW

0' 200' 400' 800'

ROW Exhibit 21	Plat #: 223105204004 Plat Size: 1.9480 Acres	Owner: Douglas County School District RE1 Proposed Easement Area: 0.1189 Acres



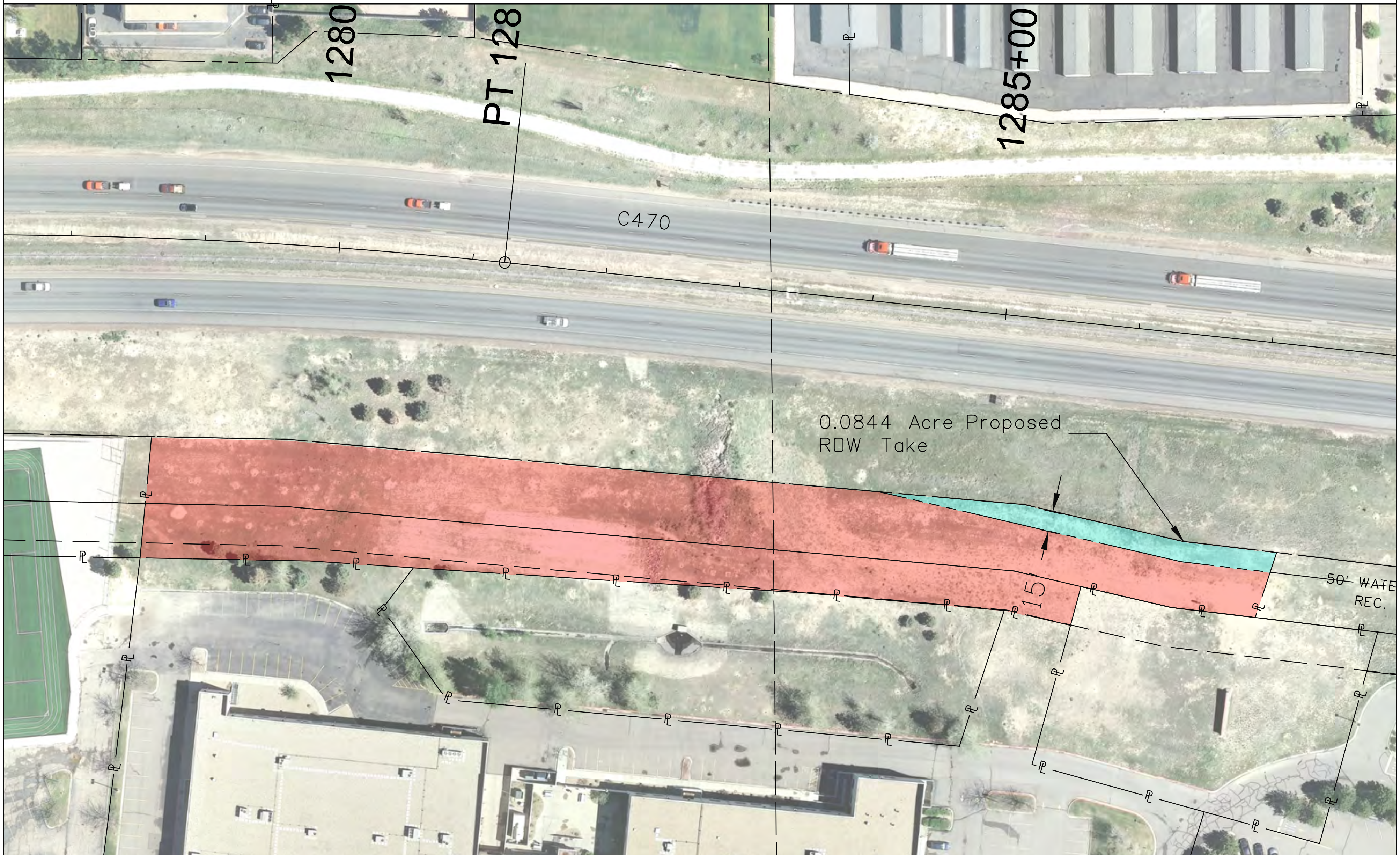
Legend
- Proposed Permanent Easement
- Existing ROW
- Existing Property Line
- Proposed Temporary Easement
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 50' 100' 200'

ROW Exhibit 22

Plat #: 223105204003
Plat Size: 1.5082 Acres

Owner: Mountain View LLC
Proposed ROW Take Area: 0.0844 Acres



Legend

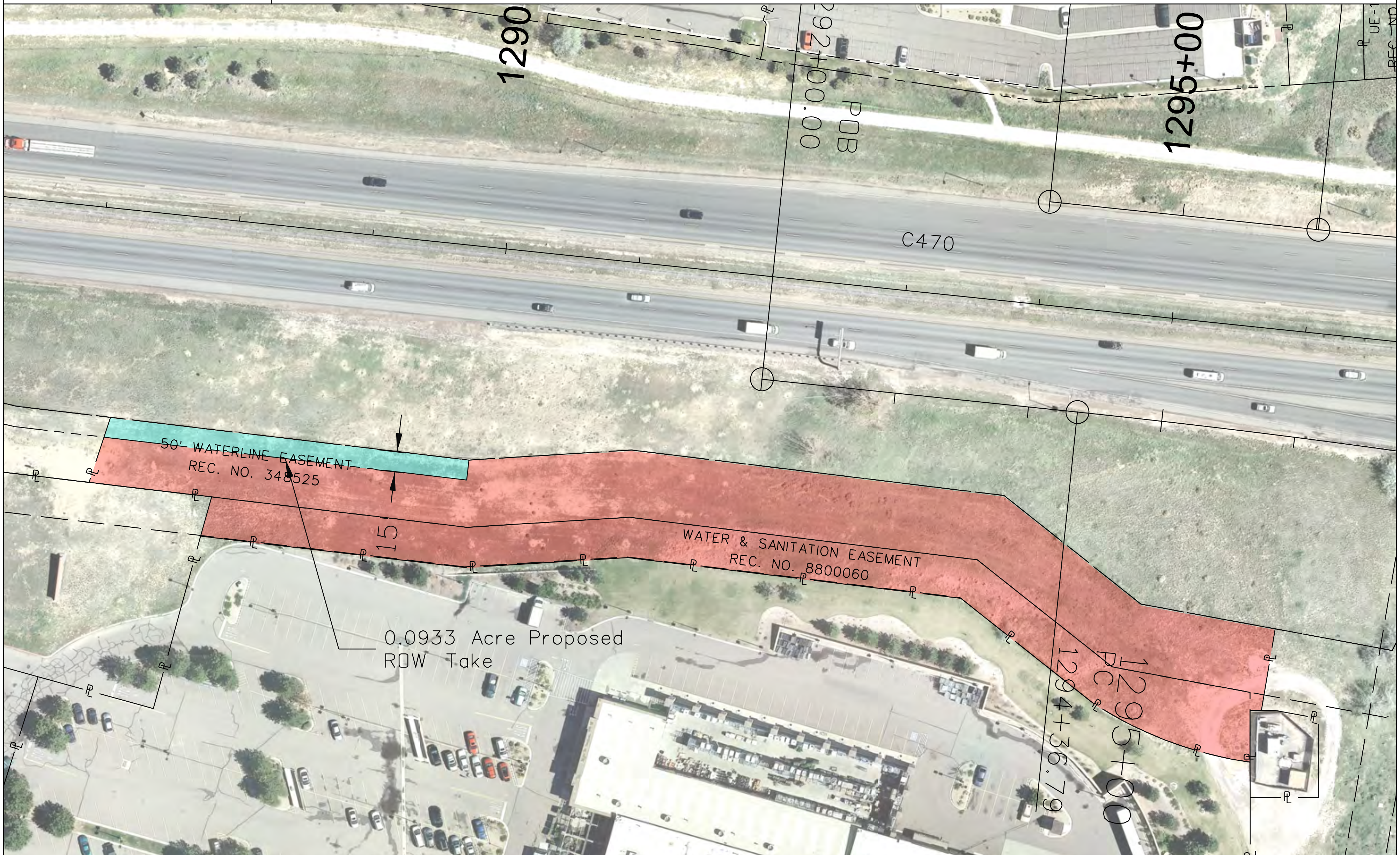
Proposed Permanent Easement
Existing ROW
Proposed Temporary Easement
Existing Property Line
Proposed ROW
Proposed ROW/Easement Area
Affected Plat

0' 50' 100' 200'

ROW Exhibit 23

Plat #: 223105102016
Plat Size: 1.6384 Acres

Owner: Wal Mart Real Estate Business Trust
Proposed ROW Take Area: 0.0933 Acres

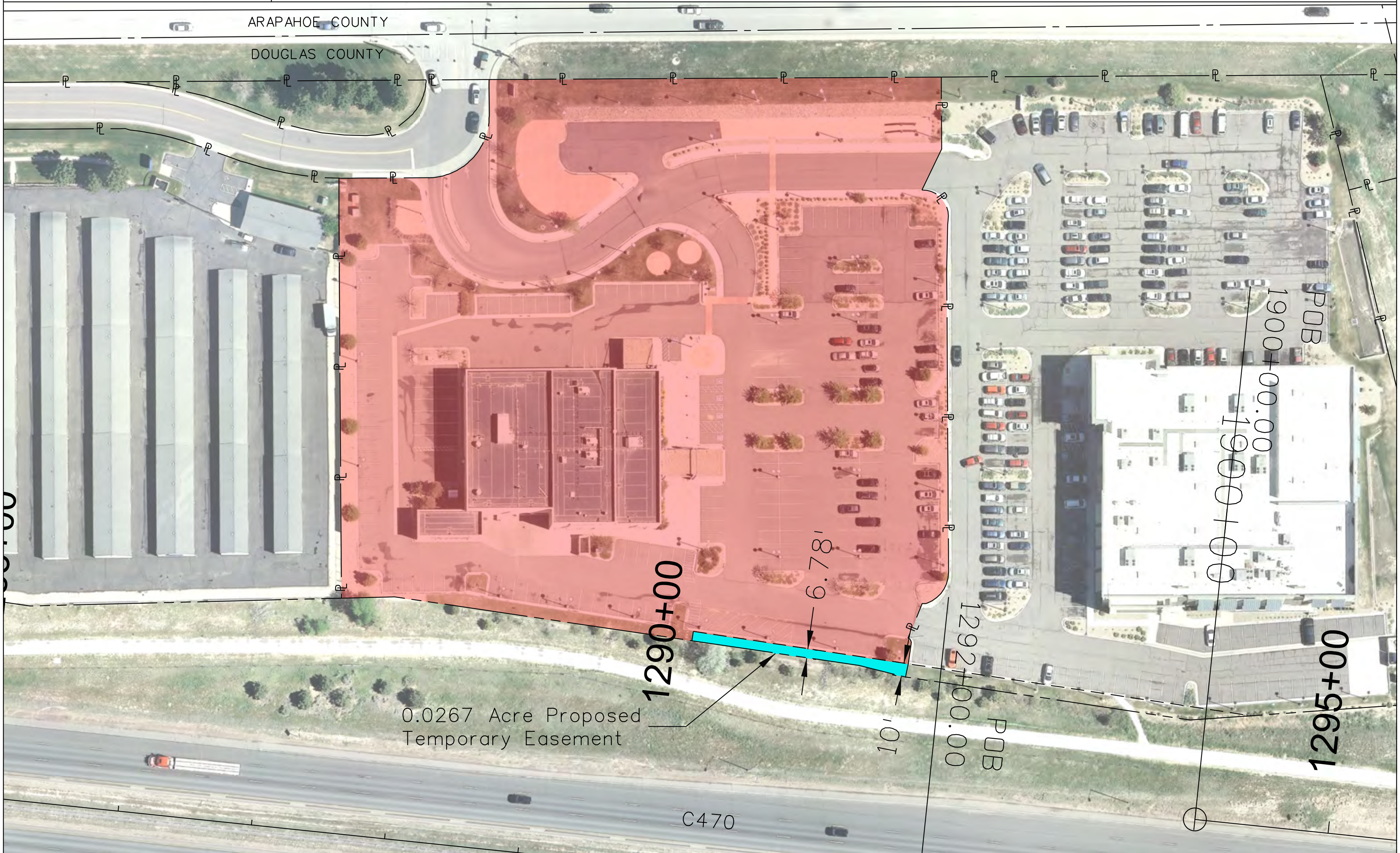


Legend

- Proposed Permanent Easement
- Existing ROW
- Proposed Temporary Easement
- Existing Property Line
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 50' 100' 200'

ROW Exhibit 24	Plat #: 223105101027 Plat Size: 4.0893 Acres	Owner: Kip Hampden LLLP Proposed Easement Area: 0.0267 Acres



Legend

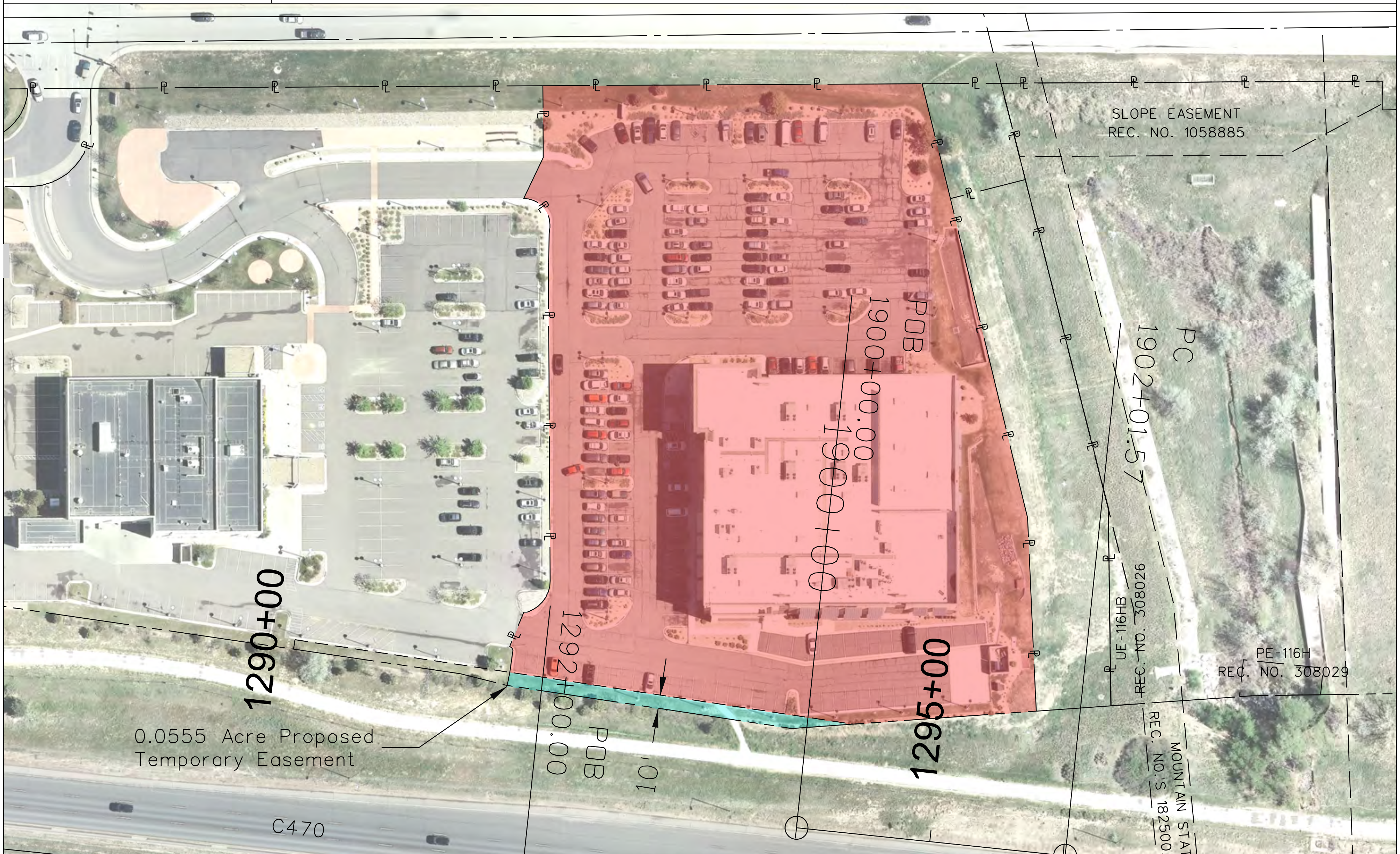
- Proposed Permanent Easement
- Existing ROW
- Proposed Temporary Easement
- Existing Property Line
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 50' 100' 200'

ROW Exhibit 25

Plat #: 223105101028
Plat Size: 3.6342 Acres

Owner: CFM Highlands Ranch Fitness LLC
Proposed Easement Area: 0.0555 Acres



Legend

Proposed Permanent Easement

Existing ROW

Proposed Temporary Easement

Existing Property Line

Proposed ROW

Proposed ROW/Easement Area

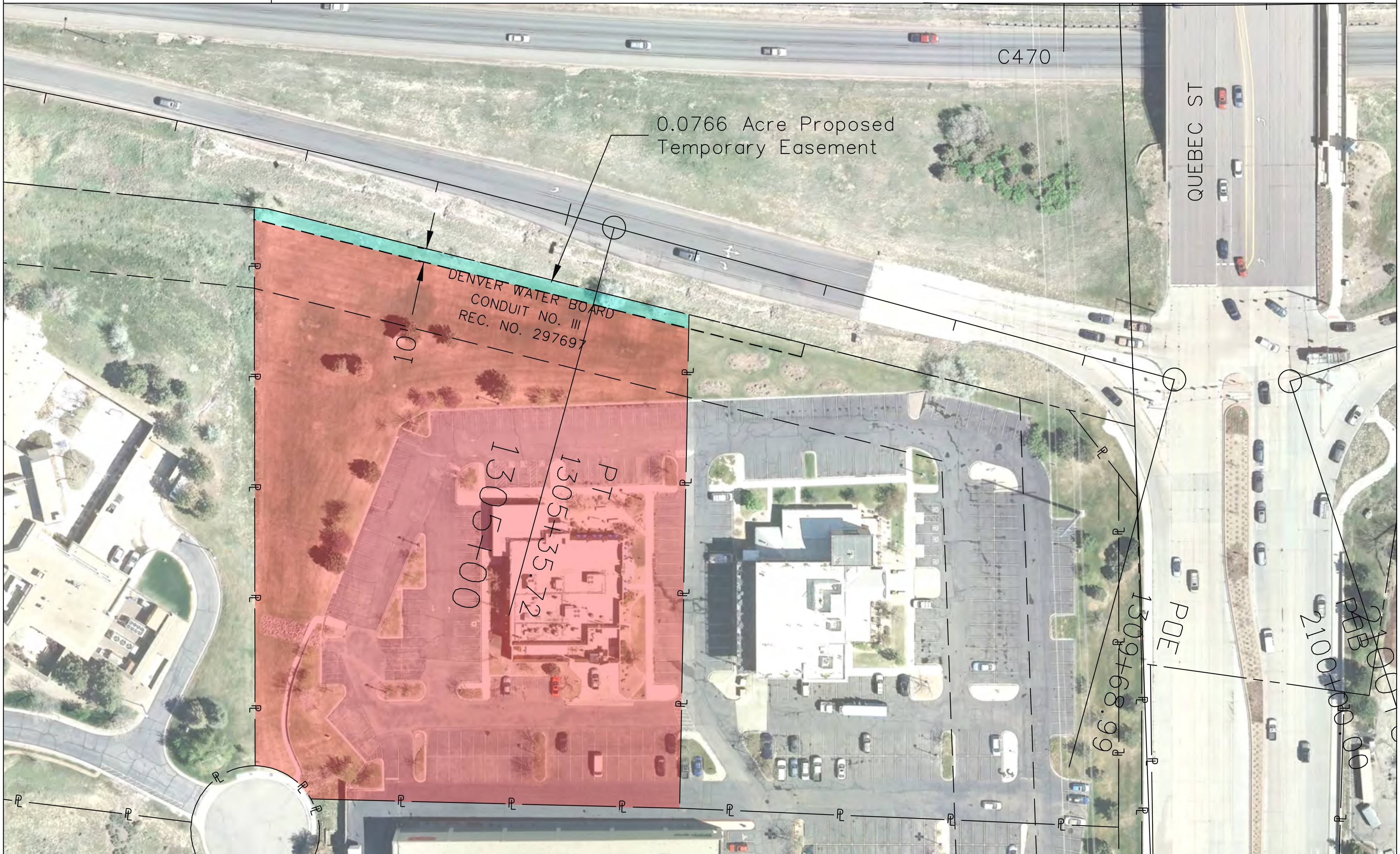
Affected Plat

0' 50' 100' 200'

ROW Exhibit 27

Plat #: 223105102019
Plat Size: 2.9583 Acres

Owner: Centre Structured Trust 5 Corporate Trust Administration
Proposed Easement Area: 0.0766 Acres



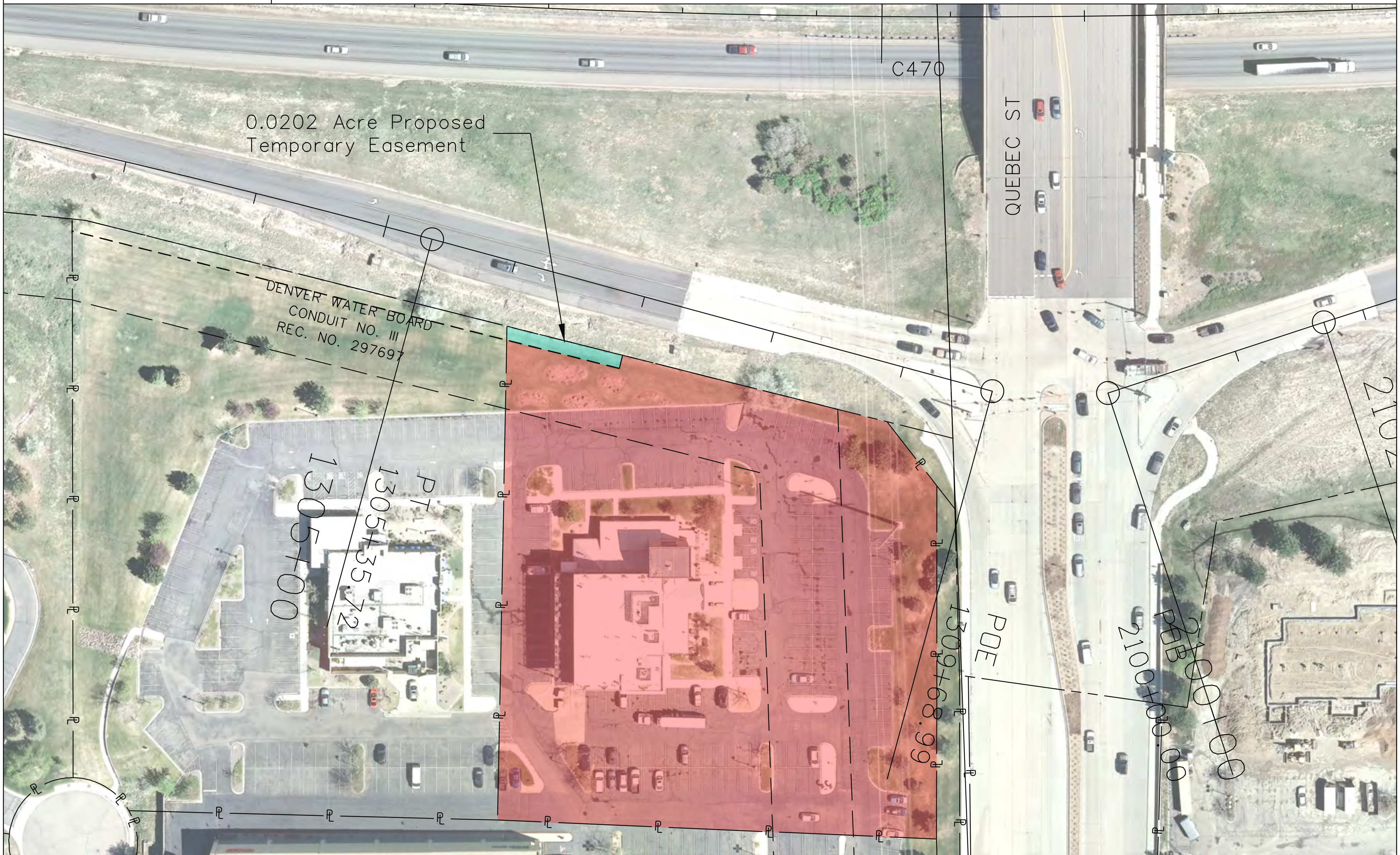
Legend
Proposed Permanent Easement
Existing ROW
Existing Property Line
Proposed Temporary Easement
Proposed ROW
Proposed ROW/Easement Area
Affected Plat

0'
50'
100'
200'

ROW Exhibit 28

Plat #: 223105102029
Plat Size: 2.4798 Acres

Owner: Meyers Restaurant Properties LLC
Proposed Easement Area: 0.0202 Acres



Legend

Proposed Permanent Easement
Existing ROW
Proposed Temporary Easement
Existing Property Line
Proposed ROW
Proposed ROW/Easement Area
Affected Plat

0' 50' 100' 200'

ROW Exhibit 29

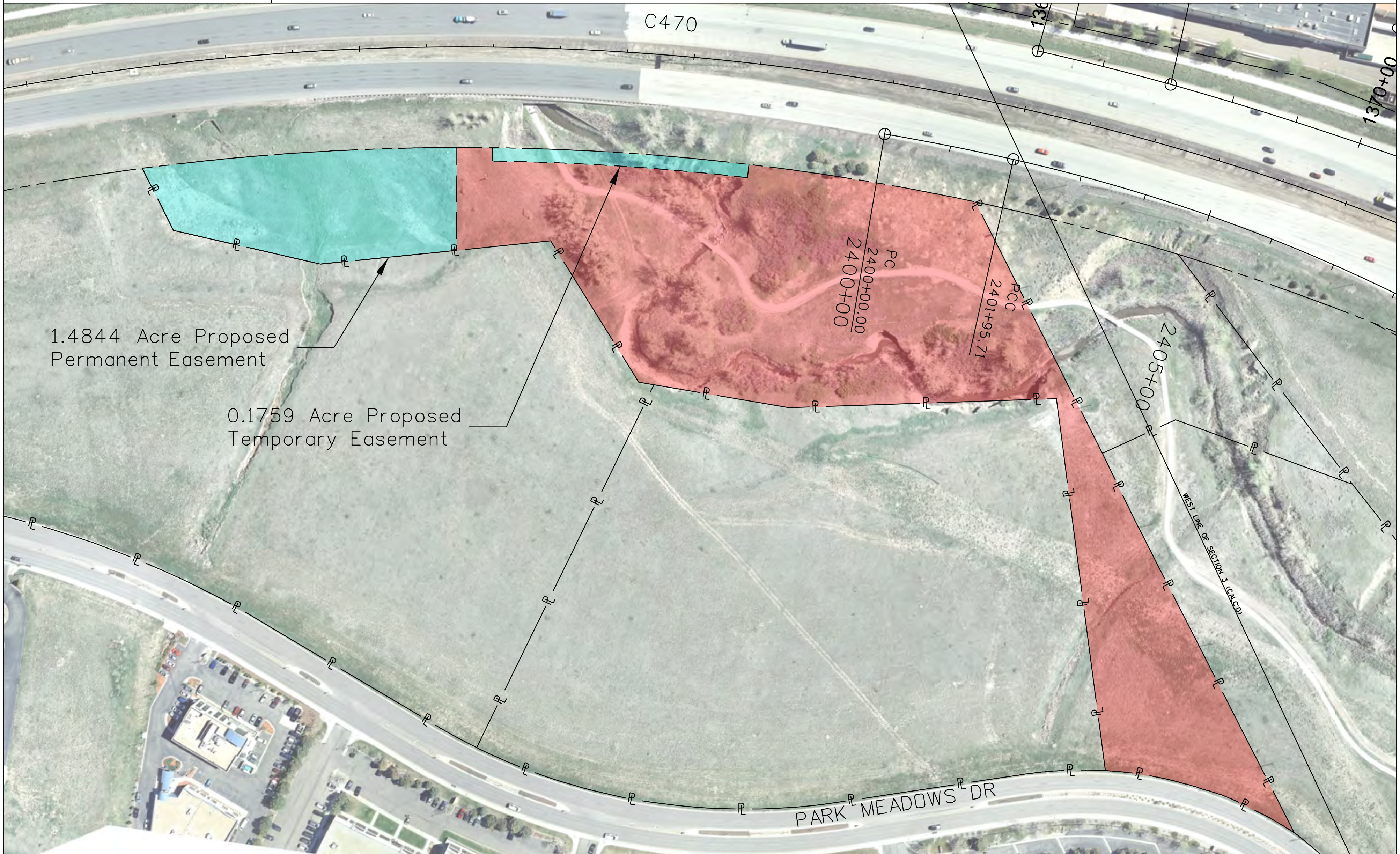
Plat #: 223104209012 Owner: Sam's Den LLC
Plat Size: 14.7754 Acres Proposed Easement Area: 0.0977 Acres

Legend
Proposed Permanent Easement
Existing ROW
Proposed Temporary Easement
Existing Property Line
Proposed ROW
Proposed ROW/Easement Area
Affected Plat

0' 100' 200' 400'

ROW Exhibit 31

Plat #: 223104105003 Owner: City of Lone Tree
Plat Size: 8.8948 Acres Proposed Easement Area: 1.6603 Acres

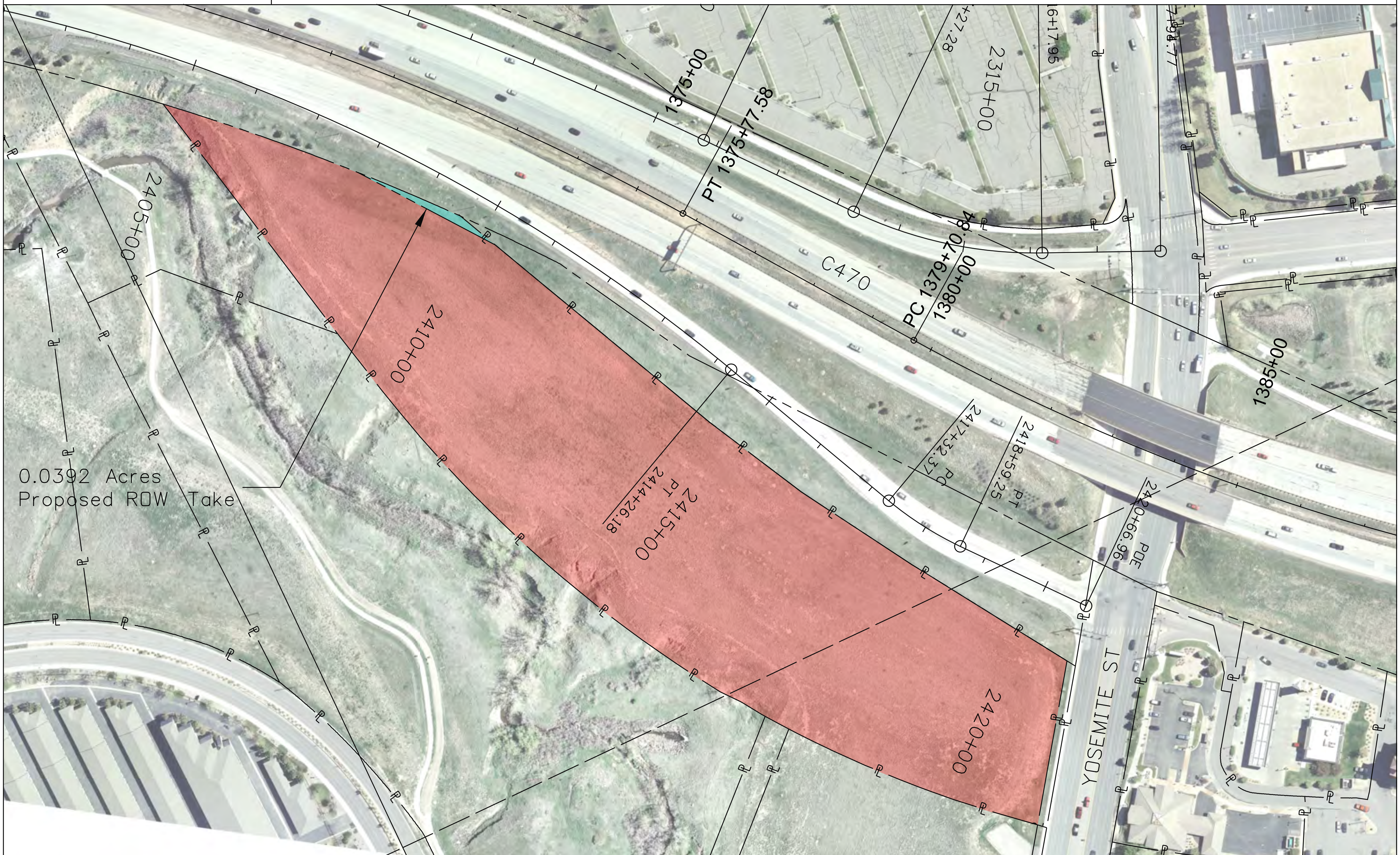


Legend

Proposed Permanent Easement	Proposed ROW/Easement Area
Existing ROW	Proposed Temporary Easement
Affected Plat	Existing Property Line
Proposed ROW	

0' 100' 200' 400'

ROW Exhibit 32	Plat #: 223103203008 Plat Size: 9.5771 Acres	Owner: Furniture Row Colo LLC Proposed ROW Take Area: 0.0392Acres



Legend

Proposed Permanent Easement

Existing ROW

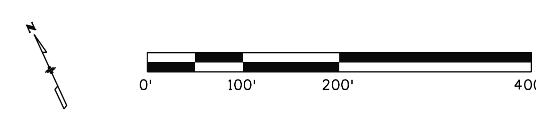
Existing Property Line

Proposed Temporary Easement

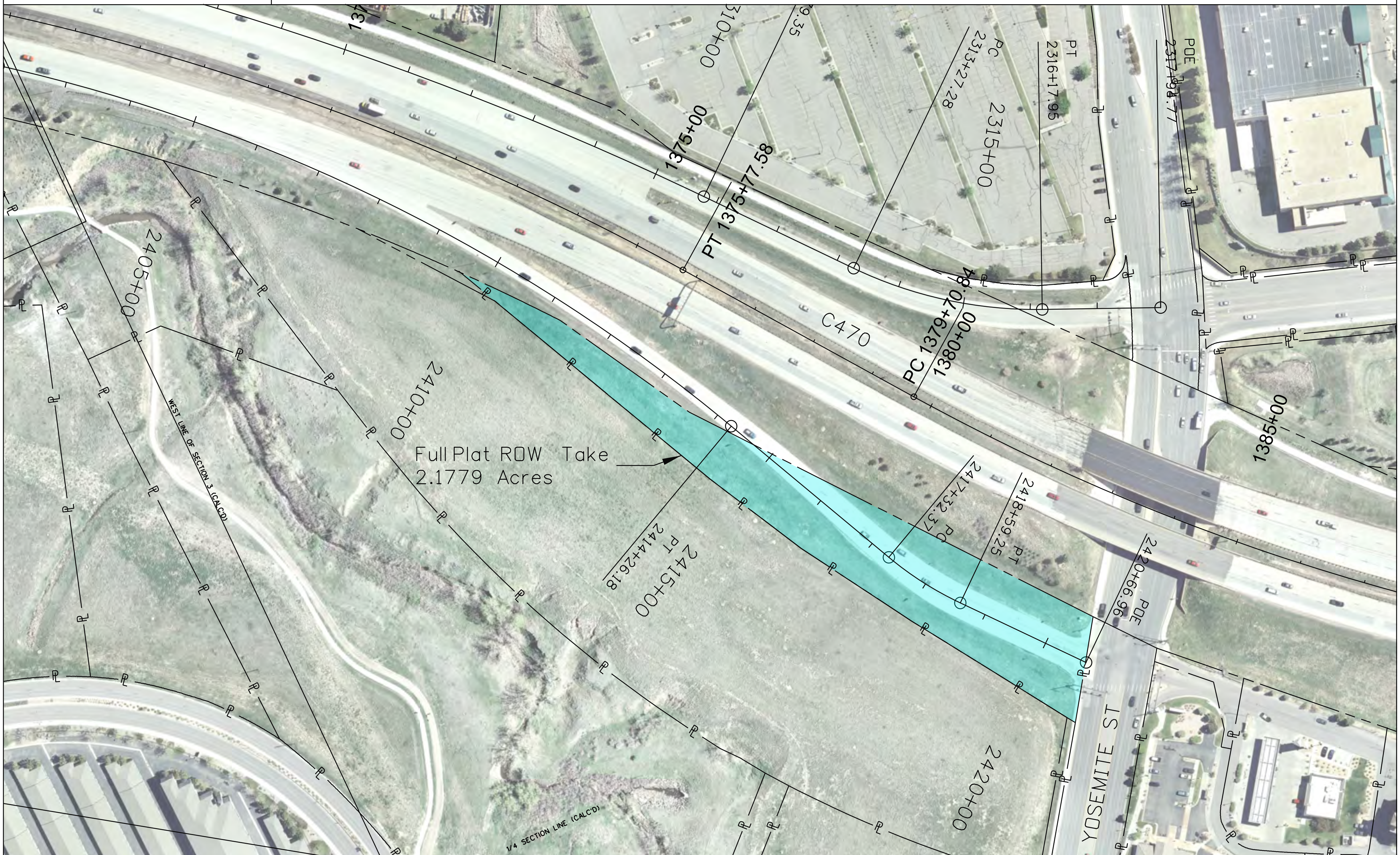
Proposed ROW

Proposed ROW/Easement Area

Affected Plat



ROW Exhibit 33	Plat #: 223103299010 Plat Size: 2.1779 Acres	Owner: Douglas County Board of County Commissioners Proposed ROW Take Area: 2.1779 Acres



Legend

- Proposed Permanent Easement
- Existing ROW
- Proposed Temporary Easement
- Existing Property Line
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 100' 200' 400'

ROW Exhibit 34

Plat #: 223103299009
Plat Size: 0.3548 Acres

Owner: Bel Larimer LLC
Proposed ROW Take Area: 0.3548 Acres

Legend			
Existing ROW	Proposed Permanent Easement	Proposed ROW/Easement Area	
Existing Property Line	Proposed Temporary Easement	Affected Plat	
	Proposed ROW		

N

0' 50' 100' 200'

ROW Exhibit 35

Plat #: 223103305014
Plat Size: 1.5060 Acres

Owner: FCF National Bank Colorado
Proposed Easement Area: 0.1135 Acres

Legend

Proposed Permanent Easement
Existing ROW
Existing Property Line
Proposed Temporary Easement
Proposed ROW
Proposed ROW/Easement Area
Affected Plat

0' 50' 100' 200'

ROW Exhibit 36	Plat #: 223103304002 Plat Size: 3.0065 Acres	Owner: South Denver Marketplace INC C/O Deloitte & Touche Proposed Easement Area: 0.1312 Acres

Legend

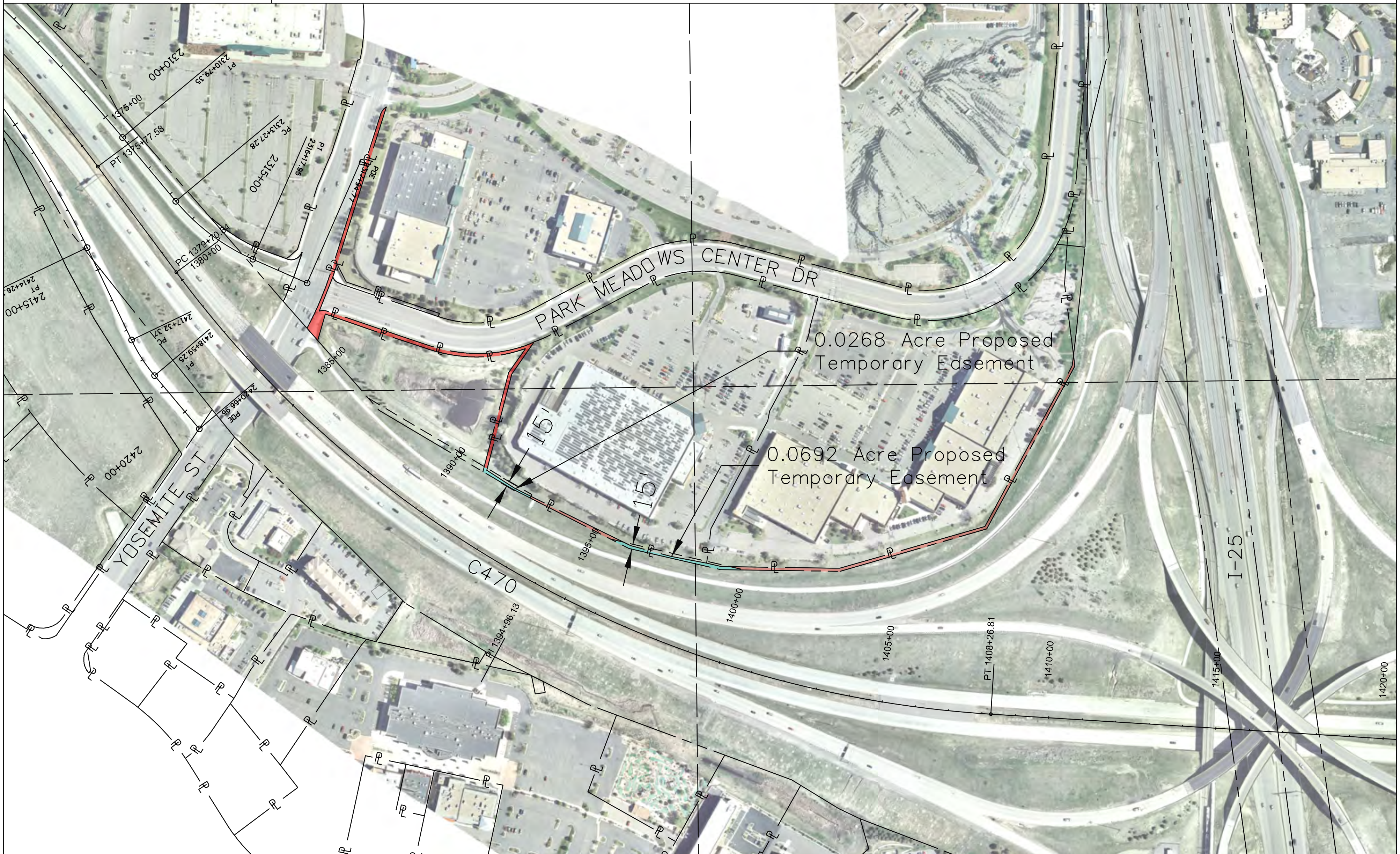
- Proposed Permanent Easement
- Existing ROW
- Existing Property Line
- Proposed Temporary Easement
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

N

0' 50' 100' 200'

ROW Exhibit 37

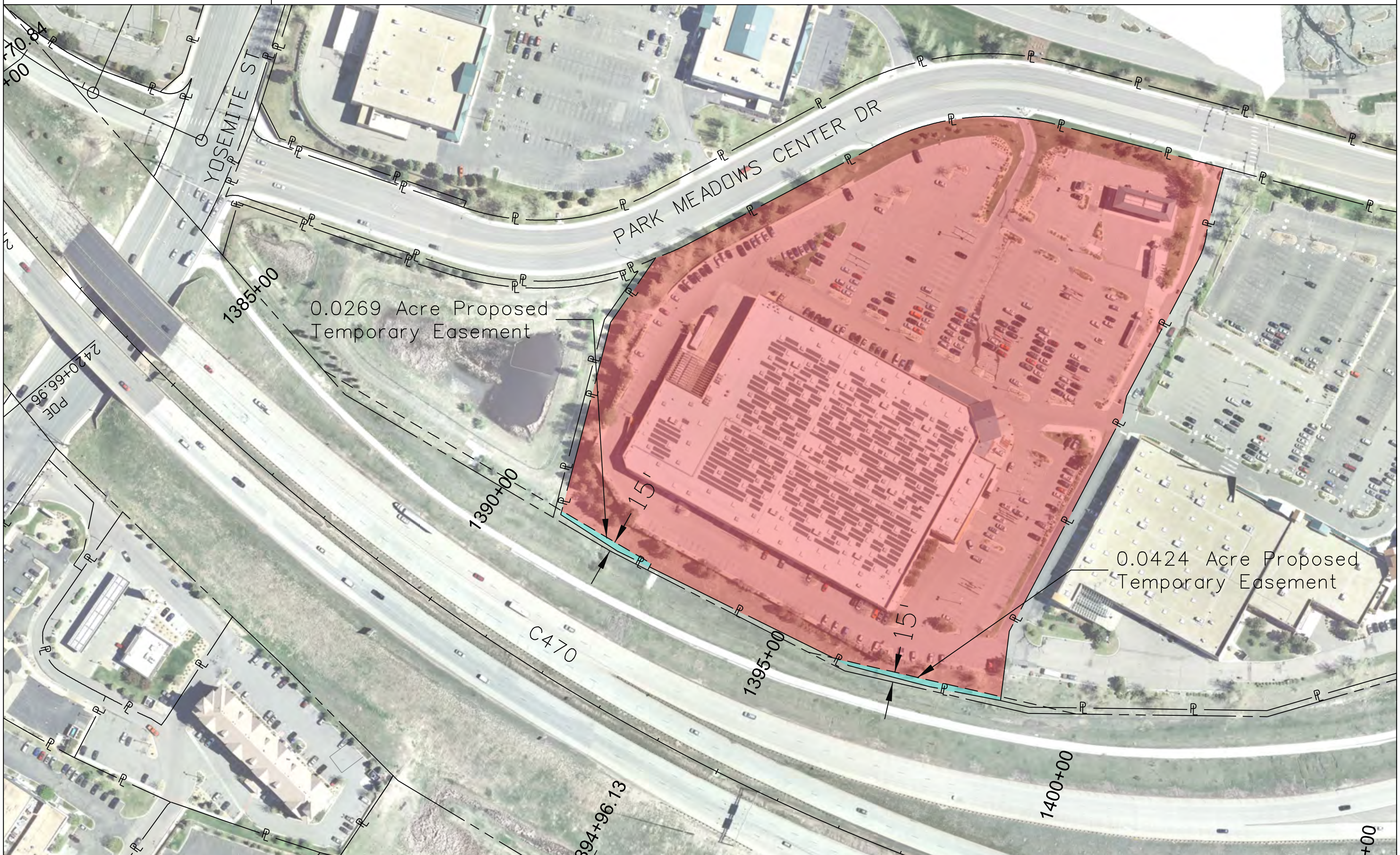
Owner: City of Lone Tree
Plat Size: 0.8567 Acres   Proposed Easement Area: 0.0960 Acres



Legend
- Proposed Permanent Easement
- Existing ROW
- Existing Property Line
- Proposed Temporary Easement
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 200' 400' 800'

ROW Exhibit 38	Plat #: 223103404002 Plat Size: 12.5478 Acres	Owner: Price Company Proposed Easement Area: 0.0693 Acres



Legend

Proposed Permanent Easement

Proposed ROW/Easement Area

Existing ROW

Proposed Temporary Easement

Affected Plat

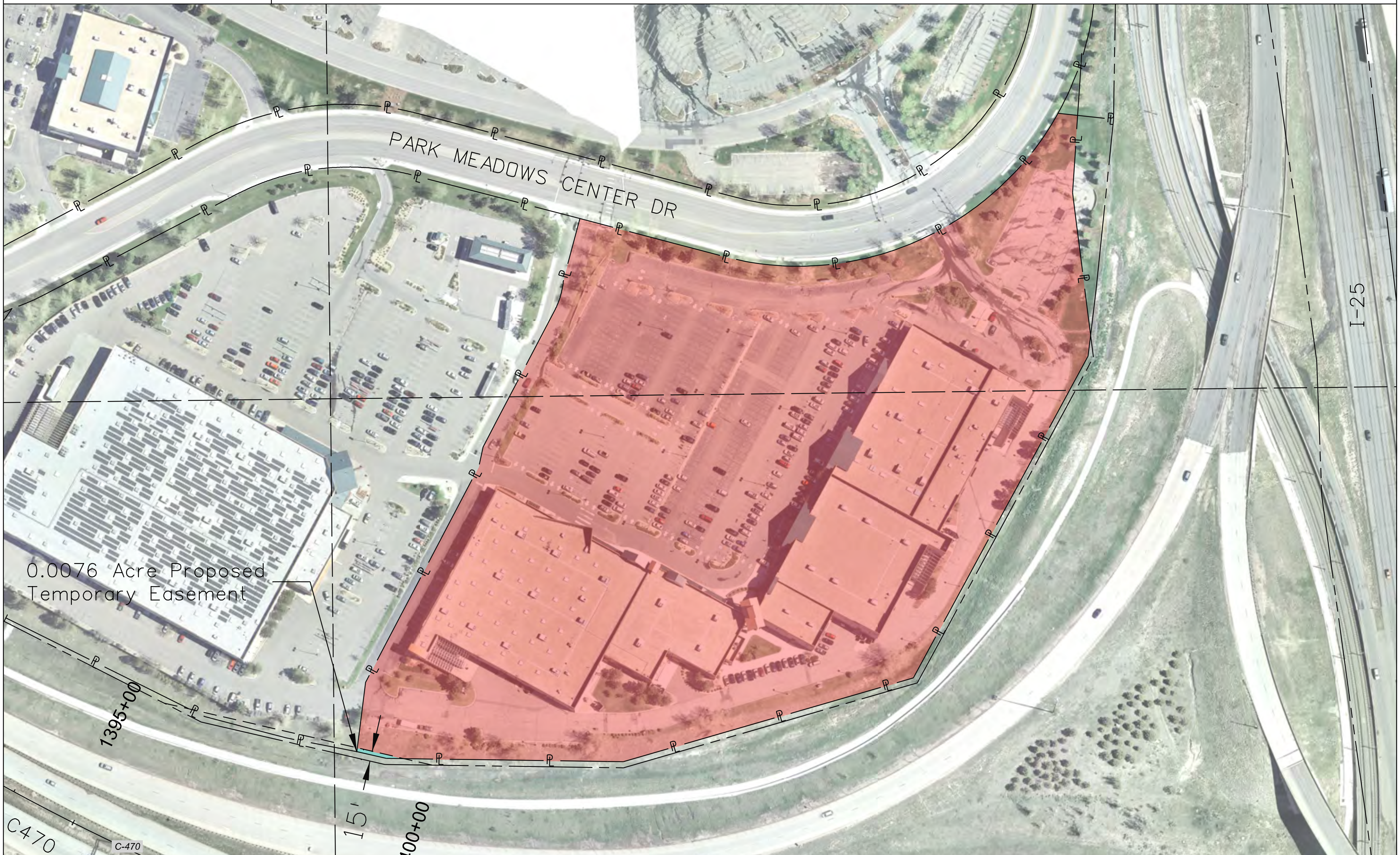
Existing Property Line

Proposed ROW

0' 100' 200' 400'

ROW Exhibit 39

Plat #: 223103404003 Owner: South Denver Marketplace INC
Plat Size: 14.2036 Acres Proposed Easement Area: 0.0076 Acres



Legend

Proposed Permanent Easement
Existing ROW
Proposed Temporary Easement
Existing Property Line
Proposed ROW
Proposed ROW/Easement Area
Affected Plat

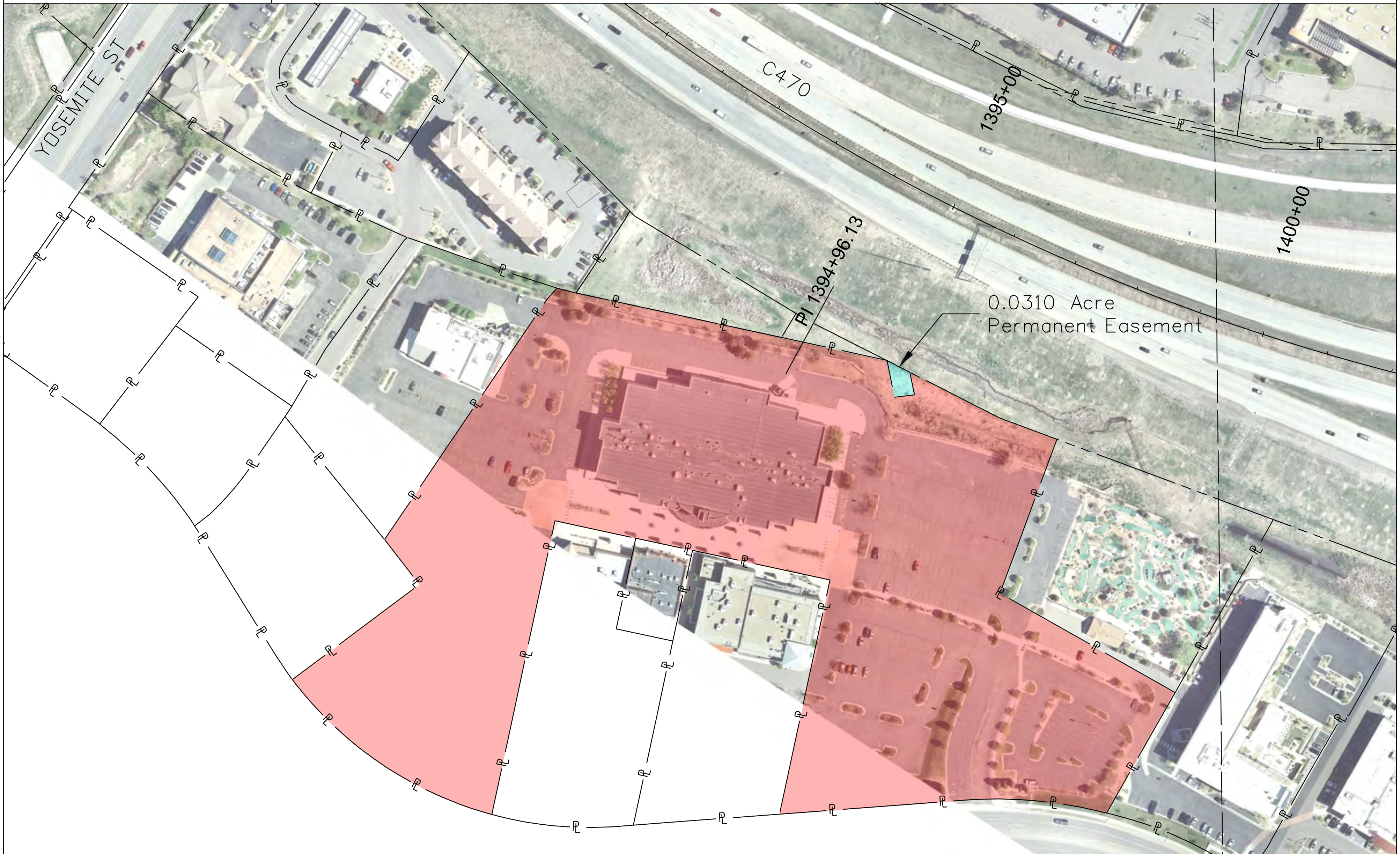
N

0' 100' 200' 400'

ROW Exhibit 41

Plat #: 223103305002
Plat Size: 12.0278 Acres

Owner: Park Meadows Business Trust
Proposed Easement Area: 0.0310 Acres



Legend

- Proposed Permanent Easement
- Existing ROW
- Existing Property Line
- Proposed Temporary Easement
- Proposed ROW
- Proposed ROW/Easement Area
- Affected Plat

0' 100' 200' 400'

Roadway Safety Technical Report

For the C-470 Corridor
Revised Environmental Assessment

November 2013

Submitted to:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted by:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

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1.0 INTRODUCTION

This Roadway Safety Technical Report for the C-470 Revised Environmental Assessment (EA) examines recent safety data for State Highway (SH) 470A, better known as C-470, from the Kipling Parkway interchange at approximately C-470 milepost 12.40 to the Interstate 25 (I-25) interchange at milepost 26.21. In 2013, the Colorado Department of Transportation (CDOT) and Federal Highway Administration (FHWA) are evaluating impacts of a Proposed Action that differs slightly from the preferred alternative in the C-470 EA that was approved by these same agencies in 2006.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in Figure 1. CDOT and FHWA have initiated the Revised EA for the 13.75-mile portion of C-470 between Kipling Parkway and I-25 to address congestion and delay, and to improve travel time reliability for C-470 users.

Figure 1
C-470 Corridor and Surrounding Vicinity

The Proposed Action would add two managed tolled express lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes would be provided between closely spaced interchanges (e.g., one mile apart). To aid motorists in entering the express lanes at the project's eastern end, new direct-connect ramps would be provided at I-25. Users of the new ramps would not have to weave across C-470 general purpose lanes to access the new express lanes. The Proposed Action does not include any new interchanges or any major interchange modifications. A minor modification at Santa Fe Drive would affect the westbound on-ramp to C-470.

2.0 SAFETY ANALYSIS FOR THE 2006 C-470 EA

CDOT's Safety and Traffic Engineering Branch analyzed three years of accident data (2000 to 2002) in support of the original C-470 EA. That analysis was documented in a February 2005 report entitled "Traffic Safety Chapter for the C-470 Corridor Environmental Assessment." The data examined in that report are now more than a decade old.

2.1 2005 CDOT Findings

The 2005 CDOT safety study examined a total of 1,565 crashes that occurred on the C-470 highway mainline, connecting ramps, and on crossing streets within interchanges. Of these, 850, or an average of 281 per year, occurred on the C-470 mainline. Those crashes occurred during the three-year period from January 1, 2000 to December 31, 2002. The study area extended westward to the Ken Caryl interchange, at C-470 milepost 10), and thus was 2.4 miles longer than the area considered in 2013.

The 2005 safety study identified the five highest accident frequency locations along the corridor and provided details about the types of accidents there. Key findings are noted in Table 1 below.

Table 1
Frequent-Accident Locations Identified from 2000 to 2002 Data

Interchange	Mileposts	Length	Accidents	Most Common	Second Most
Quebec	22.63-24.88	1.49	158	Rear end 43%	Fixed object 23%
Santa Fe	16.13-17.69	1.56	139	Rear end 66%	Fixed object 17%
Lucent	17.70-19.09	1.39	109	Rear end 57%	Fixed object 12%
I-25	24.89-26.21	1.32	81	Fixed object 33%	Rear end 23%
Broadway	19.10-20.30	1.20	74	Rear end 64%	Sideswipe 11%

The 2005 study noted that rear-end accidents were the most frequent type on mainline C-470, accounting for 48% of the total. It stated that, "most of these accidents are the direct result of one or more of the involved vehicles either unexpectedly slowing or actually stopping, due to congestion, on a high-speed roadway." Additional analysis showed that 75% of the rear end collisions occurred during the peak commute hours of 6 am to 9 am and 4 pm to 7 pm, with the number considerably higher in the afternoon peak, compared with the morning peak. Examination of 2008-2012 data in 2013 found that they were 72%. Rear-end accidents are largely associated with traffic congestion.

The 2005 safety report documented eight crashes that resulted in fatalities over the three year period of 2000 to 2002, an average of 2.33 fatal crashes per year. An unusual roadside sign along eastbound C-470 near the Chatfield Reservoir memorializes two Littleton teenagers who died in a single-vehicle rollover crash in

August 2006. That particular incident occurred prior to the years (2008 to 2012) that are included in this updated safety study. No similar signs are found along the corridor.

CDOT's overall assessment of safety conditions in 2005 was that the corridor generally had "better than expected safety performance" for a roadway of its type and intensity of use. This is called a Level of Service of Safety (LOSS) level two. The LOSS scale goes from one to four, where level one indicates low potential for accident reduction and level four indicates high potential for accident reduction.

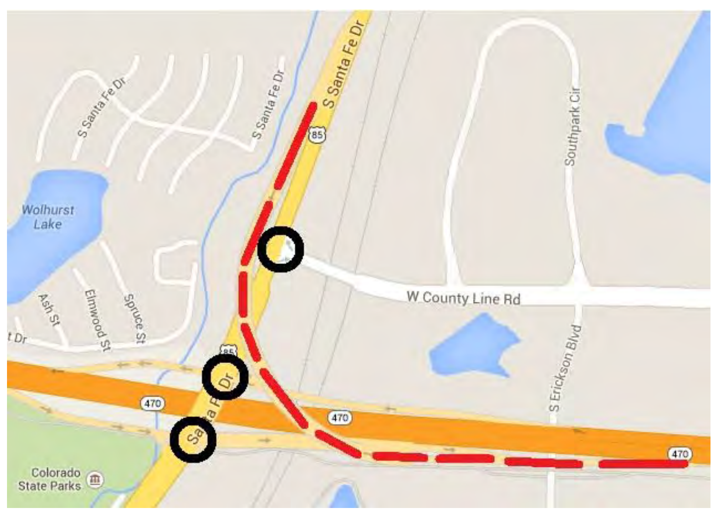
Although the 2005 CDOT safety study gave the C-470 corridor a LOSS-II rating, it did point out an emerging safety issue that was expected to worsen in the future, as follows:

> "Currently, highway users experience congested conditions, unnecessary delay and increased crash potential in several locations during peak morning and afternoon volume periods. Drivers at interchange merge-diverge zones contending with the increased vehicle density and reduced maneuvering room of peak hours initiate disruptions in the traffic stream that inevitably cause breakdown in the overall traffic flow and rapid backups. Without additional capacity, these conditions can only be expected to worsen with increased future freeway usage."

2.2 EA Project Purpose and Need

Due to the relatively safe conditions on C-470 at that time, the project purpose and need for highway improvements in the 2006 C-470 EA focused on reducing traffic congestion and improving travel time reliability, not safety improvements. However, capacity improvements could have safety benefits by reducing traffic density at freeway entrance ramps.

Figure 2
C-470/Santa Fe Drive Interchange Flyover Ramp that Opened in December 2011



The dashed red line indicates path of new flyover ramp. Black circles indicate three signalized intersections receiving southbound traffic relief from the new ramp.

2.3 Santa Fe Interchange Safety Improvements

While giving the highway mainline an adequate safety rating of LOSS-II, the 2005 report did identify the C-470/Santa Fe Drive interchange as an area of safety concern, particularly due to rear-end crashes at traffic signals. That location underwent subsequent safety analysis and eventually a flyover ramp was built to carry southbound Santa Fe to eastbound C-470 traffic, thus removing a large volume of southbound traffic from three consecutive signalized intersections at the Santa Fe interchange. Figure 2 depicts the location and extent of the flyover ramp that opened to traffic in December 2011.

With only one full year (2012) of accident data that reflect the new interchange configuration, following two prior years of data affected by construction activity, it is premature to quantify safety benefits from the opening of the Santa Fe flyover ramp at this time.

Interchange reconstruction has also occurred recently at the C-470 ramp intersections at Quebec Street (2010) and Broadway (2013), but with no new ramps added.

3.0 DRCOG 2011 REPORT ON TRAFFIC SAFETY

In October 2011, the Denver Regional Council of Governments (DRCOG) published a study called *Report on Traffic Safety in the Denver Region*. While some of the regional statistics in this report were as new as 2010, detailed data regarding the C-470 corridor were not as new. The report's section on Freeway Crash Hot Spots is based on a 2007 DRCOG study which examined data from 2002 to 2004. These data are only slightly newer than the 2000 to 2002 data examined for the C-470 EA safety study in 2005, and similarly, they are now about a decade old.

In the DRCOG study of freeway crash hot spots, the regional freeway system was viewed as 156 freeway segments, of which five comprise the C-470 EA study area. Region-wide, 18% of the segments examined were rated at LOSS Level IV, having more crashes than expected and therefore a high potential for crash reduction. These 28 segments included one on C-470. LOSS III was the grade for 38% of the region's freeway segments, including two on C-470. The 2005 analysis rated the rest of C-470 (two segments) to be rated at LOSS level I or II, indicating fewer accidents than would be expected for a four-lane freeway in the Denver metro area. From west to east, the results for C-470 were as follows:

- Kipling to Platte Canyon Road (3 miles) – LOSS level I or II
- Platte Canyon Road to west of Lucent Boulevard (3 miles)– LOSS Level III
- West of Lucent Boulevard to University Boulevard (2.5 miles) – LOSS Level IV
- University Boulevard to milepost 23/Holly Street alignment (2 miles) – LOSS Level I or II
- Milepost 23 to I-25 (3 miles) – LOSS Level III

The DRCOG 2007 analysis and the CDOT 2005 analysis examined different years of data, with one year (2002) in common. The results therefore contrast the years 2000-1 with 2003-4. The highway did not change between these two data timeframes, and traffic volumes likely did not change dramatically during such a short period of time.

A prior DRCOG safety study, published in 2003, examined accidents in 1999 and classified freeway segments into three categories, based on number of crashes per mile. Every mile of C-470 was classified in the 0 to 39 crashes per year category, while other freeway segments were found to have 40 to 99 (e.g., I-225, I-70), or 100 or more (I-25). The updated safety analysis, presented below, indicates that all miles of mainline C-470 in the study area today continue to experience 0 to 39 crashes per year.

4.0 UPDATED C-470 SAFETY ANALYSIS

For this updated safety analysis, a query of CDOT's database identified all reported accidents for the five years from 2008 to 2012, inclusive, on the C-470 mainline, its ramps, and selected cross-street intersections. The dataset examined for this safety study is summarized in Table 2. The dataset appears to be complete for the C-470 mainline, and possibly for ramps, but clearly excludes certain ramp intersections, including Wadsworth Boulevard, Santa Fe Drive, and University Boulevard. Nevertheless, there is sufficient data regarding ramp intersections to provide a reasonable picture of what occurs there.

Table 2
Summary of CDOT Five-Year Accident Dataset

Starting Milepost	Cross-street or feature	Number of Accidents by Location Type				Five-Year Total	Annual Avg.
		Main-line	Ramps	Inter-sections	Intersection-Related		
12 (west)*	Kipling Parkway	24	8	19	6	57	12
13	Wadsworth Blvd.	40	27	0	1	68	14
14	Massey Draw	69	N/A	N/A	N/A	69	14
15	Platte Canyon Rd.	73	4	0	0	77	15
16	S. Platte River	83	N/A	N/A	N/A	83	17
17	Santa Fe Dr.	140	32	0	0	172	34
18	Lucent Blvd.	119	18	43	9	189	38
19	Broadway	157	7	108	12	284	57
10	None	115	N/A	N/A	N/A	115	23
21	University Blvd.	137	54	2	1	194	39
22	Colorado Blvd.	82	N/A	N/A	N/A	82	16
23	Holly St.	92	N/A	N/A	N/A	116	23
24	Quebec St.	172	40	125	8	355	71
25	Yosemite St.	133	53	63	19	252	50
26 (east)*	Interstate 25	29	29	0	2	58	12
Five-Year Total		1,465	425	363	58	2,311	
Percent of Total		**63.4%**	**18.4%**	**15.7%**	**2.5%**	**100.0%**	
Annual Average		**293**	**85**	**73**	**12**		**463**

**The starting and ending mileposts for the study are 12.45 and 26.2, so the segment 12 is only 0.55 mile long and segment 26 is only 0.2 mile long. All segments in-between (segments 13 to 25) are each one mile in length.*

A primary focus of this analysis is C-470 mainline accidents, which accounted for 1,465 of the 2,311 total accidents. Following the extensive discussion of C-470 mainline accidents in the subsections which follow, accidents on ramps and at ramp intersections are examined separately, in shorter detail.

4.1 C-470 Mainline Accidents

Table 2 indicates that the average number of reported accidents on the C-470 mainline for the five-year period was 293 accidents per year. The type, location, and severity of mainline accidents, trends over time and contributing factors for these accidents are examined below.

4.1.1 Mainline Accidents by Type

Table 3 summarizes the five-year database for the C-470 mainline by accident type and location. It can be seen from Table 3 that the predominant category of C-470 mainline accidents was multi-vehicle collisions, which accounted for 62.2% of the total. This category is dominated by rear-end collisions, averaging 142 per year, which comprised nearly half (48%) of all accidents on mainline C-470.

The prevalence of rear-end collisions in 2008-2012 is the same percentage that was found in the 2005 C-470 safety study. The 2005 study stated that "most of these accidents are the direct result of one or more of the involved vehicles either unexpectedly slowing or actually stopping, due to congestion, on a high-speed roadway." With continued growth and development in this portion of the metro area, C-470 traffic volumes and congestion have continued to increase since then.

The second type of accident included in the multi-vehicle collisions category is sideswipe collisions, averaging 40 per year on a corridor-wide basis. This is also the second most prevalent accident type overall on mainline C-470. Sideswipe accidents can occur when motorists attempt a lane change, inadvertently drift from their lane, or attempt to merge without adequate clearance.

Collisions with a fixed object were the second leading accident category, at 26.3%, which is less than half the multi-vehicle collision share. Collisions with cable rail (e.g., in the roadway median, dividing the two directions of traffic), guard rail (preventing drivers from entering areas with no opportunity to recover vehicle control), and other fixed objects all accounted for relatively similar shares of total accidents. CDOT minimizes the inclusion of fixed objects in the vicinity of the roadway in an attempt to avoid crashes of this nature. CDOT has strict criteria for installing cable rail, guard rail, and other structures to ensure that their benefits outweigh their risks. Much of the cable rail installation is fairly recent, preventing a vehicle from veering across the median to hit other vehicles in a more catastrophic head-on collision.

A motorist will hit a fixed object only if he or she has already failed to keep the vehicle on the road. Driving off the roadway may result from attempting to avoid a crash, from inattentive or impaired driving, or perhaps due to wet or icy roadway conditions. Those factors are discussed separately, later in this report.

Table 3
C-470 Mainline Accidents by Type and Location, 2008 to 2012

Cross-street or other feature	Kipling	Wadsworth	Massey Draw	Platte Canyon	S. Platte River	Santa Fe	Lucent	Broadway		University	Colorado	Holly alignment	Quebec	Yosemite	Interstate 25	5-Year Totals	Annual Average
Starting Milepost	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
Collision with another moving vehicle (62.2%)																	
Rear-end	7	7	31	25	27	84	64	91	69	83	30	41	106	40	6	711	142
Sideswipe	4	11	8	10	16	15	10	16	16	9	12	17	16	31	9	200	40
Collision with a fixed object (26.3%)																	
Cable rail	0	3	14	14	7	7	14	23	13	22	9	11	5	4	0	146	29
Guard rail	1	5	1	4	12	12	5	5	4	2	20	9	11	25	4	120	24
Other fixed	7	7	10	8	9	16	5	8	3	8	4	3	17	9	6	120	24
Collision with a non-fixed object (6.1%)																	
Debris	0	1	1	3	0	2	4	6	3	6	2	2	6	6	1	43	8
Wild animal	1	1	3	2	6	0	4	3	1	2	0	2	2	1	0	28	6
Other	0	1	0	1	2	1	3	1	0	1	2	0	2	4	0	18	4
Non-collision (5.4%)																	
Overturning	2	4	0	3	4	1	10	4	5	4	3	6	3	8	2	59	12
Embankment	1	0	1	0	0	1	0	0	1	0	0	1	1	2	1	9	2
Other	1	0	0	3	0	1	0	0	0	0	0	0	3	3	0	11	2
5-Year Total	24	40	69	73	83	140	119	157	115	137	82	92	172	133	29	1,465	
Average/year	5*	8	14	15	17	28	24	31	23	27	16	18	34	27	6*		293

** Kipling and I-25 segments are less than one mile in length; all other segments are one mile.*

Collisions with a non-fixed object (other than a moving vehicle) accounted for 6.1% of the five-year accident total on C-470. These include collisions with debris (8 accidents per year), wild animals (6 accidents per year) and other unspecified objects (4 accidents per year) which typically cannot be predicted or controlled. Several accidents listed in this category involved crashing with a motor vehicle that was parked along the roadway. Animal crossing warning signs exist in locations near the South Platte River and other areas where crashes with animals have been recorded.

The remainder (5.4%) of the five-year accident total consists of non-collision accidents, including an average of 12 rollover accidents per year, 2 cases of driving off of embankments (i.e., without hitting guardrail), and 2 other miscellaneous cases. Rollover accidents typically indicate traveling at high speed. C-470 has posted speed limits of 65 miles per hour, which obviously some motorists exceed, sometimes even under unfavorable driving conditions.

A different type of variable included within all accident types discussed above is involvement of big-rig heavy trucks. C-470 carries the lowest percentage of heavy trucks of any freeway in the Denver metro area, and the prevalence of truck involvement in C-470 accidents is proportional to those low volumes, at about 2.5% (57 accidents out of 2,311 total, including mainline, ramps, and intersections). If truck accidents were more prevalent, out of proportion with truck volumes, this could suggest the presence of roadway design deficiencies (e.g., tight curves), but they are not more prevalent and the accident data do not suggest any such deficiencies.

4.1.2 Mainline Accidents by Location

The bottom row of Table 3 on page 6 indicates the average number of accidents on mainline C-470 on a mile-by-mile basis, from Kipling Parkway (milepost 12.45) to I-25 (milepost 26.2). The segments at the respective project termini are less than one mile in length, and thus have substantially fewer accidents. All segments in-between are one mile long. Traffic volumes on C-470 are highest at the eastern (I-25) end, and gradually diminish for successive segments to the west. This explains why there appear to be fewer accidents per mile in the westernmost parts of the study area.

The average number of yearly accidents for the full-mile segments of the C-470 mainline was approximately 20 and ranged from a low of 8 in mile 13 (Wadsworth Boulevard) to a high of 34 in mile 24 (Quebec Street), as shown in Figure 3. The vicinity of Quebec Street also had the highest number of accidents reported in the 2005 CDOT safety study, based on the data available at that time. The 2008 to 2012 data for mile 24 includes 106 rear-end accidents out of a total of 172, accounting for approximately 62% of the total. This exceeds the 48% average for the corridor overall, and is likely due in large part to traffic congestion.

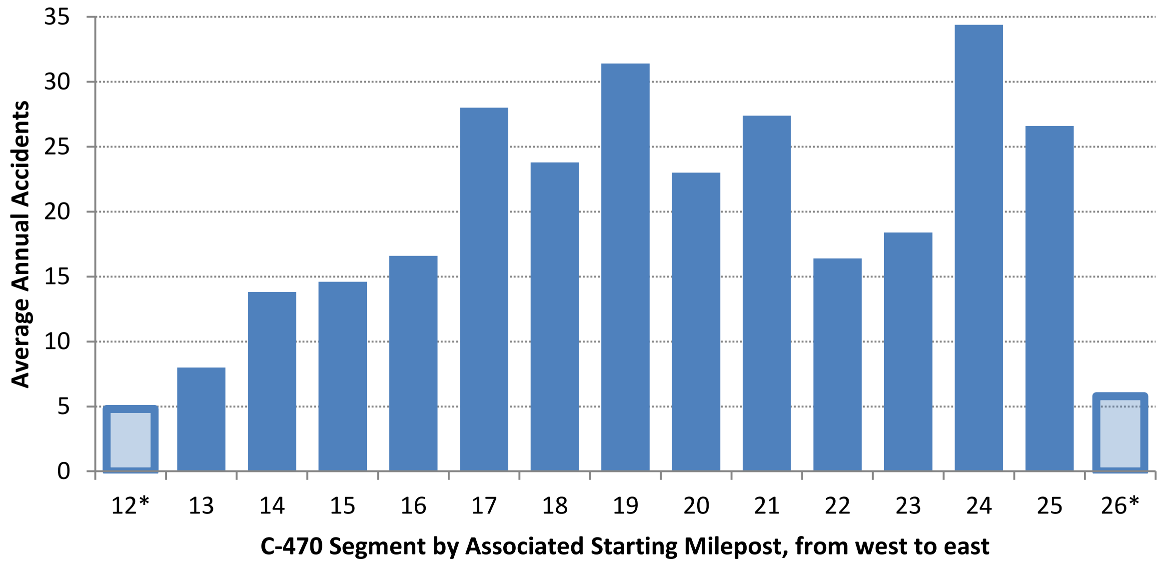
The locations with the highest average annual accidents during 2008 to 2012 were:

- mile 24 (includes the Quebec interchange) - 34 accidents per year
- mile 19 (includes the Broadway interchange) – 31 accidents per year
- mile 17 (includes the Santa Fe interchange) - 28 accidents per year
- mile 21 (includes the University interchange) - 27 accidents per year
- mile 25 (includes the Yosemite interchange) - 27 accidents per year

4.1.3 Accident Trend over Time

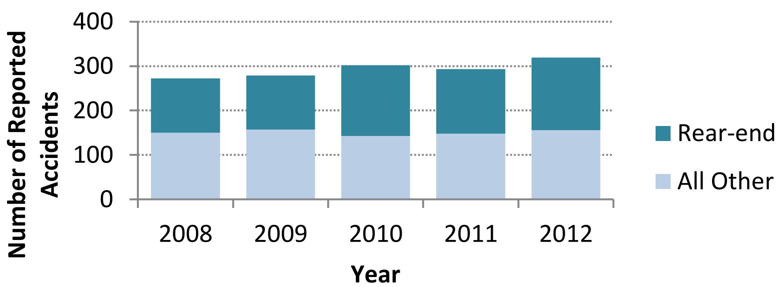
There has been a slight upward trend in the number of C-470 mainline accidents over the past five years, but only for rear-end accidents, as seen in Figure 4. The total number for all other accident types has been stable at about 150 per year, while rear-end accidents have increased and now account for just over half the mainline total.

Figure 3
Average Annual C-470 Mainline Accidents by Mile, 2008 to 2012



** Segment 12 (Milepost 12 to Kipling Parkway) is 0.55 mile long and segment 26 (Milepost 26 to I-25) is 0.2 mile long. All other segments are one mile long.*

Figure 4
C-470 Mainline Rear-End and Total Accidents by Year, 2008 to 2012



4.1.4 Mainline Accidents by Severity

Of the 1,465 C-470 mainline accidents reported during 2008 through 2012, almost 92% resulted in property damage only, almost 8% resulted in one or more injuries, and one half of one percent (8 accidents) resulted in fatalities. The details are shown in Table 4.

Mile-by-mile comparison of injury accidents does not reveal any dense clusters of injury accident locations, and the same is true for the eight accidents that resulted in fatalities. The table reports the number of accidents, not the number of people who were injured or killed.

Table 4
C-470 Mainline Accidents by Mile by Severity, 2008 to 2012

Mile	Vicinity/Landmark	Total Accidents	Property Damage Only	Accident Resulted in Injury	Accident Resulted in Fatality
12[a]	Kipling (MP 12.45)	24	21	2	1
13	Wadsworth (MP 13.9)	40	34	6	0
14	Massey Draw (14.1)	69	68	1	0
15	Platte Canyon (15.44)	73	67	6	0
16	S. Platte River (16.56)	83	73	9	0
17	Santa Fe Drive (17.05)	140	130	9	1
18	Lucent Drive (MP 18.46)	119	109	10	0
19	Broadway (19.6)	157	146	11	1
20	Broadway to University	115	103	10	2
21	University Blvd (MP 21.05)	137	128	9	0
22	Colorado Boulevard	82	69	11	2
23	Holly Street alignment	92	84	8	0
24	Quebec Street (MP 24.15)	172	159	13	0
25	Yosemite Street (MP 25.57)	133	124	8	1
26[b]	Interstate 25 (MP 26.2)	29	28	1	0
	Corridor 5-Year Totals	1,465	1,343	114	8
	Average per Year	**293**	**268**	**23**	**2**

[a] *Segment length is 0.55 mile, not one mile.* [b] *Segment length is 0.2 mile, not one mile.*

4.1.5 Other Factors Contributing to Mainline Accidents

The issues of traffic congestion contributing to rear-end accidents and traffic density contributing to sideswipe (ramp merge or lane change) accidents have been noted above. Additionally, debris, wild animals, or other unexpected objects on the roadway have caused a small percentage of total accidents. Other factors contributing to accidents include driver behavior and weather conditions. These factors are examined below, but first they are examined with regard to the eight fatal accidents reported over the last five years. Table 5 indicates that of the eight accidents that resulted in fatalities, five involved drivers who were impaired (e.g., by alcohol) or had a medical condition that contributed to the crash.

One of the eight fatal accidents involved the very unusual condition of a pedestrian being hit on the highway at night. Three of the fatal accidents appear to have involved no unusual driver circumstances. None of the eight fatal accidents involved rain, snow or icy conditions. This small sample of less than one percent of the 1,465 total mainline accidents does not appear to indicate any particular highway design deficiency. The analysis of contributing factors continues below, examining instead the entire dataset, of which more than 99% did not result in fatalities.

Table 5
General Characteristics of C-470 Fatal Accidents, 2008 to 2012

Mile	Year	Type	Weather and Lighting	Other Factors
12	2008	Other fixed object	None – dark, unlighted	Driver impaired
16	2012	Car hit pedestrian	None – dark, unlighted	None
17	2008	Sideswipe	None – daylight	Driver medical condition
20	2009	Rear end	None – dark, unlighted	Driver impaired
	2012	Rear end	None – daylight	None
22	2009	Cable rail	None – dawn or dusk	Driver medical condition
	2012	Guardrail	None – dawn or dusk	None
25	2012	Guardrail	None – dark, lighted	Driver impaired

Table 6 indicates that a majority (53%) of the reported accidents on the C-470 mainline during 2008 to 2012 involved a driver behavior or condition that was considered to contribute to the crash. The most frequent identifiable factor related to driver behavior was distracted driving, at 23% of all accidents. Distracted driving may include cell phone calling or texting activity, adjusting a radio or other vehicle control, noise from other passengers, eating or drinking while driving, and a number of other possibilities. Cell phone use and texting have definitely increased in recent years. Transportation and law enforcement agencies have responded with public awareness campaigns to discourage distracted driving.

Table 6
Driver-Related Factors Contributing to C-470 Mainline Accidents, 2008 to 2012

Driver Related Contributing Factor	Number of Accidents (Total is 1,465)	Percentage of Total Accidents
No factor identified	692	47%
Identifiable factor (details below)	773	53%
Distracted driver	338	23%
Driver inexperience	139	9%
Driver impaired	75	5%
Driver fatigue	58	4%
Aggressive driving	41	3%
Driver medical condition	22	1%
Other identifiable factor	100	8%

The "driver inexperience" category includes new drivers, such as teenagers, but also includes the frequent response of "driver unfamiliar with the area". For the entire 2,311 accident C-470 dataset (i.e., not just the mainline subset), 17.9% percent of the drivers involved were younger than age 21, and 4.5% of the 2,311 drivers had out-of-state driver's licenses. At the other end of the age scale, 2.7% of the drivers were older than 70, and 0.5% (12 drivers) were more than 80 years old.

Three of the 41 “aggressive driving” cases in the table above were hit-and-run accidents, with the at-fault driver cited. An additional 26 hit-and-run accidents reported by victims or evidenced by resulting damage (e.g., guard rail, light poles) are included in the 692 “no factor identified” category, because the driver was not apprehended and could not be questioned. The total of 29 hit-and-run accidents over five years equate to an average of about 6 per year.

Weather and pavement conditions also can contribute to accidents on mainline C-470. Table 7 indicates that adverse weather was reported for 12% of C-470 accidents, and wet pavement conditions were reported for 15% of the accidents.

Table 7
Weather and Pavement Conditions for Reported C-470 Mainline Accidents, 2008 to 2012

<table>
<tr><th colspan="2">Conditions</th><th>Number of accidents</th><th>Percentage of total accidents</th></tr>
<tr><td rowspan="6">WEATHER</td><td>Dry, clear weather</td><td>1,290</td><td>88%</td></tr>
<tr><td>Adverse weather (details below)</td><td>175</td><td>12%</td></tr>
<tr><td>Rain</td><td>109</td><td>7%</td></tr>
<tr><td>Hail, sleet or snow</td><td>54</td><td>4%</td></tr>
<tr><td>Wind, fog or other</td><td>12</td><td>1%</td></tr>
<tr><td>Weather condition totals</td><td>1,465</td><td>100%</td></tr>
<tr><td rowspan="6">PAVEMENT</td><td>Dry pavement</td><td>1,244</td><td>85%</td></tr>
<tr><td>Wet pavement</td><td>221</td><td>15%</td></tr>
<tr><td>Wet</td><td>90</td><td>6%</td></tr>
<tr><td>Snowy or slushy</td><td>66</td><td>4.5%</td></tr>
<tr><td>Icy</td><td>65</td><td>4.5%</td></tr>
<tr><td>Pavement condition totals</td><td>1,465</td><td>100%</td></tr>
</table>

The numbers for weather conditions and pavement conditions differ because slick pavement conditions can persist after snowfall or rainfall has stopped. Active precipitation reduces visibility while slick pavements reduce vehicle traction and maneuverability, often with splash-back from adjacent vehicles. Obviously, both conditions (active precipitation and wet pavement) occur simultaneously in most cases.

Another factor known to contribute to accidents on east-west portions of C-470 is <u>sun glare</u>. The CDOT accident database does not include statistics on this issue. Residents from along the C-470 corridor who commute eastbound in the morning toward I-25 and then reverse the trip in the late afternoon find themselves driving in the direction of the sun, due to the east-west orientation of the route. The low angle of the sun during peak commuting hours diminishes visibility and thus makes driving more hazardous than driving in the opposite direction. Clear, sunny conditions are far more prevalent in the area than adverse weather conditions, as is reflected by the data in Table 7.

4.2 Accidents on C-470 Ramps

While mainline accidents accounted for 63% of the CDOT accident dataset, accidents on freeway ramps accounted for 18%, the next largest grouping. Freeway ramps make the transition from arterial cross-streets to the high-speed freeway, and vice-versa. On-ramps differ significantly from off-ramps because motorists begin an on-ramp at low speed and accelerate to try to match freeway speeds, whereas off-ramps require deceleration from high speeds to make a stop or a slow turn at the intersection with the arterial. Speeds for traffic entering the highway are controlled by conditions on the highway, while speeds for traffic leaving the highway are controlled by the signalized intersection at the end of the ramp, as well as any traffic backup waiting at that intersection. These situations are highly influenced by the degree of traffic congestion at the particular location involved.

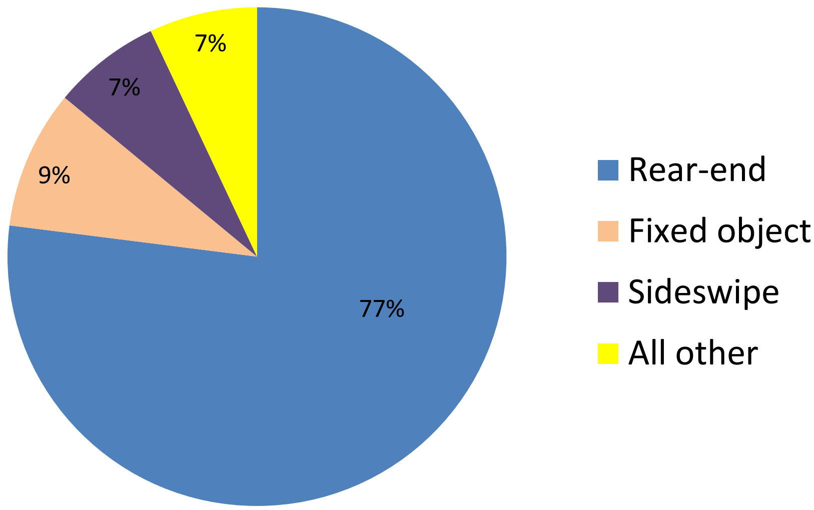
During peak hours, when C-470 traffic is congested, ramp meters at the freeway entrance require a full stop. These signals are intended to preserve traffic flow on the mainline, not to give priority to traffic entering the highway. Figure 5 is a photograph of one of these ramp meters along C-470.

The number and location of accidents on C-470 freeway ramps was indicated earlier, in Table 2. The types of accidents reported on C-470 ramps are indicated in Figure 6.

While rear-end accidents account for half of mainline accidents, they amount to just over three quarters of the accidents on ramps, due to the operational characteristics discussed above. For ramp traffic exiting C-470, intersection improvements could help to address this issue. Note that as reported earlier, three C-470 interchanges have had major reconstruction in recent years, during a portion of the time covered by the 2008 to 2012 accident dataset. For ramp traffic entering the freeway, adding auxiliary lanes could ease some apparently inadequate merge sections, and adding roadway capacity (new through lanes) could reduce traffic density, thereby providing easier freeway entry.

Figure 5
Example of Ramp Meter for Traffic Entering C-470

Figure 6
Accidents on C-470 Ramps, by Type, 2008 to 2012



Note: For this pie chart, 100% = 425 accidents

4.3 Accidents at C-470 Interchange Intersections

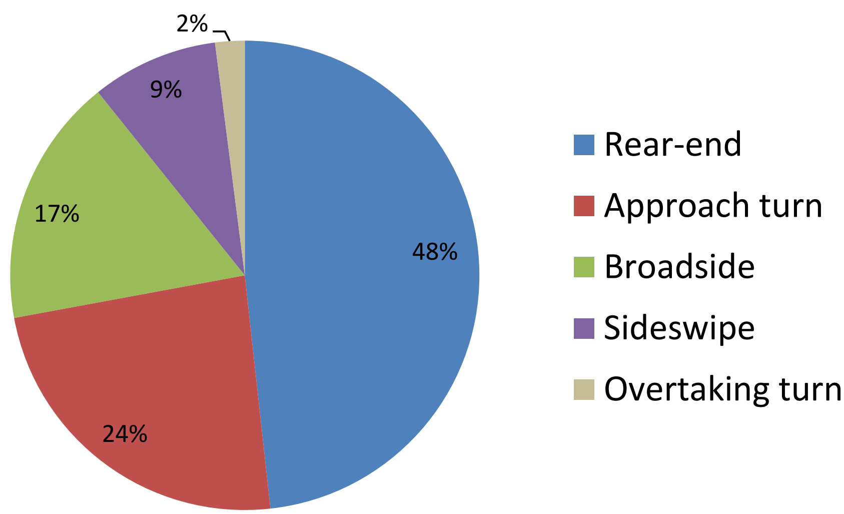
The five-year CDOT dataset of C-470 corridor accident data provided for this study included accident data for five signalized intersections where CDOT on/off ramps meet perpendicular arterial cross streets. Records for 363 accidents, an average of 73 per year, included the following, which are ordered from highest number to lowest number of accidents: Broadway (27 per year), University (25 per year), Yosemite Street (13 per year), Lucent Boulevard (8 per year) and Kipling Boulevard (4 per year). Data were not included for (in west to east order): Wadsworth Boulevard, Platte Canyon Road, Santa Fe Drive and University Boulevard.

Multi-vehicle collisions accounted for 95% of the crashes reported at ramp intersections.

Multi-vehicle collisions in this sample accounted for 344 accidents, or approximately 95% of the 363 total accidents included in the intersection accident sample. Since the percentage of multi-vehicle collisions for the C-470 freeway mainline was 62.2%, a wider variety of accident types occurred on the C-470 mainline than at its ramp intersections. Figure 7 shows substantial percentages for multi-vehicle collision types that were not reported for the mainline: approach turn, broadside, and overtaking turn. Not included in the pie chart is a single head-on accident that occurred at a C-470 ramp intersection in 2011, involving an impaired driver going the wrong way at Quebec Street.

Weather and pavement conditions and prevalence of contributing driver behaviors were already explored for the much larger dataset of mainline accidents, and so are not repeated here. The key finding with respect to accidents at C-470 intersections is that motorists crashed into each other, not roadside objects or debris. Since traffic speeds at intersections are much lower than the 65 mph mainline, motorists have more control of their vehicle and more reaction time.

Figure 7
Multi-Vehicle Collision Types at C-470 Ramp Intersections, 2008 to 2012



Note: For this pie chart, 100% = 343 accidents

Two of the 363 intersection accidents involved a collision between a motorist and a bicycle. These occurred at the Broadway and Quebec interchanges. Both of these occurred during daylight, with no adverse weather conditions or known contributing driver behaviors.

4.4 Other Intersection-Related Accidents

This reporting category of “intersection-related accidents” in the CDOT dataset is difficult to summarize because it includes accidents from all three categories previously discussed. Of 58 total accidents in this category, 28 apparently occurred on arterial cross-streets, 20 on C-470 ramps, and 8 on the CDOT mainline. The associated C-470 mile segments where these accidents occurred were reported in Table 2. The highest number, 19 accidents, was reported for mile 25, in the vicinity of Yosemite Street. At this location, there are various freeway to freeway ramps merging together, so there is some difficulty in identifying what to call a ramp, for reporting purposes. Nineteen accidents over the five-year data period average out to about four accidents per year, and in this segment (mile 25) C-470 has its highest corridor-wide traffic volume. The location with the second highest total, 12 accidents (2 per year) was Broadway. The remaining six “intersection-related” accidents per year were spread out four other full mile segments and both partial-mile segments of the C-470 study area.

Not surprisingly, given the mixed nature of these sites (mainline, ramp and cross-streets), the types of accidents recorded in this category reflects an averaging of the accident types reported earlier for those discrete location types. Rear-end accidents accounted for 58% of the total, sideswipes 14%, and three other multi-vehicle collision types at 9% (1 accident per year) or less. Three accidents involved hitting a fixed object and one involved a vehicle hitting a pedestrian during daylight, in dry weather and pavement conditions, at the Yosemite Street intersection.

Additional analysis of this accident category is not deemed useful, due to the mixed nature of the sample locations and the difficulty in applying any findings to other locations. Additionally, because the number of accidents in this sample in so small, redistributing these 2.5% of all accidents to the other three categories (mainline, ramp and intersection) would not significantly alter any of the findings presented earlier above.

5.0 IMPACTS OF ALTERNATIVES

5.1 No-Action Alternative Safety Impacts

The 2005 CDOT safety analysis included the following findings:

> "In general, the potential for exceptional accident reduction in the study area is only moderate. This is not a surprising result as this highway is of relatively recent construction and was designed to a high standard. This study, however, has revealed the strong association of elevated accident occurrence with periods of high traffic volume and congested conditions. The higher incidence of the characteristic, congestion-related rear end and same direction sideswipe collisions is noted on the mainline as well as throughout most of the included interchanges.
>
> At the included interchanges, most of the safety problems can similarly be attributed to congestion and backups during periods of high traffic volume. Accident problems at interchange-related ramp intersections can be addressed by congestion mitigation such as adding travel and storage lanes, extending existing auxiliary lanes, using protected only left turn phases where approach turn problems exist and verifying adequate yellow and all-red times where broadside problems are present. In locations such as the Santa Fe and Broadway interchanges, more extensive modifications can provide commensurate operational and safety benefits."

Since that time, interchange improvements have been made at the Quebec interchange (2010), Santa Fe Drive (2011) and Broadway (2013). These improvements are so recent that it is not feasible to quantify the safety improvements that have occurred at these locations with certainty. Meanwhile, it was seen in Figure 5 that rear-end accidents on mainline C-470 increased over the five-year period of 2008 to 2012.

Looking forward, increased traffic volumes are anticipated on C-470 with continued regional growth. Congestion on C-470 will continue to increase, potentially resulting in additional rear-end accidents.

5.2 Proposed Action Safety Impacts

The 2005 CDOT safety analysis included the following finding:

> "From a safety improvement perspective, any steps taken to increase capacity and improve traffic operations will have an accident reduction benefit. An overall

> reduction in accidents of 20% - 25% is expected to accompany capacity improvements such as adding an additional lane to the present freeway cross-section."

The Revised EA's Proposed Action would add one or two new lanes (varying by location and future year), potentially resulting in some of the accident reduction noted above.

A notable new feature of the current Proposed Action is that the managed toll express lanes would be separated from the general purpose lanes by a painted buffer width on the roadway surface, rather than by a concrete barrier. A concrete barrier, proposed in the 2006 EA, would have introduced a fixed object into the highway right-of-way, potentially increasing the number of fixed object collisions that currently account for about one quarter (26.3%) of reported C-470 accidents. The lack of a physical barrier between the new managed lanes and the adjacent general purpose lanes means that inevitably some motorists will change lanes across the buffer in locations where such a change is not permitted. This may pose a sideswipe hazard to motorists who expect to see ingress and egress movements occur only at the lawful locations.

Also, since the managed toll express lanes are expected to have higher operating speeds than the general purpose lanes, there would be a speed differential at ingress and egress locations. Speed differentials introduce accident potential at the designated merge locations.

Finally, increased accidents may occur at or near the locations of lawful ingress as motorists try to comprehend the toll information and make a last-second decision whether or not to enter the managed lanes. Advance signing would be installed, of course, to prepare motorists for this decision, but nevertheless some last-second changes of mind may occur. Clear, simple advanced signing is recommended to minimize this scenario. The addition of the needed new signage would introduce new fixed objects into the highway right-of-way, thereby increasing accident potential. However, as noted earlier, a motorist would have to already have lost control and veered off the roadway in order to hit a fixed object.

Recapping, the Proposed Action is expected to decrease rear-end accidents (by far the most prevalent C-470 accident type) by reducing congestion, but will introduce new merging locations, unlawful merges, speed differentials, and additional fixed objects. C-470 as a whole is not known to have high accident rates, and the purpose and need for C-470 improvements is based on traffic congestion and the need for improved travel time reliability, not safety problems. Nevertheless the Proposed Action will be designed in accordance with current, applicable safety standards, which will remedy some deficiencies of the existing freeway.

Traffic Noise Technical Report

For the C-470 Corridor Revised Environmental Assessment

July 2015

Submitted To:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted By:
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1675 Broadway, Suite 200
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TABLES (Cont.)

1.0 INTRODUCTION

The Colorado Department of Transportation (CDOT) and the Federal Highway (FHWA) have identified a need for capacity and mobility improvements to the C-470 corridor from Kipling Parkway to Interstate 25 (I-25). CDOT right-of-way within this portion of the C-470 corridor, which will be referenced as the "project area," is located in the South Denver Metropolitan area and crosses through portions of Douglas, Arapahoe, and Jefferson Counties as shown in **Figure 1**. This Traffic Noise Technical Memorandum describes the results of a noise study conducted along this corridor.

Figure 1. C-470 Corridor and its Surrounding Vicinity

1.1 Purpose and Need

The purpose of this project is to address traffic congestion from Kipling Parkway to I-25, reduce traveler delay, and improve reliability for corridor users.

1.2 Alternatives

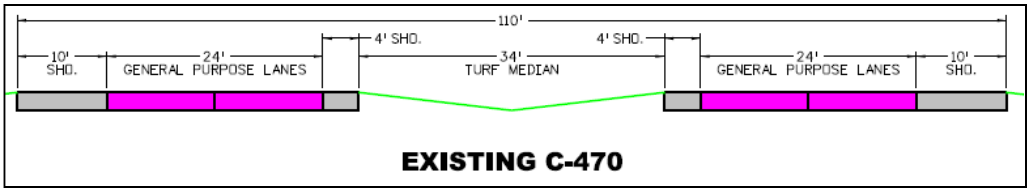
Two alternatives are presented and evaluated in the 2013 Environment Assessment (EA) for the project. These alternatives are the No-Action Alternative and the Proposed Action.

<u>C-470 No-Action Alternative</u>

The No-Action Alternative includes no new construction or action to improve the existing C-470 roadway between Kipling Parkway (milepost 12.449) and Interstate 25 (milepost 26.195) other than performing basic maintenance and/or safety improvements to maintain roadway operation.

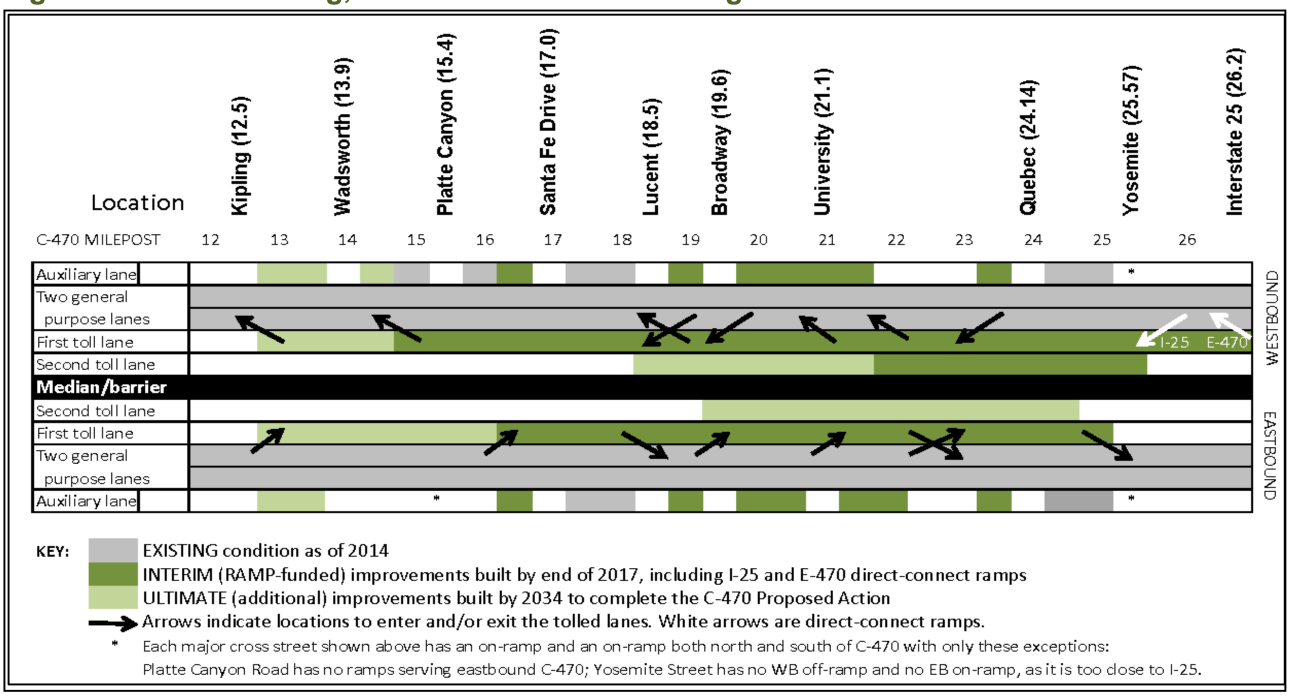
Within the project area limits, the existing C-470 roadway consists of two general purpose lanes in each direction between Kipling Parkway and I-25. An auxiliary lane in each direction exists between the Quebec Street interchange and the I-25 interchange, serving as continuous acceleration and deceleration lanes. The existing roadway consists of 12-foot travel lanes, including auxiliary lanes, with inside and outside shoulders, plus a 34-foot unpaved median, as shown in **Figure 2**. Paved shoulder widths vary between four and ten feet. CDOT has installed ramp metering at all entrance ramps to C-470 within the project area, with the exception of Kipling Parkway. Ramp metering may be installed at that location in the future when warranted.

Figure 2. Existing C-470 Typical Cross Section



<u>C-470 Proposed Action</u>
The C-470 Proposed Action would add managed express lanes and new auxiliary lanes to improve traffic flow, and would reconstruct more than half of the existing pavement to address structural deficiencies. It is expected to be built in two phases. A $230 million construction project to be built by the end of 2017 would provide interim improvements with currently available funds. Additional improvements resulting in the ultimate configuration would complete the Proposed Action by the year 2034. For details, see **Figure 3** below.

Figure 3. C-470 Existing, Interim and Ultimate Configuration

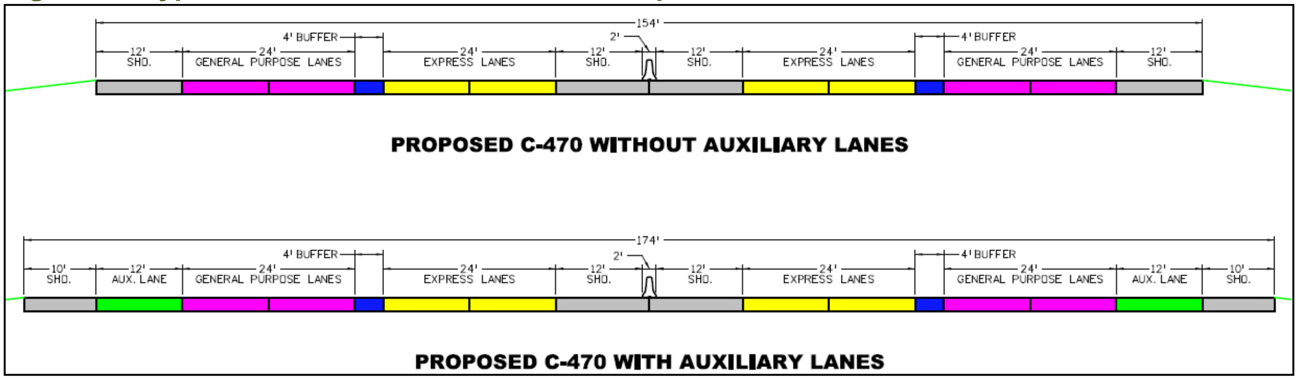


In the more heavily travelled, eastern half of the project, the Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross-section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes.

In the less heavily travelled, western half of the project, the Proposed Action would add only one tolled Managed Express Lane in each direction, but would be designed to accommodate an additional lane in the future. Westbound, the second toll lane would end at Lucent Boulevard, and the westbound single toll lane would end about one mile east of Kipling Parkway. Eastbound, the first toll lane would begin east of Kipling. The second eastbound toll lane would begin in the vicinity of Broadway.

The new proposed typical sections are shown in **Figure 4**, with typical widths of 154 feet and 174 feet.

Figure 4. Typical Cross Sections for C-470 Proposed Action



The Proposed Action includes no new interchanges and no major interchange modifications, except for the addition of two "direct-connect" ramps at the I-25/C-470 interchange.

1.3 Changes from the 2006 C-470 Environmental Assessment

The noise analysis completed in July 2005 for the 2006 C-470 EA was prepared using FHWA's prior noise model (STAMINA), 2002 Federal and state noise abatement guidelines, year 2025 traffic projections, and a slightly different proposed action. No decision document was issued to approve the project. Therefore, the 2005 noise mitigation recommendations are no longer valid and the 2014 noise analysis for the Revised EA supersedes the 2005 analysis.

2.0 APPLICABLE NOISE STANDARDS

The C-470 Proposed Action would use state and federal funds and thus is subject to regulations that govern highway traffic noise for Federal-aid and Federal action projects contained in Part 772 of Title 23 of the Code of Federal Regulations (23CFR772). These regulations describe the methods that must be followed in the evaluation and mitigation of highway traffic noise in Federal-aid and Federal action highway projects. The regulations require each state highway agency to prepare and adopt written guidelines specific to that state which must demonstrate compliance with 23CFR772.

CDOT's Noise Analysis and Abatement Guidelines dated January 15, 2015, see Appendix A, describe CDOT policy and program to implement 23CFR772. These guidelines establish noise abatement criteria, design and cost requirements for noise mitigation. Traffic noise impacts occur when noise levels, for different categories of land uses and activities, meet or exceed the CDOT Noise Abatement Criteria (NAC) shown in **Table 1.** The noise impact threshold for residential (Category B) and recreational outdoor use areas (Category C) receptors is 66 dB(A). The guidelines also state that noise mitigation must be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 dB(A) or more.

Table 1. CDOT Noise Abatement Criteria

Activity Category	Activity Leq(h)*	Evaluation Location	Activity Description
A	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to its intended purpose.
B[1]	66	Exterior	Residential
C[1]	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[1]	71	NA	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	NA	NA	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	NA	NA	Undeveloped lands that are not permitted for development.

[1] Includes undeveloped lands permitted for this activity category.
* Hourly A- weighted sound level in dB(A), reflecting a 1-dB(A) approach value below 23CFR772 values.

CDOT guidelines also outline a method for determining the “feasibility and reasonableness” of proposed mitigation measures. Feasibility issues include:

- Can a 5 dB(A) noise reduction be achieved by constructing a noise barrier or berm?
- Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
- Can a noise barrier or berm less than 20 feet tall be constructed?

Reasonableness issues include:

- Has the design goal of 7 dB(A) noise reduction for mitigation measure been met for at least one impacted receptor?
- Is the Cost Benefit Index below $6,800 per receptor per dB(A) reduced?
- Are more than 50% of benefitted resident/owners in favor of the recommended noise mitigation measure?

This noise analysis complies with regulatory requirements defined in 23CFR772 and CDOT Noise Analysis and Abatement Guidelines approved January 15, 2015 by FHWA.

3.0 NOISE PREDICTION METHODOLOGY

Noise levels were predicted using the TNM 2.5 highway noise level prediction software program developed by the Federal Highway Administration, which is approved for use on CDOT and Federal-aid projects. TNM calculates the hourly noise level at a receptor location based on the following factors:

- the noise emission level of automobiles, medium trucks, heavy trucks, buses, and motorcycles
- the volume and speed of each of these vehicle types on each key roadway
- the relative location of all roadways, receptors, and terrain features
- the type of land cover between each receptor and each roadway

Sub-section 3.1 describes the TNM input data used to predict existing and 2035 design-year conditions. Sub-section 3.2 describes the validation of the model.

The following paragraphs from the Colorado Noise Analysis and Abatement Guidelines explain the technical terminology for the units of measurement that the model uses:

> *Since sound travels in waves, there are also varying frequencies associated with each sound event. The human ear does not respond equally to all frequencies, however, and filtering of these frequencies must be done in order to obtain accurate measurements and descriptions of highway traffic noise, as this noise is comprised of many frequencies. The filtering (weighting of frequencies) of the "A" scale on sound-level meters most closely approximates the average frequency response of the human ear, and is the scale that is used for traffic noise analyses. Decibel units described in this manner are referred to as A-weighted decibels, or dB(A).*
>
> *As sound intensity tends to fluctuate with time, a method is required to describe a noise source, such as a highway, in a steady state condition. The descriptor most commonly used in environmental noise analysis is the equivalent steady state sound level, or Leq. This value is representative of the same amount of acoustic energy that is contained in a time-varying sound measurement over a specified period. For highway traffic noise analyses in Colorado that time period is one hour, and the value then reflects the hourly equivalent sound level, or Leq(h).*

3.1 TNM Model Input and Assumptions

<u>Vehicle Emission Levels</u>
Vehicle emission levels refer to the noise level of vehicles measured at a reference distance and a reference speed. TNM provides separate emission levels for automobiles, medium trucks (trucks with two axles, six tires, and a gross vehicle weight greater than 4500 kg and less than 12,000 kg), and heavy trucks (trucks with three or more axles and a gross vehicle weight greater than 12,000 kg).

<u>Traffic</u>
The loudest hour for noise occurs when the highest volume of traffic is traveling at the highest free flow speed for the particular roadway. This is often <u>not</u> the peak hour, when heavy traffic volumes result in lower speeds. For the C-470 Proposed Action this would be a theoretical point in time when the express, general purpose, and auxiliary lanes are all carrying the highest possible traffic volumes while maintaining free flow speeds. The problem with this scenario is

that demand for express lanes (tolled) does not peak until the general purpose and auxiliary lanes are overly congested. These congested flow rates on the general purpose and auxiliary lanes, while carrying more vehicles, have significantly lower travel speeds and thus do not represent the loudest or worst hours for noise. The same can be said for the other scenario when the general purpose and auxiliary lanes are running at free flow speed with high traffic volumes and express lanes are underutilized.

To replicate the loudest possible noise condition for existing, no-build and the Proposed Action, all lanes of C-470, including cross streets, were modeled with a theoretical maximum traffic volume per lane at the posted speed. This is the worst-case noise scenario for modeling purposes. These traffic volumes, presented in the January 15, 2015 Noise Abatement Guidelines, were developed by CDOT using the Highway Capacity Manual (2000) and TNM.

Truck percentages for the general purpose and auxiliary lanes were developed from June 2014 traffic counts taken at various locations on the corridor. As with many express lane projects, trucks are not expected to use the express lanes. Truckers generally avoid congested peak hours and tolled facilities. For the C-470 noise analysis, one percent trucks were included in the express lanes as a worst-case assumption. The resulting modeled traffic volumes are shown in **Table 2.**

Table 2. Assumed Loudest Hour Traffic

Posted Speed	Volume/Lane/Hour					
	Total	Automobiles	Midsize Trucks	Heavy Trucks	Buses	Motorcycles
General Purpose and Auxiliary Lanes						
65	1800	1,741	36	18	2	2
	100%	97%	2%	1%	0.1%	0.1%
Express Lanes						
65	1800	1,782	12	6	0	0
	100%	99%	0.7%	0.3%	0%	0%

It should be noted that the existing and no-build models result in identical noise level results because of the use of the same maximized worst-case noise and lane geometry.

Terrain

The terrain surrounding C-470 is rolling foothills with both natural and man-made features such as ridges, berms, ponds, and existing noise walls. These features can directly affect the propagation of traffic noise to the surrounding area and receptors. The locations and elevations of the major features along C-470 were determined using the CAD topographic files and included in the TNM model. An example of the modeled terrain features are shown as green lines in the TNM screen shot in **Figure 5**.

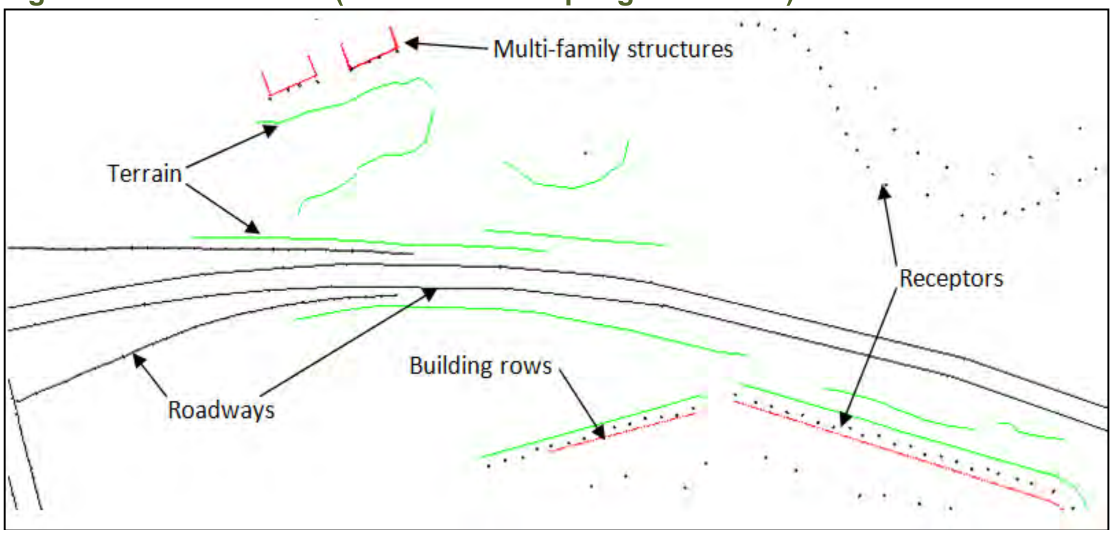
Ground Cover

Throughout the study area, ground cover adjacent to C-470 consists primarily of field grass with sporadic trees.

Buildings

Developed areas along the C-470 corridor have a mix of single and multi-family homes, with commercial properties located primarily around the interchange areas. Closely spaced or large buildings structures impede the transmission of sound from the roadway to the receptors. In TNM, building rows are used to replicate the effect of closely spaced structures and three-sided barriers are used to replicate the effects of large multi-family structures. The locations and elevations of these features was determined using the CAD topographic files and included in the TNM model and are shown in **Figure 5**.

Figure 5. TNM Features (C-470 east of Kipling Boulevard)



Receptors

Modeled receptors, as shown in the TNM screen shot in **Figure 5** and the example location in **Figure 6**, are located in the outdoor use areas of individual residential, commercial, and recreational properties within 500 feet of C-470. All first row homes were modeled as individual receptors. Second and third row homes, depending on modeled noise levels, were either modeled as individual receptors or grouped. Individual 2nd, 3rd, and 4th level residential units with outdoor use areas, such as balconies, were modeled as individual receptors. The locations and elevations of these features was determined using the CAD topographic files and included in the TNM model. Individual receptors locations are identified for each analysis area in Section 4.

Figure 6. Receptor Location Example (Wingate Neighborhood)

<u>Roadways</u>
The existing and proposed roadway alignments, including profiles and pavement width, for C-470 and cross streets, were determined using the CAD roadway design files and topographical survey data and included in the TNM model and are shown in **Figure 5**. Where two lanes are moving traffic in the same direction, e.g. westbound general purpose, the two lanes were combined in a single TNM roadway in the center of the two lanes with the combined traffic. All single travel lanes (e.g., most ramps and auxiliary lanes) were modeled as a single TNM roadway in the center of the lane.

3.2 Validation of Noise Model

The above-described modeling procedures were validated by measuring noise levels at fifteen locations along the corridor and comparing the measured readings with the TNM model predictions for these same locations with the same traffic. These sites are shown in **Figure 7**. Noise levels were measured on July 2nd and 3rd, 2013 which were warm, dry, wind free (less than 10 mph) days, using Quest 2900 integrating/logging level meters. Each meter was field-calibrated before and re-checked after the measurements. At the same time that noise levels were measured, the associated traffic counts, vehicle type data, and average speeds were collected. Noise measurements were collected during off-peak hours to ensure free flow traffic. Two readings were conducted at each site. Modifications to the TNM model were made if required to ensure the model was sufficiently replicating the site conditions and the manner in which sound propagates through the environment.

The measured and predicted noise levels are compared in **Table 3.** The noise model is expected to predict noise levels with an accuracy of ± 3 dB(A), which suggests the model of existing conditions is accurately predicting the noise environment.

Figure 7. Field Measurement Sites

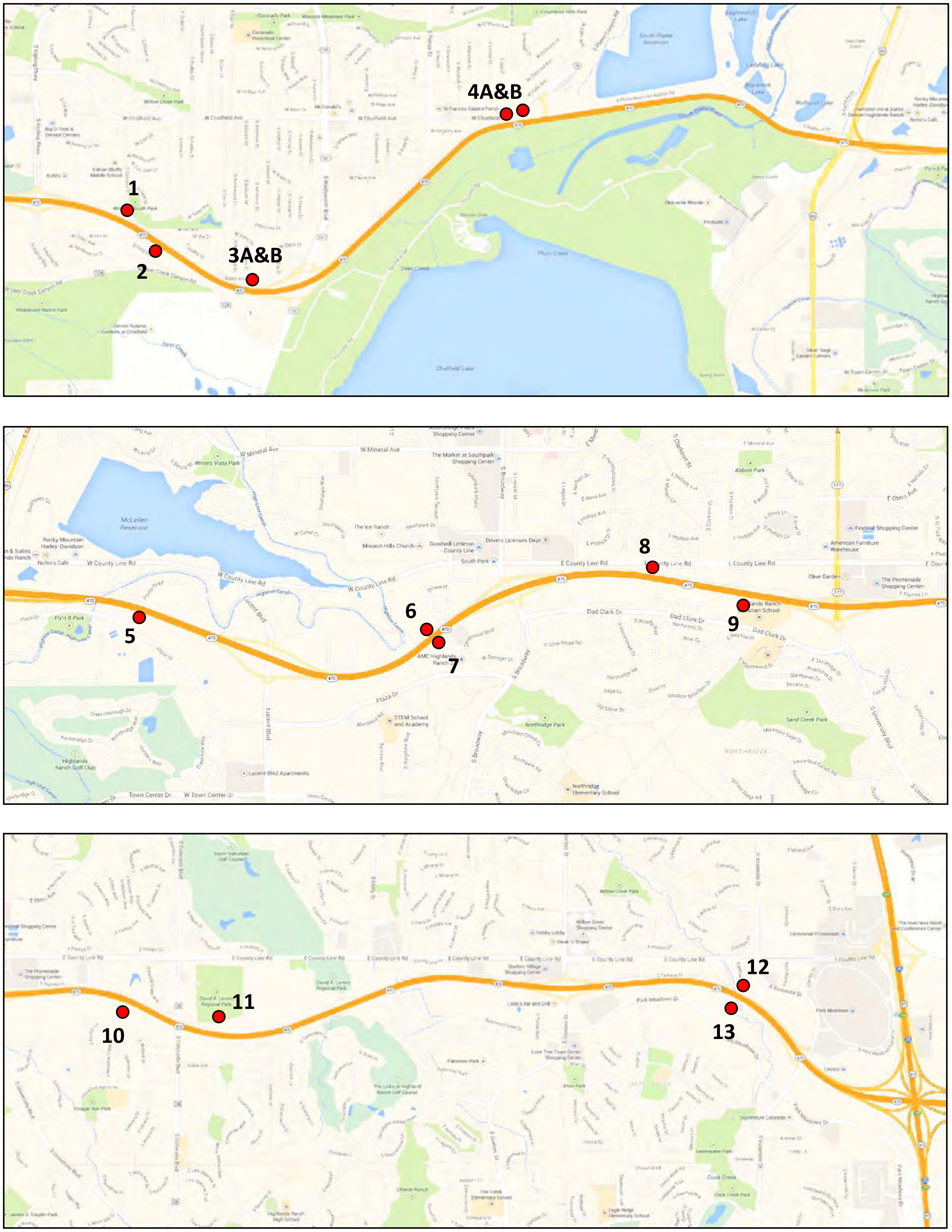


Table 3 - Noise Model Validation

Site #	Location	Field (dB(A) Leq)	Direction of Travel	Traffic (Hourly Equivalent)					Model (dB(A) Leq)	Variance (dB(A) Leq)	Notes/ Issues in Field
				Auto	MT	HT	Mo	Bus			
1 - 1	Deer Creek Park/Pool (east of Kipling)	74.8	WB	1,782	54	42	18	6	73.7	1.1	
			EB	1,212	24	48	6	0			
1 – 2*		77.9	WB	1,668	48	60	30	6	74.0	3.9	Pool traffic & truck
			EB	1,674	12	48	6	0			
2 - 1	Chatfield Bluffs Neighborhood (east of Kipling)	71.2	WB	1,782	54	42	18	6	70.8	0.4	
			EB	1,212	24	48	6	0			
2 - 2		71.8	WB	1,668	48	60	30	6	71.4	0.4	
			EB	1,674	12	48	6	0			
3A - 1	Meadowbrook Home side (N) of berm (west of Wadsworth)	53.7	WB	1,278	42	24	0	0	55.6	-1.9	
			EB	1,506	30	66	6	0			
3A - 2		55.6	WB	1,596	48	66	18	0	56.1	-0.5	
			EB	1,650	6	66	0	0			
3B - 1	Meadowbrook C-470 side (S) of berm (west of Wadsworth)	73.2	WB	1,278	42	24	0	0	71.6	1.6	
			EB	1,506	30	66	6	0			
3B – 2*		68.2	WB	1,596	48	66	18	0	72.3	-4.1	Meter error
			EB	1,650	6	66	0	0			
4A-1	Columbine Hills/Chatfield Ave behind the existing barrier	59.7	WB	2,484	72	54	6	0	61.2	-1.5	
			EB	2,112	36	84	42	24			
			Front	450	6	0	0	0			
4A-2		59.7	WB	2,310	66	54	42	0	61.5	-1.8	
			EB	1,848	6	60	24	0			
			Front	438	0	0	0	0			
4B-1	Columbine Hills/Chatfield Ave	65.5	WB	2,484	72	54	6	0	67.3	-1.8	
			EB	2,112	36	84	42	24			
			Front	450	6	0	0	0			
4B-2		66.6	WB	2,310	66	54	42	0	66.7	-0.1	
			EB	1,848	6	60	24	0			
			Front	438	0	0	0	0			
5-1	Highlands Ranch Sign (Broadway to University)	69.1	WB	3,642	90	42	6	6	67.8	1.3	
			EB	3,444	60	36	18	12			
5-2		67.4	WB	3,744	102	18	24	0	67.8	-0.4	
			EB	3,354	18	54	18	12			
6-1	Bluffs Apts (west of Broadway)	73.8	WB	3,108	60	48	18	0	72.4	1.4	
			EB	2,622	30	36	12	6			
6-2		74.3	WB	3,366	66	78	30	18	73.0	1.3	
			EB	3,354	18	54	18	12			

* Readings 1-2 and 3B-2 varied by greater than 3 dB(A) with the model results and were thus not used in the calibration process.

Table 3 - Noise Model Validation (Cont.)

Site #	Location	Field (dB(A) Leq)	Direction of Travel	Vehicle (Hourly Equivalent) Auto	MT	HT	Mo	Bus	Model (dB(A) Leq)	Variance (dB(A) Leq)	Notes/ Issues in Field
7-1	AMC Theater (west of Broadway)	72.8	WB	3,108	60	48	18	0	74.6	-1.8	
			EB	2,622	30	36	12	6			
7-2		72.2	WB	3,366	66	78	30	18	74.5	-2.3	
			EB	2,616	48	60	36	12			
8-1	U-Stor-it (east of Broadway)	72	WB	2,934	36	48	18	0	74.4	-2.4	
			EB	2,424	102	42	12	6			
8-2		73.6	WB	3,168	30	60	24	12	74.8	-1.2	
			EB	2,796	108	36	18	0			
9-1	Denver Christian HS (west of University)	72.6	WB	2,934	36	48	18	0	74.1	-1.5	
			EB	2,424	102	42	12	6			
9-2		72.6	WB	3,168	30	60	24	12	74.6	-2.0	
			EB	2,796	108	36	18	0			
10-1	Highlands Ranch Sign (University to Colorado)	58.6	WB	2,489	65	32	32	0	60.7	-2.1	
			EB	2,886	30	60	48	18			
10-2		59.1	WB	3,126	66	60	12	6	60.7	-1.6	
			EB	2,760	30	78	12	12			
11-1	David Lorenz Park (east of Colorado)	63.2	WB	2,489	65	32	32	0	64.8	-1.6	
			EB	2,886	30	60	48	18			
11-2		64.1	WB	3,126	66	60	12	6	64.7	-0.6	
			EB	2,760	30	78	12	12			
12-1	Commercial area (N of C-470, west of Park Meadows)	75	WB	2,940	108	54	12	6	74.1	0.9	
			EB	3,576	60	30	24	6			
12-2		75.1	WB	3,144	90	48	12	0	74.2	0.9	
			EB	3,384	90	66	18	6			
13-1	Willow Creek Trail (S of C-470, west of Park Meadows)	65.1	WB	2,940	108	54	12	6	67.2	-2.1	
			EB	3,576	60	30	24	6			
13-1		65.6	WB	3,144	90	48	12	0	67.4	-1.8	
			EB	3,384	90	66	18	6			

4.0 NOISE IMPACT ASSESSMENT AND MITIGATION ANALYSIS

The validated noise models were the basis for the development of the noise prediction models for the 2013 existing, 2035 No Action, and 2035 Proposed Action traffic scenarios. These models were then used to predict noise levels for all receptor locations.

4.1 Noise Impact Assessment

Traffic noise impacts occur when noise levels, for different categories of land uses and activities, meet or exceed the CDOT Noise Abatement Criteria (NAC) shown in **Table 1.** The noise impact threshold for residential (Category B) and recreational outdoor use areas (Category C) receptors is 66 dB(A). The guidelines also state that noise mitigation must be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 dB(A) or more.

4.2 Mitigation Analysis

Any and all receptors which were determined to be impacted by noise must be evaluated for traffic noise mitigation. This requires that the overall social, economic, and environmental effects of the mitigation be evaluated against the benefits. When determining mitigation measures, primary consideration is to be given to exterior areas surrounding residential areas or areas of frequent human use for other uses such as parks and commercial districts where a reduced noise level would be of benefit. All feasible and reasonable mitigation measures are required to be included in the highway project.

The following are common mitigation measures that may be incorporated in highway projects to reduce traffic noise impacts.

- Traffic management measures, such as lane-use restrictions, designated truck routes, and speed limit reductions. While lesser speeds do decrease noise levels, it generally will take a reduction in speed of approximately 20 miles per hour to achieve a readily perceptible (5 dB(A)) reduction of noise at its source
- Alteration of horizontal and vertical alignments to reduce noise impacts. Acquisition of undeveloped land for buffer zone creation. This is not an option as the area is a highly developed corridor with residential uses adjacent to the roadway.
- Noise insulation, but for NAC Activity Category D structures only.
- Construction of noise barriers or earthen berms within highway right-of-way is the most common mitigation measure employed by CDOT and will be evaluated for this project.

CDOT guidelines outline a method for determining the “feasibility and reasonableness” of constructing an acoustically effective noise barrier at a particular site. Feasibility considerations include:

- Can a 5 dB(A) noise reduction be achieved by constructing a noise barrier or berm?
- Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
- Can a noise barrier or berm less than 20 feet tall be constructed?

Reasonableness issues include:

- Is the design goal of 7 dB(A) noise reduction for mitigation measure met for at least one impacted receptor?
- Is the Cost Benefit Index below $6,800 per receptor per dB(A)?

- Are more than 50% of benefitted resident/owners in favor of the recommended noise mitigation measure?

The cost benefit index is not intended to function as an accurate cost itemization for the design and construction of a noise barrier, but rather to provide a consistent level of consideration that will be used for CDOT noise mitigation decision-making. For purposes of the mitigation evaluation, the unit cost for a generic wall, as prescribed by CDOT, is $45 per exposed square foot, which approximates the typical costs in construction of a standard concrete/masonry barrier that does not require special site considerations. This cost is based on an average of 2005 to 2009 noise wall square footage costs collected from CDOT cost tabulations. This cost does not include engineering design, right-of-way acquisition, and utility mitigations.

Communities, recreational resources, and noise sensitive commercial properties within 500 feet of C-470 were analyzed separately for noise impact and mitigation. The areas are as follows; with residential areas in order from west to east:

4.3 Kipling Parkway to Wadsworth Boulevard
- Redstone Ranch
- Chatfield Bluffs
- Wingate
- Meadowbrook

4.4 Wadsworth Boulevard to Santa Fe Drive
- Chatfield Avenue
- Columbine Hills
- Wolhurst

4.5 Santa Fe Drive to Broadway
- Littleton Commons
- Villas at Verona
- Bluffs at Highlands Ranch

4.6 Broadway to University Boulevard
- Township at Highlands Ranch
- Highlands Ranch Dad Clark

4.7 University Boulevard to Colorado Boulevard
- Highlands Ranch Venneford Ranch
- Autumn Chase, Copper Canyon and Canyon Ranch

4.8 Colorado Boulevard to Quebec Street
- Shadow Canyon
- Gleneagles Village
- Palomino Park

4.9 I-25 Crest

4.10 Recreational Resources

4.11 Noise Sensitive Commercial Properties

The analysis description for each area includes:

- Map of receptor locations,
- Screen shot of the TNM model,
- Predicted existing, no build, and 2035 Proposed Action noise levels,
- Change in noise levels between the existing and the Proposed Action,
- Determination of whether predicted noise levels equal or exceed CDOT's abatement criteria, as presented in Section 2.0 Applicable Noise Standards,
- Noise mitigation analysis with feasible and reasonable evaluation (as presented in Section 2.0, Applicable Noise Standards), and
- Mitigation recommendation.

4.3 Kipling Parkway to Wadsworth Boulevard

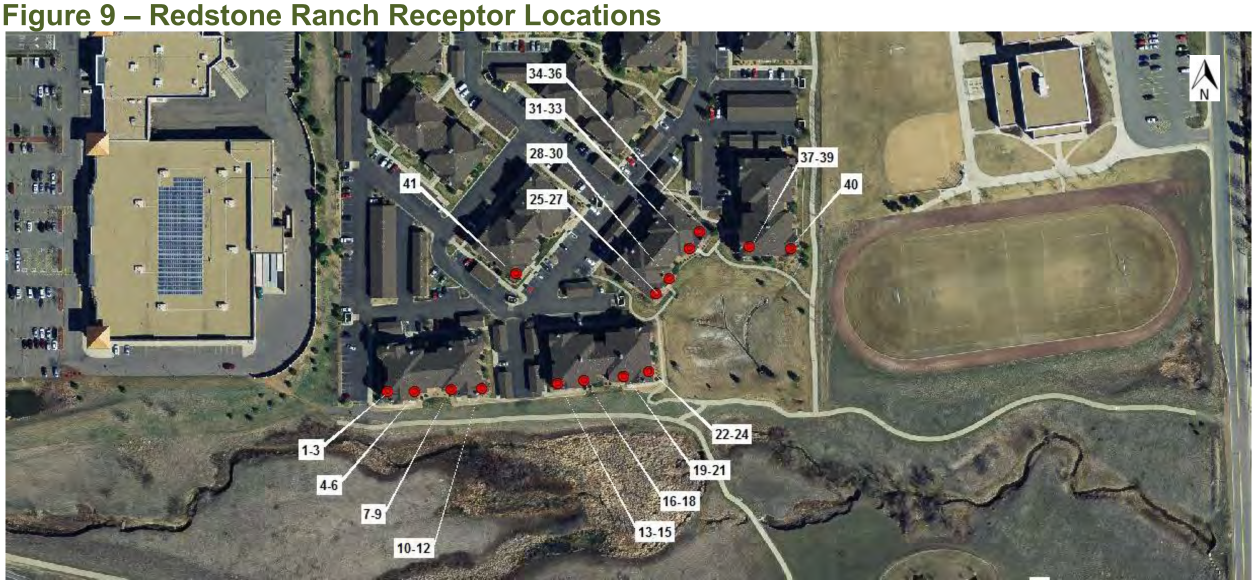
The Kipling Parkway to Wadsworth Boulevard area includes the communities of Redstone Ranch, Chatfield Bluffs, Wingate and Meadowbrook, as shown in **Figure 8**.

Figure 8 – Kipling Parkway to Wadsworth Boulevard

Redstone Ranch

Redstone Ranch is a multi-storied residential complex north of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 9. N**oise levels were predicted at each of 41 receptor locations for both existing and Proposed Action conditions and are shown in **Table 4.**

Figure 9 – Redstone Ranch Receptor Locations



Note: Impacted receptors are shaded green

Table 4 – Redstone Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	58.0	58.4	0.4	No	No
2	Residential	B	60.9	61.3	0.4	No	No
3	Residential	B	62.9	63.0	0.1	No	No
4	Residential	B	57.9	58.3	0.4	No	No
5	Residential	B	60.6	61.0	0.4	No	No
6	Residential	B	62.2	62.5	0.3	No	No
7	Residential	B	58.0	58.5	0.5	No	No
8	Residential	B	60.5	61.1	0.6	No	No
9	Residential	B	62.2	62.5	0.3	No	No
10	Residential	B	57.9	58.5	0.6	No	No
11	Residential	B	60.3	61.0	0.7	No	No
12	Residential	B	61.6	62.4	0.8	No	No
13	Residential	B	57.7	58.0	0.3	No	No
14	Residential	B	60.2	61.0	0.8	No	No
15	Residential	B	61.2	62.3	1.1	No	No
16	Residential	B	57.6	57.9	0.3	No	No
17	Residential	B	60.1	61.1	1.0	No	No
18	Residential	B	61.0	62.4	1.4	No	No
19	Residential	B	57.3	57.8	0.5	No	No
20	Residential	B	60.1	60.9	0.8	No	No
21	Residential	B	61.0	62.3	1.3	No	No
22	Residential	B	56.0	57.1	1.1	No	No
23	Residential	B	59.6	60.5	0.9	No	No
24	Residential	B	60.8	62.1	1.3	No	No
25	Residential	B	51.4	53.4	2.0	No	No
26	Residential	B	56.0	57.2	1.2	No	No
27	Residential	B	58.4	59.7	1.3	No	No
28	Residential	B	51.5	53.2	1.7	No	No
29	Residential	B	55.7	57.0	1.3	No	No
30	Residential	B	58.3	59.5	1.2	No	No
31	Residential	B	51.5	53.2	1.7	No	No
32	Residential	B	55.4	56.8	1.4	No	No
33	Residential	B	58.3	59.3	1.0	No	No
34	Residential	B	51.6	53.1	1.5	No	No
35	Residential	B	55.3	56.6	1.3	No	No
36	Residential	B	58.2	59.0	0.8	No	No
37	Residential	B	51.8	53.5	1.7	No	No
38	Residential	B	55.4	57.0	1.6	No	No
39	Residential	B	58.4	59.3	0.9	No	No
40	Residential	B	51.9	53.9	2.0	No	No
41	Residential	B	52.5	53.0	0.5	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. This table contains no impacted receptors

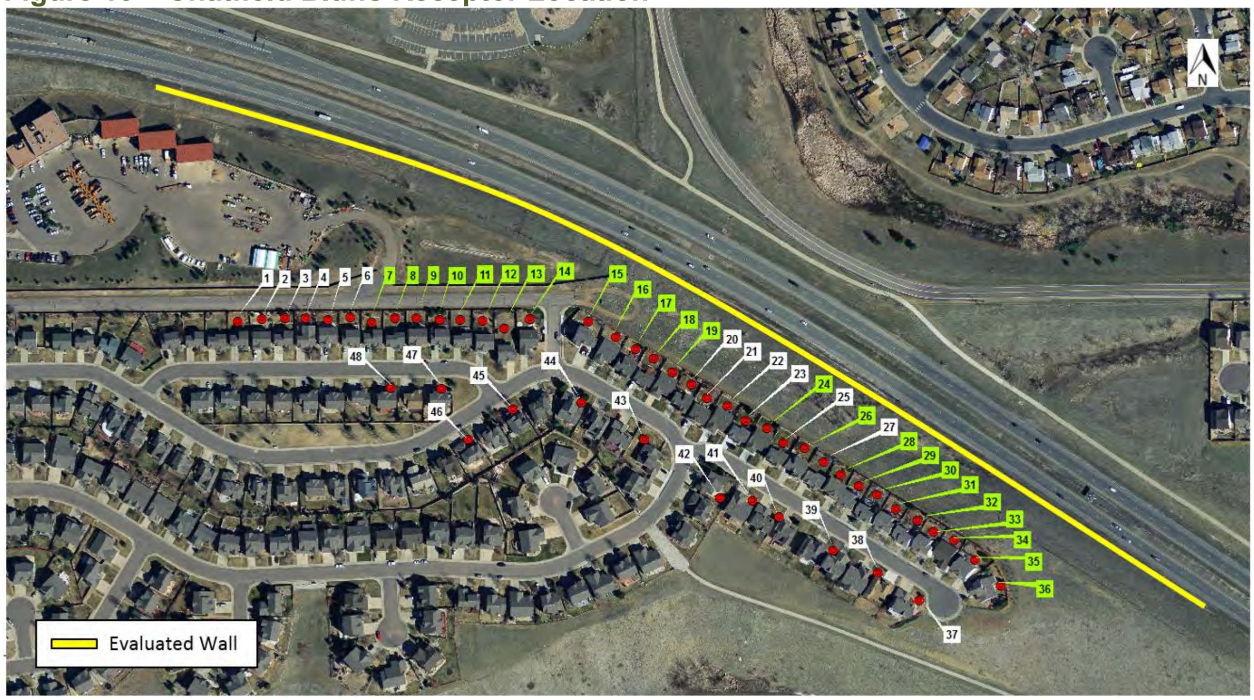
Redstone Ranch Noise Impact Assessment

Table 4 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. No receptors equal or exceed CDOT impact criteria for residential properties. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation.

Chatfield Bluffs

Chatfield Bluffs is a single-family residential development south of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 10. Figure 11** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 5.**

Figure 10 – Chatfield Bluffs Receptor Location



Note: Impacted receptors are shaded green

Figure 11 – Chatfield Bluffs TNM Proposed Action Model View

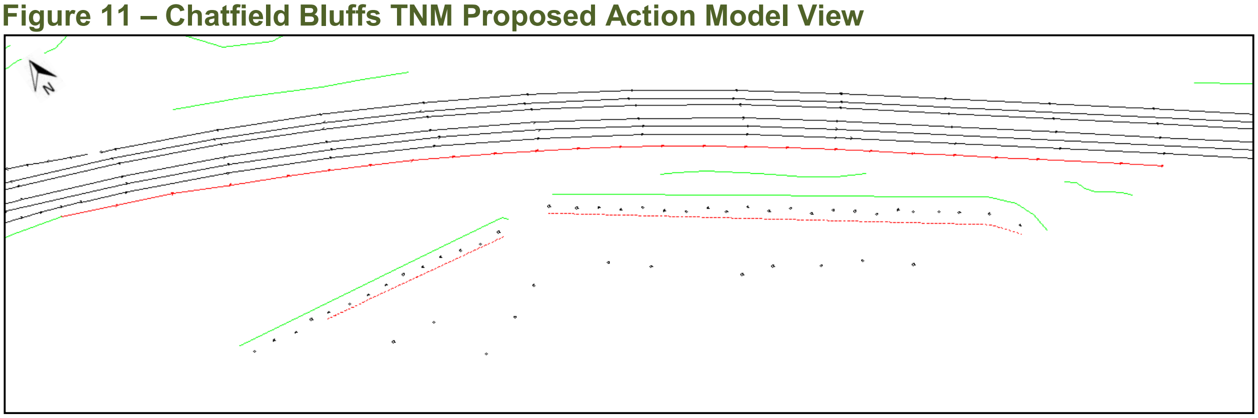


Table 5 – Chatfield Bluffs Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	60.9	63.8	2.9	No	No
2	Residential	B	60.9	64.2	3.3	No	No
3	Residential	B	61.2	64.1	2.9	No	No
4	Residential	B	61.5	65.1	3.6	No	No
5	Residential	B	61.4	65.1	3.7	No	No
6	Residential	B	61.5	65.2	3.7	No	No
7	Residential	B	61.7	65.5	3.8	Yes	No
8	Residential	B	61.8	65.9	4.1	Yes	No
9	Residential	B	62.1	66.9	4.8	Yes	No
10	Residential	B	62.2	67.0	4.8	Yes	No
11	Residential	B	62.3	67.6	5.3	Yes	No
12	Residential	B	62.6	68.0	5.4	Yes	No
13	Residential	B	62.7	68.4	5.7	Yes	No
14	Residential	B	64.3	70.1	5.8	Yes	No
15	Residential	B	69.2	73.3	4.1	Yes	No
16	Residential	B	68.2	72.6	4.4	Yes	No
17	Residential	B	67.8	72.2	4.4	Yes	No
18	Residential	B	64.8	69.5	4.7	Yes	No
19	Residential	B	64.7	68.8	4.1	Yes	No
20	Residential	B	62.1	65.2	3.1	No	No
21	Residential	B	61.9	64.2	2.3	No	No
22	Residential	B	63.0	65.1	2.1	No	No
23	Residential	B	61.7	64.1	2.4	No	No
24	Residential	B	64.3	66.4	2.1	Yes	No
25	Residential	B	62.6	64.9	2.3	No	No
26	Residential	B	64.7	67.2	2.5	Yes	No
27	Residential	B	62.7	65.4	2.7	No	No
28	Residential	B	67.9	71.2	3.3	Yes	No
29	Residential	B	68.8	71.9	3.1	Yes	No
30	Residential	B	67.8	71.2	3.4	Yes	No
31	Residential	B	69.5	72.4	2.9	Yes	No
32	Residential	B	68.7	71.9	3.2	Yes	No
33	Residential	B	68.3	71.4	3.1	Yes	No
34	Residential	B	66.6	69.9	3.3	Yes	No
35	Residential	B	65.0	69.1	4.1	Yes	No
36	Residential	B	64.2	68.1	3.9	Yes	No
37	Residential	B	54.6	57.9	3.3	No	No
38	Residential	B	52.5	55.2	2.7	No	No
39	Residential	B	51.9	54.7	2.8	No	No
40	Residential	B	51.2	54.5	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 5 – Chatfield Bluffs Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
41	Residential	B	52.3	55.7	3.4	No	No
42	Residential	B	54.9	58.8	3.9	No	No
43	Residential	B	56.7	61.2	4.5	No	No
44	Residential	B	57.1	62.3	5.2	No	No
45	Residential	B	56.6	60.4	3.8	No	No
46	Residential	B	55.1	58.8	3.7	No	No
47	Residential	B	55.7	58.9	3.2	No	No
48	Residential	B	55.4	58.2	2.8	No	No
41	Residential	B	52.3	55.7	3.4	No	No
42	Residential	B	54.9	58.8	3.9	No	No
43	Residential	B	56.7	61.2	4.5	No	No
44	Residential	B	57.1	62.3	5.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Chatfield Bluffs Noise Impact Assessment

Table 5 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 10** and **Table 5.** Twenty-four receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 73.3 dB(A) at receptor 15. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Chatfield Bluffs Noise Mitigation Assessment

A 2,650 foot long noise wall was modeled in C-470 right-of-way with heights up to 20 feet. The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 2,500 feet long averaging and 18.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 10 dB(A) exceeding the 7 dB(A) design goal reduction. However, several locations, such as receptors 24 and 25, were unable to receive the minimal 5 dB(A) reduction with a 20 foot tall barrier. The insertion losses are presented in Table 5. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$2,081,250	(Cost of wall = 2,500 feet long x 18.5 feet tall x $45/sf = $2,081,250)
÷ 165.8	(Total dB(A) reduction for the 24 receptors with equal to or greater than 5 dB(A) reduction)
$12,553	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 6 – Chatfield Bluffs Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
7	Residential	B	65.5	60.4	5.1
8	Residential	B	65.9	60.2	5.7
9	Residential	B	66.9	60.5	6.4
10	Residential	B	67.0	60.3	6.7
11	Residential	B	67.6	60.4	7.2
12	Residential	B	68.0	60.4	7.6
13	Residential	B	68.4	60.5	7.9
14	Residential	B	70.1	61.1	9.0
15	Residential	B	73.3	63.2	10.1
16	Residential	B	72.6	62.4	10.2
17	Residential	B	72.2	62.4	9.8
18	Residential	B	69.5	62.0	7.5
19	Residential	B	68.8	62.6	6.2
24	Residential	B	66.4	63.2	3.2
26	Residential	B	67.2	62.7	4.5
28	Residential	B	71.2	62.6	8.6
29	Residential	B	71.9	62.6	9.3
30	Residential	B	71.2	62.5	8.7
31	Residential	B	72.4	63.6	8.8
32	Residential	B	71.9	63.7	8.2
33	Residential	B	71.4	64.2	7.2
34	Residential	B	69.9	64.4	5.5
35	Residential	B	69.1	64.1	5.0
36	Residential	B	68.1	63.0	5.1
				Total dB(A) Reduction (5dB(A) or greater)	**165.8**

In summary, the Chatfield Bluffs area has twenty-four impacted receptors that could benefit from noise mitigation. However, the CBI is above CDOT's cost threshold and mitigation is not recommended.

Wingate

Wingate is a single-family residential development north of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Receptors were developed for each front and select second row outdoor use area as shown in **Figure 12.** Existing and future noise levels are presented in **Table 7.**

Wingate Noise Impact Assessment

Using the above described prediction methodology, noise levels were predicted at each front row and selected second row outdoor use areas as shown in **Figure 12** for both existing and Proposed Action conditions. **Table 7** shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. The highest predicted future noise level is 65.1 dB(A) at receptor 11. No receptors equal or exceed CDOT impact criteria for residential properties. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation.

Figure 12 – Wingate Receptor Locations

Note: Impacted receptors are shaded green

Table 7 – Wingate Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	54.2	57.3	3.1	No	No
2	Residential	B	54.9	58.0	3.1	No	No
3	Residential	B	55.6	58.9	3.3	No	No
4	Residential	B	56.4	59.7	3.3	No	No
5	Residential	B	57.5	60.3	2.8	No	No
6	Residential	B	58.4	61.6	3.2	No	No
7	Residential	B	59.1	63.0	3.9	No	No
8	Residential	B	59.9	63.7	3.8	No	No
9	Residential	B	60.4	64.0	3.6	No	No
10	Residential	B	61.2	64.8	3.6	No	No
11	Residential	B	61.2	65.1	3.9	No	No
12	Residential	B	60.8	64.0	3.2	No	No
13	Residential	B	60.5	63.9	3.4	No	No
14	Residential	B	59.5	63.0	3.5	No	No
15	Residential	B	59.0	62.2	3.2	No	No
16	Residential	B	57.8	61.4	3.6	No	No
17	Residential	B	56.6	60.4	3.8	No	No
18	Residential	B	55.5	59.5	4.0	No	No
19	Residential	B	54.9	58.8	3.9	No	No
20	Residential	B	54.5	58.4	3.9	No	No
21	Residential	B	54.2	58.2	4.0	No	No
22	Residential	B	53.8	57.8	4.0	No	No
23	Residential	B	53.7	57.8	4.1	No	No
24	Residential	B	53.8	58.0	4.2	No	No
25	Residential	B	52.4	57.4	5.0	No	No
26	Residential	B	52.3	57.2	4.9	No	No
27	Residential	B	52.8	57.4	4.6	No	No
28	Residential	B	53.7	57.7	4.0	No	No
29	Residential	B	55.3	59.4	4.1	No	No
30	Residential	B	57.4	61.1	3.7	No	No
31	Residential	B	58.1	61.8	3.7	No	No
32	Residential	B	58.8	62.4	3.6	No	No
33	Residential	B	58.7	62.0	3.3	No	No
34	Residential	B	57.3	60.3	3.0	No	No
35	Residential	B	55.4	58.3	2.9	No	No
36	Residential	B	60.9	57.0	-3.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. This table contains no impacted receptors

Meadowbrook

Meadowbrook is a single-family residential development north of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Two large berms and existing noise walls along C-470 provide significant traffic noise attenuation today and into the future. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and selected second row outdoor use areas as shown in **Figure 13. Figure 14** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 8.**

Figure 13 – Meadowbrook Receptor Locations

Note: Impacted receptors are shaded green

Figure 14 – Meadowbrook TNM Proposed Action Model View

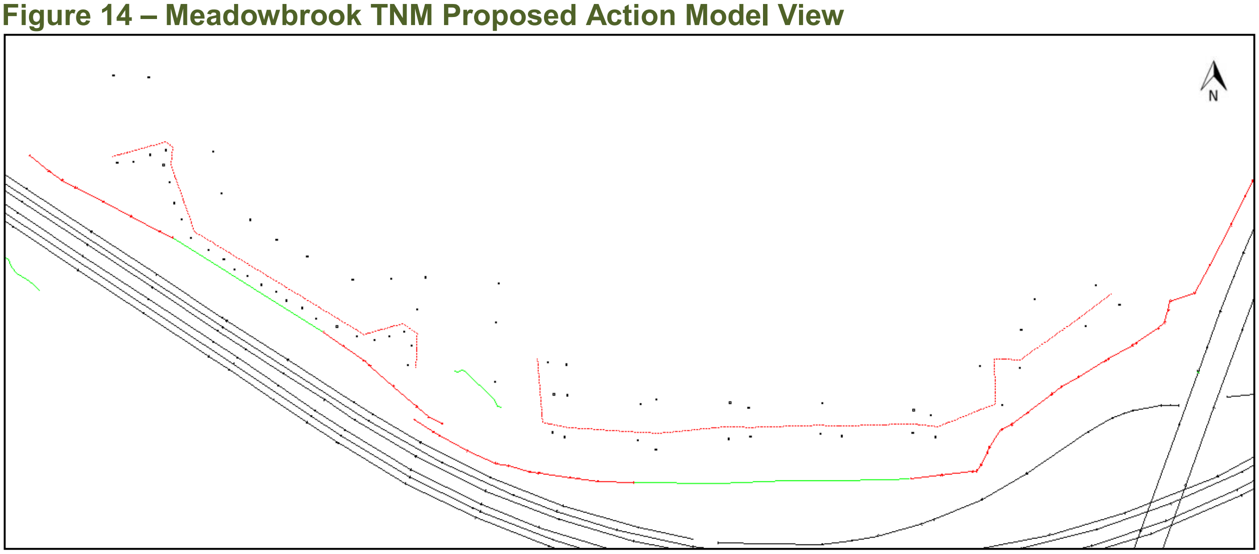


Table 8 – Meadowbrook Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	57.2	59.2	2.0	No	No
2	Residential	B	64.5	67.0	2.5	Yes	No
3	Residential	B	61.0	62.9	1.9	No	No
4	Residential	B	58.6	60.7	2.1	No	No
5	Residential	B	56.6	59.0	2.4	No	No
6	Residential	B	56.1	58.5	2.4	No	No
7	Residential	B	56.3	59.1	2.8	No	No
8	Residential	B	56.4	59.4	3.0	No	No
9	Residential	B	57.7	61.5	3.8	No	No
10	Residential	B	58.7	63.4	4.7	No	No
11	Residential	B	64.6	69.7	5.1	Yes	No
12	Residential	B	66.5	70.9	4.4	Yes	No
13	Residential	B	65.1	69.8	4.7	Yes	No
14	Residential	B	68.0	71.6	3.6	Yes	No
15	Residential	B	61.1	65.9	4.8	Yes	No
16	Residential	B	58.4	63.6	5.2	No	No
17	Residential	B	61.2	65.9	4.7	Yes	No
18	Residential	B	62.4	66.7	4.3	Yes	No
19	Residential	B	62.6	67.3	4.7	Yes	No
20	Residential	B	59.8	63.2	3.4	No	No
21	Residential	B	60.2	63.4	3.2	No	No
22	Residential	B	59.0	62.2	3.2	No	No
23	Residential	B	58.5	61.7	3.2	No	No
24	Residential	B	57.6	61.1	3.5	No	No
25	Residential	B	57.8	61.2	3.4	No	No
26	Residential	B	60.0	63.5	3.5	No	No
27	Residential	B	59.7	63.1	3.4	No	No
28	Residential	B	56.6	60.3	3.7	No	No
29	Residential	B	56.7	60.1	3.4	No	No
30	Residential	B	57.4	61.2	3.8	No	No
31	Residential	B	59.7	63.1	3.4	No	No
32	Residential	B	60.6	63.5	2.9	No	No
33	Residential	B	59.9	64.3	4.4	No	No
34	Residential	B	60.3	64.7	4.4	No	No
35	Residential	B	59.0	63.6	4.6	No	No
36	Residential	B	60.4	65.3	4.9	No	No
37	Residential	B	63.2	68.0	4.8	Yes	No
38	Residential	B	66.0	70.2	4.2	Yes	No
39	Residential	B	59.8	64.1	4.3	No	No
40	Residential	B	57.9	62.2	4.3	No	No
41	Residential	B	55.8	59.1	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 8 – Meadowbrook Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
42	Residential	B	56.6	60.6	4.0	No	No
43	Residential	B	57.2	61.0	3.8	No	No
44	Residential	B	56.6	60.1	3.5	No	No
45	Residential	B	56.6	59.7	3.1	No	No
46	Residential	B	55.4	58.6	3.2	No	No
47	Residential	B	54.9	58.6	3.7	No	No
48	Residential	B	55.5	60.3	4.8	No	No
49	Residential	B	58.0	62.9	4.9	No	No
50	Residential	B	55.1	59.1	4.0	No	No
51	Residential	B	56.6	61.5	4.9	No	No
52	Residential	B	60.5	65.3	4.8	No	No
53	Residential	B	63.9	68.1	4.2	Yes	No
54	Residential	B	62.3	67.2	4.9	Yes	No
55	Residential	B	57.7	61.6	3.9	No	No
56	Residential	B	57.5	61.0	3.5	No	No
57	Residential	B	56.8	59.6	2.8	No	No
58	Residential	B	56.8	59.4	2.6	No	No
59	Residential	B	56.0	58.2	2.2	No	No
60	Residential	B	59.6	62.4	2.8	No	No
61	Residential	B	61.4	64.0	2.6	No	No
62	Residential	B	61.4	62.6	1.2	No	No
63	Residential	B	58.8	60.7	1.9	No	No
64	Residential	B	58.0	60.8	2.8	No	No
65	Residential	B	55.5	57.3	1.8	No	No
66	Residential	B	55.4	57.3	1.9	No	No
67	Residential	B	57.9	59.6	1.7	No	No
68	Residential	B	60.4	65.3	4.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Meadowbrook Noise Impact Assessment

Table 8 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 10** and **Table 5.** Thirteen receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.6 dB(A) at receptor 14. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Meadowbrook Noise Mitigation Assessment

The impacted receptors were grouped in three distinct areas: the western area beyond the existing rise in the topography; the central area between the western rise in topography and the eastern berm; and the eastern area of the community near Wadsworth Avenue as shown in **Figure 13.** Walls up to 20 feet tall were modeled in C-470 right-of-way for each area.

Western - For the western end of the community, only receptors M37 and M38 are impacted. The optimal wall providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 485 feet long and averaging 18.4 feet tall. This wall provided over 5 dB(A) in noise reduction and did achieve the design goal of 7 dB(A) of noise reduction for one receptor. The insertion losses are presented in **Table 9**. No other receptors received 5 dB(A) of noise reduction. CDOT has set a noise barrier cost of $45 per square foot for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$401,580	(Cost of wall = 485 feet long x 18.4 feet tall x $45/sf = $401,580)
÷ 18.9	(Total dB(A) reduction for the 3 receptors with equal to or greater than 5 dB(A) reduction)
$21,248	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Central – A combination of overlapping walls, to accommodate the trail, and extension of the existing noise barrier were modeled in C-470 right-of-way with heights up to 20 feet. The optimal wall configuration, providing the greatest noise reduction for impacted receptors per square foot of wall, was a combination of a 485 long wall with an average height of 13.5 feet and 340 foot long wall with an average height of 19.2, and a 410 foot long extension of the existing wall with and average extension of 8 feet. With this optimized wall is predicted to provided impacted properties with at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 8.2 dB(A), achieving the design goal of 7 dB(A). The insertion losses are presented in **Table 9**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$294,638	(Cost of 1st segment of combined wall = 485 feet long x 13.5 feet tall x $45/sf = $294,638)
$293,760	(Cost of 2nd segment of combined wall = 340 feet long x 19.2 feet tall x $45/sf = $293,760)
$147,600	(Cost of 3rd segment of combined wall = 410 feet long x 8 feet tall x $45/sf = $147,600)
$735,998	Total
÷ 58.3	(Total dB(A) reduction for all receptors with equal to or greater than 5 dB(A) reduction)
$12,624	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Eastern - For the eastern end of the community the only impacted receptor is M2. The optimal wall providing the greatest noise reduction was a combination of filling in the gap between two existing noise walls (68 foot long by 12 feet high) and an extension up of on existing wall (400 feet long by 10 feet high). This combination of walls provided 7.0 dB(A) in noise reduction, achieving the design goal of 7 dB(A) of noise reduction. The insertion loss is presented in **Table 9**. No other receptors received 5 dB(A) of noise reduction. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$ 36,720	(Cost of gap segment of combined wall = 68 feet long x 12 feet tall x $45/sf = $36,720)
$180,000	(Cost of extension segment of combined wall = 400 feet long x 10 feet tall x $45/sf = $180,000)
$216,720	Total
÷ 7.0	(Total dB(A) reduction for all receptors with equal to or greater than 5 dB(A) reduction)
$ 30,960	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 9 – Meadowbrook Impacted Receptors with Mitigation

Impacted Receptors				Modeled Noise Levels (dB(A))		
ID No.		Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Western	36	Residential	B	65.3	59.8	5.5
	37	Residential	B	68.0	61.6	6.4
	38	Residential	B	70.2	63.2	7.0
	Total dB(A) Reduction (5dB(A) or greater)					**18.9**
Central	11	Residential	B	69.7	63.3	6.4
	12	Residential	B	70.9	64.2	6.7
	13	Residential	B	69.8	63.5	6.3
	14	Residential	B	71.6	63.4	8.2
	15	Residential	B	65.9	60.8	5.1
	17	Residential	B	65.9	60.8	5.1
	18	Residential	B	66.7	61.6	5.1
	19	Residential	B	67.3	62.3	5.0
	53	Residential	B	68.1	62.8	5.3
	54	Residential	B	67.2	62.1	5.1
	Total dB(A) Reduction (5dB(A) or greater)					**58.3**
Eastern	2	Residential	B	67.0	60.0	7.0
	Total dB(A) Reduction (5dB(A) or greater)					**7.0**

In summary, the Meadowbrook area has 14 receptors that could benefit from noise mitigation. However, the CBI is above CDOT's cost threshold and mitigation is not recommended.

4.4 Wadsworth Boulevard to Santa Fe Drive

The Wadsworth Boulevard to Santa Fe area includes the communities of Chatfield Avenue, Columbine Hills and Wolhurst as shown in **Figure 15**.

Figure 15 – Wadsworth Boulevard to Santa Fe Drive

Chatfield Avenue

Chatfield Avenue is a single family residential development north of C-470 between Santa Fe Drive and Wadsworth Boulevard as shown in **Figure 15**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 16. Figure 17** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 10.**

Figure 16 – Chatfield Avenue Receptor Locations

Note: Impacted receptors are shaded green

Figure 17 – Chatfield Avenue TNM Proposed Action Model View

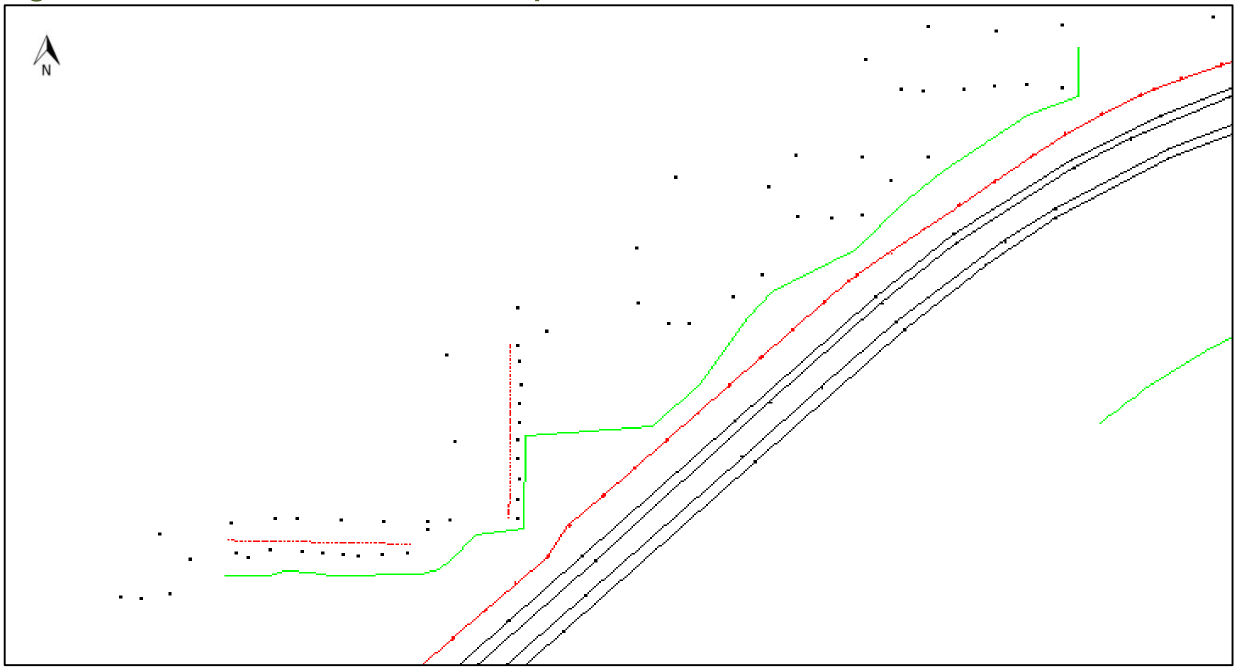


Table 10 – Chatfield Avenue Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	56.7	57.8	1.1	No	No
2	Residential	B	56.0	57.1	1.1	No	No
3	Residential	B	55.6	56.6	1.0	No	No
4	Residential	B	55.2	56.3	1.1	No	No
5	Residential	B	54.7	55.9	1.2	No	No
6	Residential	B	54.5	55.7	1.2	No	No
7	Residential	B	54.7	56.2	1.5	No	No
8	Residential	B	55.5	57.2	1.7	No	No
9	Residential	B	57.1	59.2	2.1	No	No
10	Residential	B	56.4	58.6	2.2	No	No
11	Residential	B	55.8	58.1	2.3	No	No
12	Residential	B	58.5	61.0	2.5	No	No
13	Residential	B	60.1	62.8	2.7	No	No
14	Residential	B	59.0	61.7	2.7	No	No
15	Residential	B	58.6	61.3	2.7	No	No
16	Residential	B	57.9	60.4	2.5	No	No
17	Residential	B	59.4	61.5	2.1	No	No
18	Residential	B	59.5	61.7	2.2	No	No
19	Residential	B	60.2	62.4	2.2	No	No
20	Residential	B	61.0	63.6	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 10 – Chatfield Avenue Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
21	Residential	B	61.8	64.7	2.9	No	No
22	Residential	B	62.5	65.8	3.3	Yes	No
23	Residential	B	63.2	66.6	3.4	Yes	No
24	Residential	B	63.5	67.0	3.5	Yes	No
25	Residential	B	64.8	68.7	3.9	Yes	No
26	Residential	B	66.9	70.4	3.5	Yes	No
27	Residential	B	68.5	71.7	3.2	Yes	No
28	Residential	B	64.6	68.3	3.7	Yes	No
29	Residential	B	63.5	67.8	4.3	Yes	No
30	Residential	B	64.4	68.2	3.8	Yes	No
31	Residential	B	62.8	66.9	4.1	Yes	No
32	Residential	B	61.7	65.6	3.9	Yes	No
33	Residential	B	61.3	64.9	3.6	No	No
34	Residential	B	60.7	63.9	3.2	No	No
35	Residential	B	60.4	63.0	2.6	No	No
36	Residential	B	60.0	61.8	1.8	No	No
37	Residential	B	59.5	61.0	1.5	No	No
38	Residential	B	59.3	60.6	1.3	No	No
39	Residential	B	58.3	59.4	1.1	No	No
40	Residential	B	58.9	59.5	0.6	No	No
41	Residential	B	58.3	58.9	0.6	No	No
42	Residential	B	57.6	58.6	1.0	No	No
43	Residential	B	56.5	58.3	1.8	No	No
44	Residential	B	62.0	63.5	1.5	No	No
45	Residential	B	62.7	64.5	1.8	No	No
46	Residential	B	63.1	64.9	1.8	No	No
47	Residential	B	63.9	65.9	2.0	No	No
48	Residential	B	64.4	67.0	2.6	Yes	No
49	Residential	B	63.7	67.7	4.0	Yes	No
50	Residential	B	61.9	64.8	2.9	No	No
51	Residential	B	59.4	62.2	2.8	No	No
52	Residential	B	57.6	59.8	2.2	No	No
53	Residential	B	57.0	59.1	2.1	No	No
54	Residential	B	53.4	55.6	2.2	No	No
55	Residential	B	54.1	56.4	2.3	No	No
56	Residential	B	53.0	55.0	2.0	No	No
57	Residential	B	54.1	55.9	1.8	No	No
58	Residential	B	55.7	56.5	0.8	No	No
59	Residential	B	60.8	61.0	0.2	No	No
60	Residential	B	60.1	60.5	0.4	No	No
61	Residential	B	61.3	61.7	0.4	No	No
62	Residential	B	63.7	64.1	0.4	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Chatfield Avenue Noise Impact Assessment

Table 10 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 15** and **Table 10.** Fourteen receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.7 dB(A) at receptor 27. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Chatfield Avenue Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 900 feet long and averaging 13.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with two achieving or exceeding the 7 dB(A) design goal. However, several locations, such as receptors 22 and 47, were unable to receive the minimal 5 dB(A) reduction with the optimal wall. The insertion losses are presented in Table 11. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$546,750	(Cost of wall = 900 feet long x 13.5 feet tall x $45/sf = $546,750)
÷ 83.1	(Total dB(A) reduction for the 14 receptors with equal to or greater than 5 dB(A) reduction)
$6,579	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 11 – Chatfield Avenue Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
22	Residential	B	65.8	61.3	4.5
23	Residential	B	66.6	61.5	5.1
24	Residential	B	67.0	61.3	5.7
25	Residential	B	68.7	62.1	6.6
26	Residential	B	70.4	63.4	7.0
27	Residential	B	71.7	63.3	8.4
28	Residential	B	68.3	61.6	6.7
29	Residential	B	67.8	61.0	6.8
30	Residential	B	68.2	62.0	6.2
31	Residential	B	66.9	61.1	5.8
32	Residential	B	65.6	60.4	5.2
47	Residential	B	65.9	61.9	4.0
48	Residential	B	67.0	62.0	5.0
49	Residential	B	67.7	61.6	6.1
			Total dB(A) Reduction (5dB(A) or greater)		**83.1**

In summary, the Chatfield Avenue area has 14 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is therefore recommended.

Columbine Hills

Columbine Hills is a single-family residential development north of C-470 between Santa Fe Drive and Wadsworth Boulevard as shown in **Figure 15**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 17. Figure 18** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 12.**

Figure 18 – Columbine Hills Receptor Locations

Note: Impacted receptors are shaded green

Figure 19 – Columbine Hills TNM Proposed Action Model View

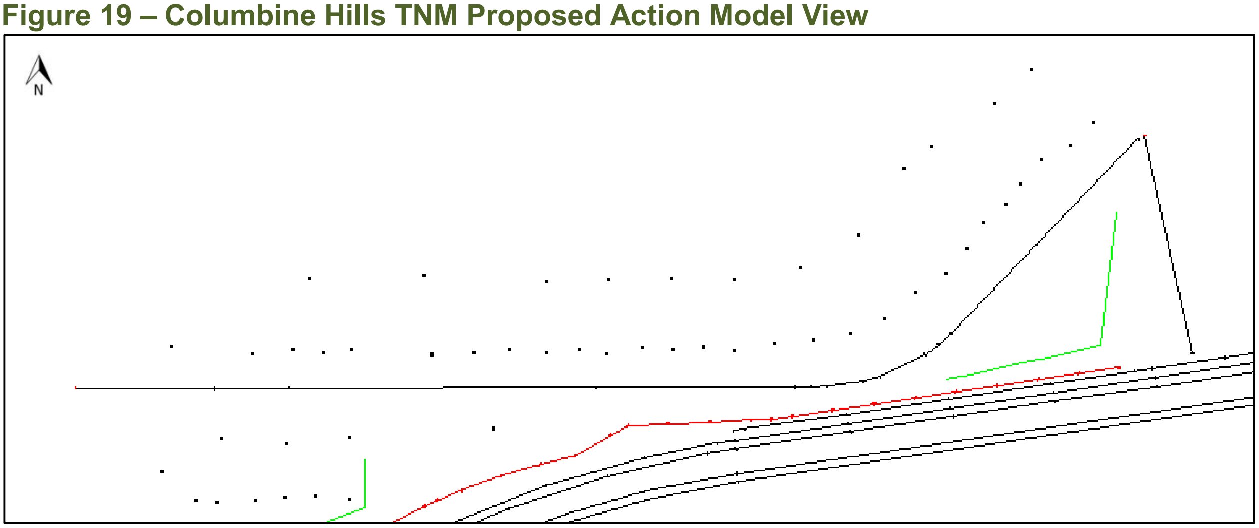


Table 12 – Columbine Hills Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	62.1	62.8	0.7	No	No
2	Residential	B	62.6	63.8	1.2	No	No
3	Residential	B	60.7	62.6	1.9	No	No
4	Residential	B	61.4	63.5	2.1	No	No
5	Residential	B	62.0	64.0	2.0	No	No
6	Residential	B	61.6	63.7	2.1	No	No
7	Residential	B	62.6	64.3	1.7	No	No
8	Residential	B	62.9	64.5	1.6	No	No
9	Residential	B	62.1	64.2	2.1	No	No
10	Residential	B	63.5	65.2	1.7	No	No
11	Residential	B	64.5	66.5	2.0	Yes	No
12	Residential	B	65.7	68.3	2.6	Yes	No
13	Residential	B	66.4	69.4	3.0	Yes	No
14	Residential	B	66.8	69.1	2.3	Yes	No
15	Residential	B	66.5	69.0	2.5	Yes	No
16	Residential	B	66.5	68.6	2.1	Yes	No
17	Residential	B	65.4	67.3	1.9	Yes	No
18	Residential	B	65.4	66.3	0.9	Yes	No
19	Residential	B	64.5	65.2	0.7	No	No
20	Residential	B	64.7	65.2	0.5	No	No
21	Residential	B	64.1	64.5	0.4	No	No
22	Residential	B	64.5	64.7	0.2	No	No
23	Residential	B	64.8	65.0	0.2	No	No
24	Residential	B	64.0	64.1	0.1	No	No
25	Residential	B	64.3	64.4	0.1	No	No
26	Residential	B	63.6	63.7	0.1	No	No
27	Residential	B	64.4	64.5	0.1	No	No
28	Residential	B	62.3	62.4	0.1	No	No
29	Residential	B	53.5	54.5	1.0	No	No
30	Residential	B	53.9	55.2	1.3	No	No
31	Residential	B	55.4	57.3	1.9	No	No
32	Residential	B	56.4	58.2	1.8	No	No
33	Residential	B	57.2	59.5	2.3	No	No
34	Residential	B	57.7	60.4	2.7	No	No
35	Residential	B	57.2	60.3	3.1	No	No
36	Residential	B	56.1	59.6	3.5	No	No
37	Residential	B	54.1	58.2	4.1	No	No
38	Residential	B	54.5	58.6	4.1	No	No
39	Residential	B	54.5	57.6	3.1	No	No
40	Residential	B	53.4	56.3	2.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Columbine Hills Noise Impact Assessment

Table 12 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 17** and **Table 12.** Ten receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 69.4 dB(A) at receptor 13. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Columbine Hills Noise Mitigation Assessment

The optimal wall, which is an extension of the existing wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,200 feet long and 20 feet tall. With the maximum height wall only one impacted property is predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) and none would achieve the design goal of 7dB(A). The lack of acoustic efficiency of the wall along C-470 is primarily due to the Chatfield Avenue traffic noise generated at a far closer proximity to the residences than C-470.The insertion losses are presented in **Table 13**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,080,000	(Cost of wall = 1,200 feet long x 20 feet tall x $45/sf = $1,080,000)
÷ 5.6	(Total dB(A) reduction for all receptors with equal to or greater than 5 dB(A) reduction)
$192,857	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in **Appendix B**.

Table 13 – Columbine Hills Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
11	Residential	B	66.5	63.3	3.2
12	Residential	B	68.3	63.5	4.8
13	Residential	B	69.4	63.8	5.6
14	Residential	B	69.1	65.1	4.0
15	Residential	B	69.2	64.8	4.4
16	Residential	B	68.7	65.3	3.4
17	Residential	B	67.7	65.0	2.7
18	Residential	B	66.6	65.6	1.0
19	Residential	B	65.6	64.9	0.7
20	Residential	B	65.5	65.2	0.3
			Total dB(A) Reduction (5 dB(A) or greater)		**5.6**

In summary, the Columbine Hills area has ten impacted receptors of which only one could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is over CDOT's cost threshold and mitigation is not recommended.

Wolhurst

Wolhurst is a single family residential development on the northwest quadrant of C-470 and Santa Fe Drive. The Wolhurst community has a pair of overlapping noise walls adjacent to C-470 totaling approximately 1,675 linear feet that were installed as part of the Santa Fe interchange improvements. These existing noise walls will be impacted by the Proposed Action due to the realignment of the westbound on-ramp and will be relocated and replaced in kind as part of this project. The existing and future noise walls were included in the model using the prediction methodology described in Section 3.0. Receptors were developed for each front row and select second row outdoor use area as shown in **Figure 20. Figure 21** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 14.**

Figure 20 – Wolhurst Receptor Locations

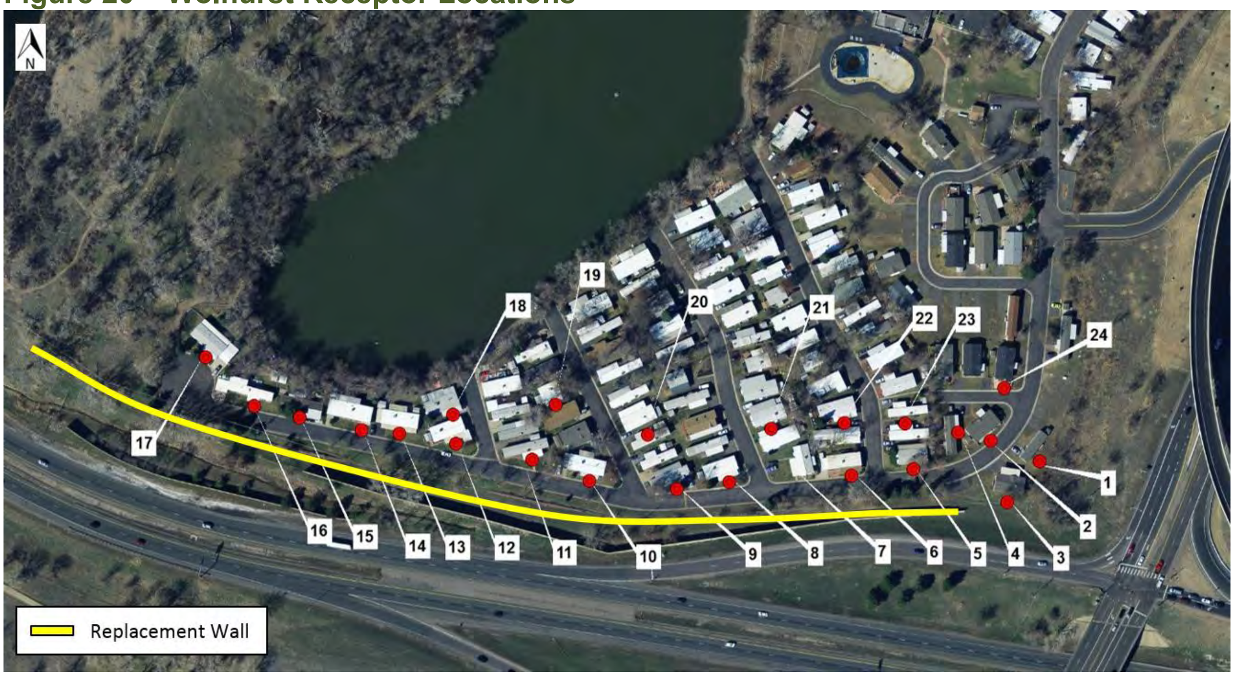
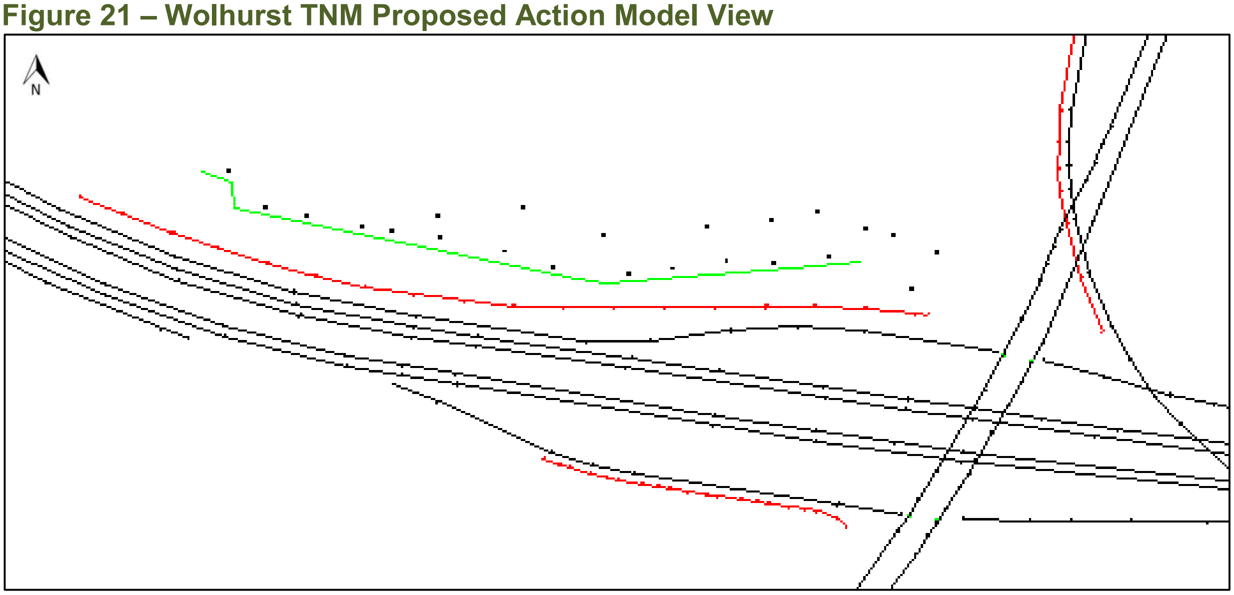


Figure 21 – Wolhurst TNM Proposed Action Model View



Wolhurst Noise Impact Assessment

Table 14 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. The Proposed Action includes the replacement of the existing wall with a single continuous wall measuring 1,500 feet long and averaging 15.5 foot high. With this wall no receptors are impacted by noise. Because this is the replacement of an existing noise wall a Benefit Cost Index was not required. **The existing wall will be replaced.**

Table 14 – Wolhurst Noise Model Results

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	63.2	63.7	0.5	No	No
2	Residential	B	62.0	62.5	0.5	No	No
3	Residential	B	64.3	64.6	0.3	No	No
4	Residential	B	61.6	62.2	0.6	No	No
5	Residential	B	61.3	62.4	1.1	No	No
6	Residential	B	61.3	61.8	0.5	No	No
7	Residential	B	61.8	62.3	0.5	No	No
8	Residential	B	62.5	63.0	0.5	No	No
9	Residential	B	62.9	63.4	0.5	No	No
10	Residential	B	62.9	63.9	1.0	No	No
11	Residential	B	62.6	64.0	1.4	No	No
12	Residential	B	61.9	64.1	2.2	No	No
13	Residential	B	61.4	64.3	2.9	No	No
14	Residential	B	61.1	64.4	3.3	No	No
15	Residential	B	61.7	64.8	3.1	No	No
16	Residential	B	62.5	65.4	2.9	No	No
17	Residential	B	61.7	65.4	3.7	No	No
18	Residential	B	61.6	63.8	2.2	No	No
19	Residential	B	61.8	63.2	1.4	No	No
20	Residential	B	62.4	63.1	0.7	No	No
21	Residential	B	61.5	62.1	0.6	No	No
22	Residential	B	61.1	61.7	0.6	No	No
23	Residential	B	61.0	61.6	0.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

4.5 Santa Fe Drive to Broadway

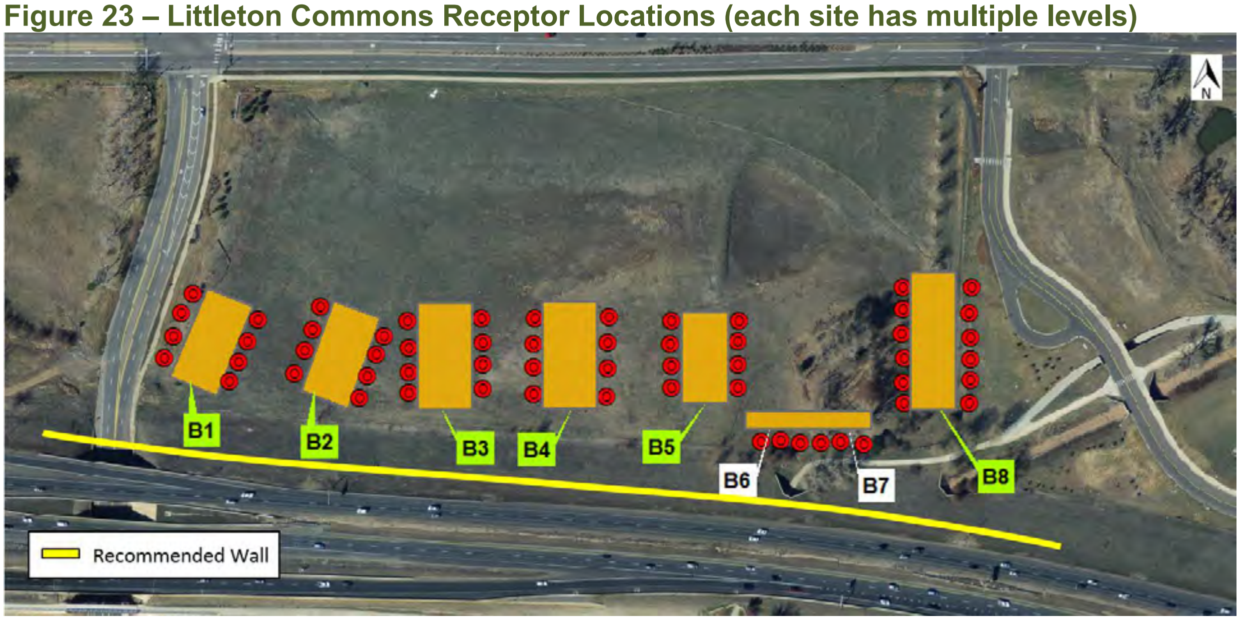
The Santa Fe Drive to Broadway area includes the communities of Littleton Commons, Villas at Verona and Bluffs at Highlands Ranch shown in **Figure 22**.

Figure 22 – Santa Fe Drive to Broadway

Littleton Commons

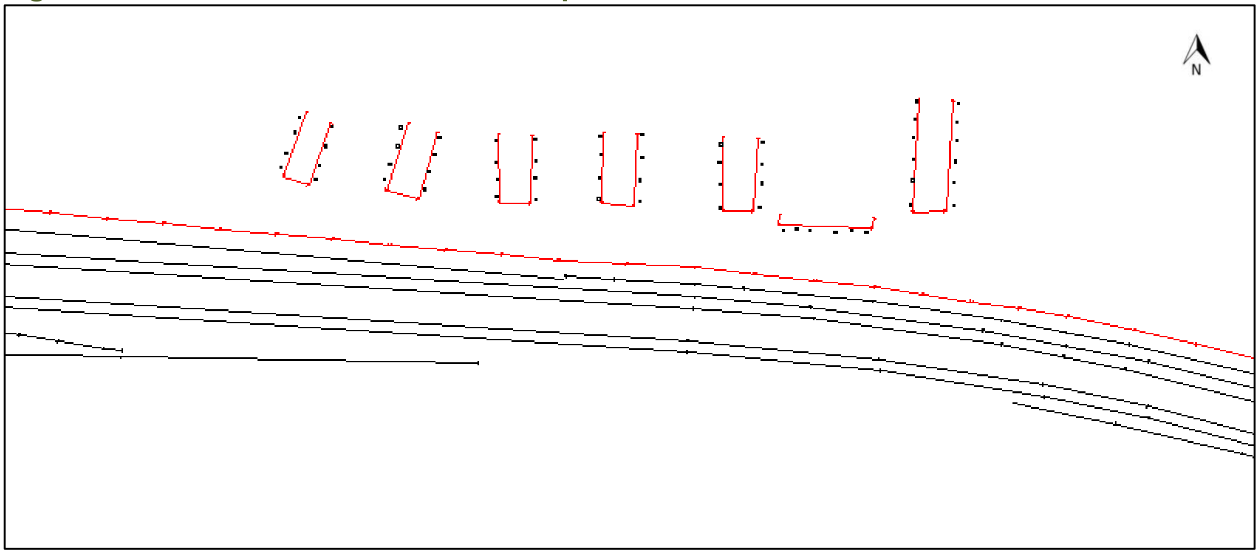
Littleton Commons is a multi-storied residential complex currently under construction, with approved plans from the City of Littleton, north of C-470 between Broadway and Santa Fe Drive as shown in **Figure 22**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 23.** It should be noted that **Figure 23** was developed from site plans provided by the Littleton Commons which is currently under construction. **Figure 24** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 162 receptor locations for both existing and Proposed Action conditions and are shown in **Table 14.**

Figure 23 – Littleton Commons Receptor Locations (each site has multiple levels)



Note: Impacted receptors are shaded green

Figure 24 – Littleton Commons TNM Proposed Action Model View



Littleton Commons Noise Impact Assessment

Table 15 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 23** and **Table 15.** Twenty-seven receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 73.1 dB(A) at receptor B1-4-3. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Littleton Commons Noise Mitigation Assessment

Much of the complex is well below the grade of the roadway, thus the optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 2,200 feet long and 7 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 9.5 dB(A), achieving the design goal of 7 dB(A). The insertion losses are presented in **Table 16**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$693,000	(Cost of wall = 2,200 feet long x 7 feet tall x $45/sf = $693,000)
÷ 226.7	(Total dB(A) reduction for the 36 receptors with equal to or greater than 5 dB(A) reduction)
$3,057	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 15 – Littleton Commons Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B1-1-1	Residential	B	56.7	58.9	2.2	No	No
2	Residential	B	63.1	65.9	2.8	Yes	No
3	Residential	B	66.9	68.6	1.7	Yes	No
B1-2-1	Residential	B	57.1	59.4	2.3	No	No
2	Residential	B	63.3	66.2	2.9	Yes	No
3	Residential	B	67.7	69.3	1.6	Yes	No
B1-3-1	Residential	B	57.9	60.1	2.2	No	No
2	Residential	B	64.4	67.3	2.9	Yes	No
3	Residential	B	69.5	71.0	1.5	Yes	No
B1-4-1	Residential	B	59.1	61.3	2.2	No	No
2	Residential	B	65.8	67.9	2.1	Yes	No
3	Residential	B	71.4	73.1	1.7	Yes	No
B1-5-1	Residential	B	56.6	59.1	2.5	No	No
2	Residential	B	61.9	64.8	2.9	No	No
3	Residential	B	71.5	72.6	1.1	Yes	No
B1-6-1	Residential	B	55.6	58.1	2.5	No	No
2	Residential	B	60.3	63.9	3.6	No	No
3	Residential	B	69.0	70.4	1.4	Yes	No
B1-7-1	Residential	B	55.6	57.6	2.0	No	No
2	Residential	B	60.4	62.7	2.3	No	No
3	Residential	B	66.6	68.8	2.2	Yes	No
B1-8-1	Residential	B	54.2	56.5	2.3	No	No
2	Residential	B	59.3	61.4	2.1	No	No
3	Residential	B	64.7	67.3	2.6	Yes	No
B2-1-1	Residential	B	52.4	54.5	2.1	No	No
2	Residential	B	55.8	58.8	3.0	No	No
3	Residential	B	60.4	62.7	2.3	No	No
B2-2-1	Residential	B	53.0	55.1	2.1	No	No
2	Residential	B	56.3	59.5	3.2	No	No
3	Residential	B	61.3	64.3	3.0	No	No
B2-3-1	Residential	B	53.5	55.9	2.4	No	No
2	Residential	B	57.7	59.9	2.2	No	No
3	Residential	B	64.1	66.2	2.1	Yes	No
B2-4-1	Residential	B	55.1	57.0	1.9	No	No
2	Residential	B	59.6	61.4	1.8	No	No
3	Residential	B	67.3	68.6	1.3	Yes	No
B2-5-1	Residential	B	55.8	58.5	2.7	No	No
2	Residential	B	61.0	64.5	3.5	No	No
3	Residential	B	71.3	73.3	2.0	Yes	No
B2-6-1	Residential	B	55.7	58.0	2.3	No	No
2	Residential	B	59.7	63.3	3.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 15 – Littleton Commons Noise Model Results without Mitigation (cont 1)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
3	Residential	B	68.2	70.9	2.7	Yes	No
B2-7-1	Residential	B	55.2	57.7	2.5	No	No
2	Residential	B	59.8	62.7	2.9	No	No
3	Residential	B	65.9	69.0	3.1	Yes	No
B2-8-1	Residential	B	54.6	56.6	2.0	No	No
2	Residential	B	59.1	61.1	2.0	No	No
3	Residential	B	64.3	66.9	2.6	Yes	No
B3-1-1	Residential	B	54.7	55.6	0.9	No	No
2	Residential	B	57.1	59.1	2.0	No	No
3	Residential	B	61.0	63.3	2.3	No	No
B3-2-1	Residential	B	54.9	56.4	1.5	No	No
2	Residential	B	58.0	59.6	1.6	No	No
3	Residential	B	63.7	65.0	1.3	No	No
B3-3-1	Residential	B	55.2	57.5	2.3	No	No
2	Residential	B	58.8	60.3	1.5	No	No
3	Residential	B	66.2	66.6	0.4	Yes	No
B3-4-1	Residential	B	55.9	57.4	1.5	No	No
2	Residential	B	59.2	61.3	2.1	No	No
3	Residential	B	66.3	68.1	1.8	Yes	No
B3-5-1	Residential	B	53.4	55.5	2.1	No	No
2	Residential	B	56.7	60.3	3.6	No	No
3	Residential	B	61.5	65.2	3.7	No	No
B3-6-1	Residential	B	51.3	54.7	3.4	No	No
2	Residential	B	55.2	59.2	4.0	No	No
3	Residential	B	58.3	64.1	5.8	No	No
B3-7-1	Residential	B	50.8	54.7	3.9	No	No
2	Residential	B	55.0	58.3	3.3	No	No
3	Residential	B	57.5	64.3	6.8	No	No
B3-8-1	Residential	B	50.9	53.7	2.8	No	No
2	Residential	B	53.9	57.3	3.4	No	No
3	Residential	B	56.6	62.7	6.1	No	No
B4-1-1	Residential	B	52.1	54.5	2.4	No	No
2	Residential	B	54.1	56.3	2.2	No	No
3	Residential	B	56.0	60.3	4.3	No	No
B4-2-1	Residential	B	52.4	55.8	3.4	No	No
2	Residential	B	54.8	57.6	2.8	No	No
3	Residential	B	56.8	60.8	4.0	No	No
B4-3-1	Residential	B	53.0	55.4	2.4	No	No
2	Residential	B	55.0	58.6	3.6	No	No
3	Residential	B	58.2	60.9	2.7	No	No
B4-4-1	Residential	B	53.4	56.0	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 15 – Littleton Commons Noise Model Results without Mitigation (cont 2)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
2	Residential	B	56.4	59.9	3.5	No	No
3	Residential	B	60.8	63.7	2.9	No	No
B4-5-1	Residential	B	51.0	55.6	4.6	No	No
2	Residential	B	54.2	60.5	6.3	No	No
3	Residential	B	58.6	63.4	4.8	No	No
B4-6-1	Residential	B	52.2	56.8	4.6	No	No
2	Residential	B	55.3	61.8	6.5	No	No
3	Residential	B	59.8	65.4	5.6	No	No
B4-7-1	Residential	B	51.9	56.9	5.0	No	No
2	Residential	B	56.4	62.9	6.5	No	No
3	Residential	B	61.3	67.3	6.0	No	No
B4-8-1	Residential	B	52.7	58.3	5.6	No	No
2	Residential	B	58.4	63.0	4.6	No	No
3	Residential	B	64.6	69.6	5.0	Yes	No
B5-1-1	Residential	B	51.9	55.9	4.0	No	No
2	Residential	B	53.8	58.7	4.9	No	No
3	Residential	B	56.7	63.5	6.8	No	No
B5-2-1	Residential	B	51.5	58.6	7.1	No	No
2	Residential	B	54.7	58.6	3.9	No	No
3	Residential	B	56.8	63.4	6.6	No	No
B5-3-1	Residential	B	51.8	56.3	4.5	No	No
2	Residential	B	55.3	59.6	4.3	No	No
3	Residential	B	57.8	64.4	6.6	No	No
B5-4-1	Residential	B	54.2	58.2	4.0	No	No
2	Residential	B	56.1	61.0	4.9	No	No
3	Residential	B	59.9	64.0	4.1	No	No
B5-5-1	Residential	B	52.6	58.7	6.1	No	No
2	Residential	B	58.1	62.5	4.4	No	No
3	Residential	B	63.9	69.7	5.8	No	No
B5-6-1	Residential	B	52.4	56.9	4.5	No	No
2	Residential	B	55.1	62.0	6.9	No	No
3	Residential	B	60.7	67.3	6.6	Yes	No
B5-7-1	Residential	B	52.2	57.1	4.9	No	No
2	Residential	B	55.9	62.3	6.4	No	No
3	Residential	B	59.9	66.9	7.0	Yes	No
B5-8-1	Residential	B	52.6	58.8	6.2	No	No
2	Residential	B	56.8	62.4	5.6	No	No
3	Residential	B	59.7	65.9	6.2	Yes	No
B6-1-1	Residential	B	55.1	59.6	4.5	No	No
B6-2-1	Residential	B	54.9	59.5	4.6	No	No
B6-3-1	Residential	B	54.7	59.2	4.5	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 15 – Littleton Commons Noise Model Results without Mitigation (cont 3)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B7-4-1	Residential	B	54.3	58.8	4.5	No	No
B7-5-1	Residential	B	54.1	58.7	4.6	No	No
B7-6-1	Residential	B	53.9	58.5	4.6	No	No
B8-1-1	Residential	B	53.0	58.6	5.6	No	No
2	Residential	B	56.3	60.8	4.5	No	No
3	Residential	B	58.2	63.0	4.8	No	No
B8-2-1	Residential	B	53.1	58.7	5.6	No	No
2	Residential	B	55.4	60.9	5.5	No	No
3	Residential	B	58.5	63.6	5.1	No	No
B8-3-1	Residential	B	52.5	58.2	5.7	No	No
2	Residential	B	55.4	61.1	5.7	No	No
3	Residential	B	58.9	64.0	5.1	No	No
B8-4-1	Residential	B	52.0	57.9	5.9	No	No
2	Residential	B	55.6	61.3	5.7	No	No
3	Residential	B	59.0	64.8	5.8	No	No
B8-5-1	Residential	B	52.1	56.8	4.7	No	No
2	Residential	B	55.6	60.7	5.1	No	No
3	Residential	B	59.1	65.2	6.1	No	No
B8-6-1	Residential	B	52.5	57.6	5.1	No	No
2	Residential	B	56.7	60.8	4.1	No	No
3	Residential	B	59.6	66.3	6.7	Yes	No
B8-7-1	Residential	B	53.8	58.2	4.4	No	No
2	Residential	B	57.6	61.6	4.0	No	No
3	Residential	B	59.7	67.0	7.3	No	No
B8-8-1	Residential	B	53.3	56.2	2.9	No	No
2	Residential	B	55.8	59.7	3.9	No	No
3	Residential	B	58.3	64.6	6.3	No	No
B8-9-1	Residential	B	53.2	55.7	2.5	No	No
2	Residential	B	55.4	59.9	4.5	No	No
3	Residential	B	58.4	64.2	5.8	No	No
B8-10-1	Residential	B	53.0	55.6	2.6	No	No
2	Residential	B	55.1	59.4	4.3	No	No
3	Residential	B	57.9	62.7	4.8	No	No
B8-11-1	Residential	B	52.9	55.9	3.0	No	No
2	Residential	B	54.8	59.1	4.3	No	No
3	Residential	B	57.5	61.8	4.3	No	No
B8-12-1	Residential	B	52.8	55.4	2.6	No	No
2	Residential	B	54.7	58.7	4.0	No	No
3	Residential	B	57.2	61.2	4.0	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 16 – Littleton Commons Impacted Receptors with Mitigation

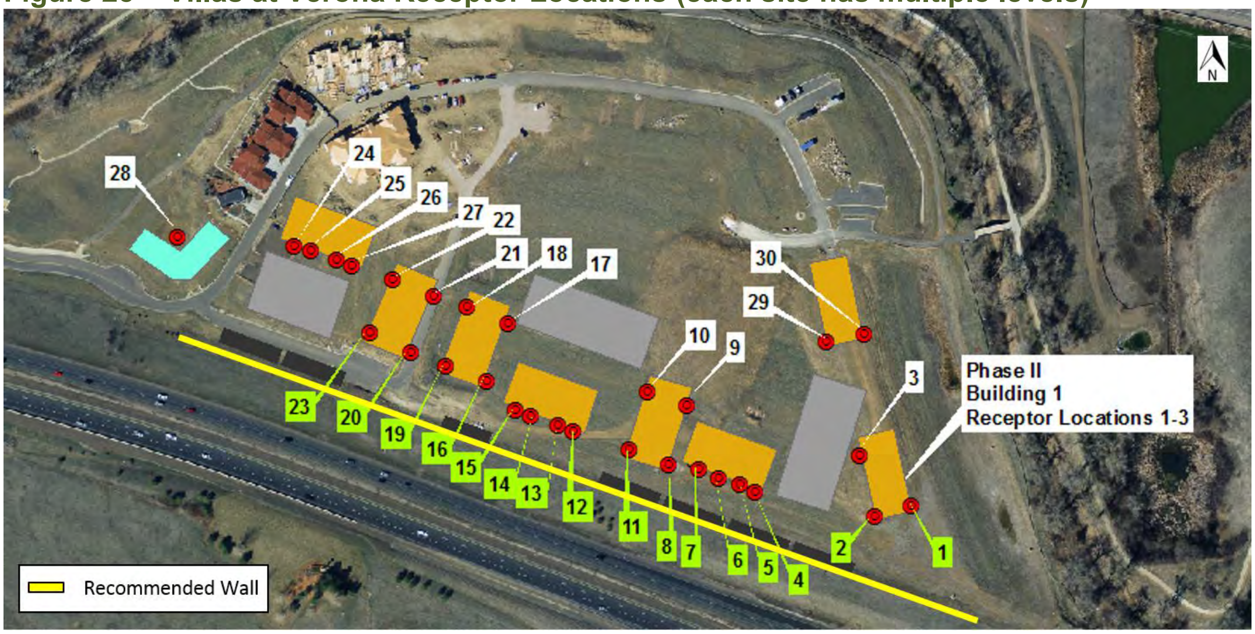
Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
B1-1-2	Residential	B	65.9	61.9	4.0
B1-1-3	Residential	B	68.6	63.6	5.0
B1-2-2	Residential	B	66.2	62.2	4.0
B1-2-3	Residential	B	69.3	63.9	5.4
B1-3-2	Residential	B	67.3	62.4	4.9
B1-3-3	Residential	B	71.0	64.4	6.6
B1-4-2	Residential	B	67.9	63.0	4.9
B1-4-3	Residential	B	73.1	65.6	7.5
B1-5-3	Residential	B	72.6	64.1	8.5
B1-6-3	Residential	B	70.4	62.6	7.8
B1-7-3	Residential	B	68.8	61.1	7.7
B1-8-3	Residential	B	67.3	59.8	7.5
B2-3-3	Residential	B	66.2	60.0	6.2
B2-4-3	Residential	B	68.6	61.7	6.9
B2-5-3	Residential	B	73.3	63.8	9.5
B2-6-3	Residential	B	70.9	62.4	8.5
B2-7-3	Residential	B	69.0	61.2	7.8
B2-8-3	Residential	B	66.9	59.9	7.0
B3-3-3	Residential	B	66.6	61.1	5.5
B3-4-3	Residential	B	68.1	62.2	5.9
B4-7-3	Residential	B	67.3	61.4	5.9
B4-8-3	Residential	B	69.6	63.1	6.5
B5-5-3	Residential	B	69.7	63.4	6.3
B5-6-3	Residential	B	67.3	61.5	5.8
B5-7-3	Residential	B	66.9	60.8	6.1
B5-8-3	Residential	B	65.9	59.9	6.0
B8-6-3	Residential	B	66.3	61.1	5.2
B8-7-3	Residential	B	67.0	62.0	5.0
Other Benefitted	Residential	B			67.1
			Total dB(A) Reduction (5 dB(A) or greater)		**226.7**

In summary, the Littleton Commons area has 36 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

Villas at Verona

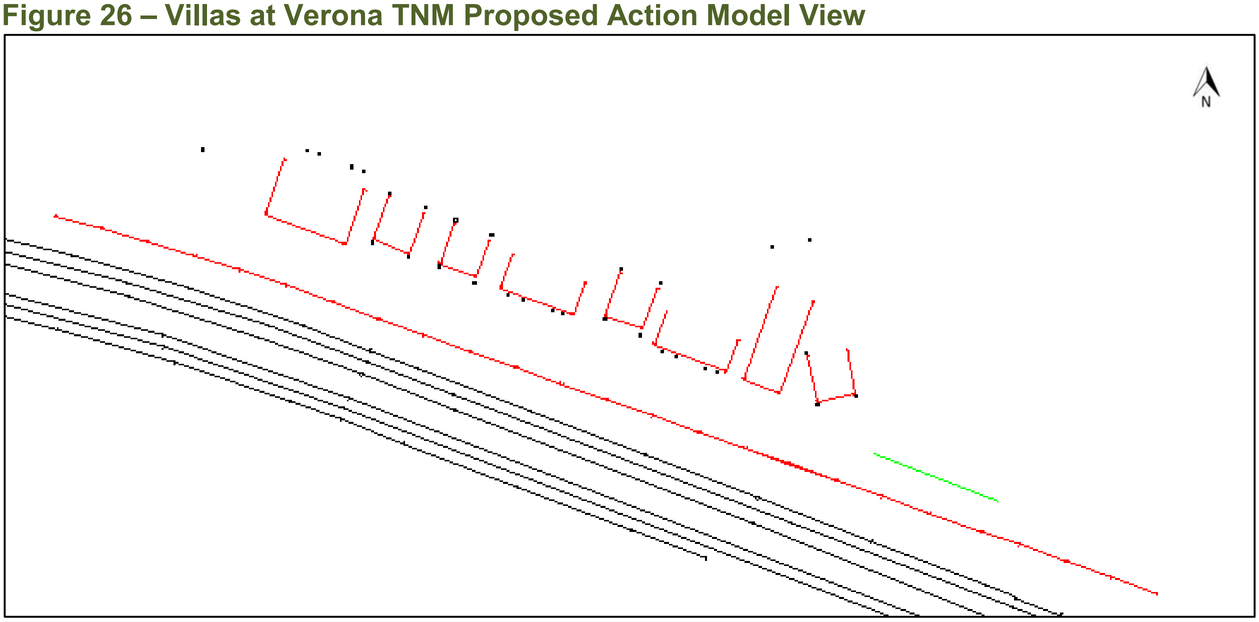
Villas at Verona is a multi-storied residential complex currently under construction north of C-470 between Broadway and Santa Fe Drive as shown in **Figure 22**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 25.** It should be noted that **Figure 25** was developed from site plans provided by the Villas at Verona which is currently under construction. **Figure 26** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 117 receptor locations for both existing and Proposed Action conditions and are shown in **Table 17.**

Figure 25 – Villas at Verona Receptor Locations (each site has multiple levels)



Note: Impacted receptors are shaded green

Figure 26 – Villas at Verona TNM Proposed Action Model View



Villas at Verona Noise Impact Assessment

Table 17 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 25** and **Table 17.** Fifty-nine receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 75.7 dB(A) at receptor 20-4. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Villas at Verona Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,720 feet long and 18.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 12.3 dB(A). Some third and fourth receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. The insertion losses are presented in **Table 18**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,431,900	(Cost of wall = 1,720 feet long x 18.5 feet tall x $45/sf = $1,431,900)
÷ 647.8	(Total dB(A) reduction for the 74 receptors with equal to or greater than 5 dB(A) reduction)
$2,210	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 17 – Villas at Verona Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	59.8	63.0	3.2	No	No
1-2	Residential	B	66.4	69.5	3.1	Yes	No
1-3	Residential	B	70.9	73.6	2.7	Yes	No
1-4	Residential	B	71.0	73.7	2.7	Yes	No
2	Residential	B	60.8	64.5	3.7	No	No
2-2	Residential	B	69.2	72.3	3.1	Yes	No
2-3	Residential	B	72.1	74.8	2.7	Yes	No
2-4	Residential	B	72.2	74.9	2.7	Yes	No
3	Residential	B	51.3	54.9	3.6	No	No
3-2	Residential	B	56.5	60.0	3.5	No	No
3-3	Residential	B	65.2	67.0	1.8	Yes	No
3-4	Residential	B	66.7	69.3	2.6	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 17 – Villas at Verona Noise Model Results without Mitigation (cont 1)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
4	Residential	B	60.0	64.0	4.0	No	No
4-2	Residential	B	69.6	72.8	3.2	Yes	No
4-3	Residential	B	72.2	75.0	2.8	Yes	No
4-4	Residential	B	72.3	75.2	2.9	Yes	No
5	Residential	B	60.1	64.1	4.0	No	No
5-2	Residential	B	69.7	72.8	3.1	Yes	No
5-3	Residential	B	72.2	75.1	2.9	Yes	No
5-4	Residential	B	72.3	75.2	2.9	Yes	No
6	Residential	B	60.8	64.7	3.9	No	No
6-2	Residential	B	70.1	73.4	3.3	Yes	No
6-3	Residential	B	72.2	75.1	2.9	Yes	No
6-4	Residential	B	72.3	75.3	3.0	Yes	No
7	Residential	B	60.6	64.5	3.9	No	No
7-2	Residential	B	70.1	73.4	3.3	Yes	No
7-3	Residential	B	72.2	75.2	3.0	Yes	No
7-4	Residential	B	72.3	75.3	3.0	Yes	No
8	Residential	B	60.9	65.7	4.8	Yes	No
8-2	Residential	B	69.8	73.2	3.4	Yes	No
8-3	Residential	B	71.8	74.8	3.0	Yes	No
8-4	Residential	B	71.9	74.9	3.0	Yes	No
9	Residential	B	50.7	53.9	3.2	No	No
9-2	Residential	B	56.1	60.0	3.9	No	No
9-3	Residential	B	60.5	63.4	2.9	No	No
9-4	Residential	B	61.3	64.2	2.9	No	No
10	Residential	B	53.3	59.2	5.9	No	No
10-2	Residential	B	60.1	64.0	3.9	No	No
10-3	Residential	B	62.9	66.1	3.2	Yes	No
10-4	Residential	B	63.3	66.5	3.2	Yes	No
11	Residential	B	62.8	67.9	5.1	Yes	No
11-2	Residential	B	70.3	73.7	3.4	Yes	No
11-3	Residential	B	71.8	74.9	3.1	Yes	No
11-4	Residential	B	71.9	75.0	3.1	Yes	No
12	Residential	B	62.4	66.2	3.8	Yes	No
12-2	Residential	B	70.9	74.3	3.4	Yes	No
12-3	Residential	B	72.2	75.4	3.2	Yes	No
12-4	Residential	B	72.3	75.5	3.2	Yes	No
13	Residential	B	62.7	66.4	3.7	Yes	No
13-2	Residential	B	71.0	74.4	3.4	Yes	No
13-3	Residential	B	72.2	75.5	3.3	Yes	No
13-4	Residential	B	72.4	75.6	3.2	Yes	No
V14	Residential	B	63.0	66.9	3.9	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 17 – Villas at Verona Noise Model Results without Mitigation (cont 2)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
14-2	Residential	B	71.1	74.4	3.3	Yes	No
14-3	Residential	B	72.2	75.5	3.3	Yes	No
14-4	Residential	B	72.3	75.6	3.3	Yes	No
15	Residential	B	63.8	66.7	2.9	Yes	No
15-2	Residential	B	71.2	74.6	3.4	Yes	No
15-3	Residential	B	72.3	75.6	3.3	Yes	No
15-4	Residential	B	72.4	75.7	3.3	Yes	No
16	Residential	B	63.1	65.8	2.7	Yes	No
16-2	Residential	B	71.0	74.2	3.2	Yes	No
16-3	Residential	B	72.2	75.6	3.4	Yes	No
16-4	Residential	B	72.4	75.8	3.4	Yes	No
17	Residential	B	55.0	58.2	3.2	No	No
17-2	Residential	B	61.5	65.4	3.9	Yes	No
17-3	Residential	B	63.9	67.4	3.5	Yes	No
17-4	Residential	B	64.2	67.8	3.6	Yes	No
18	Residential	B	55.6	57.9	2.3	No	No
18-2	Residential	B	61.7	63.9	2.2	No	No
18-3	Residential	B	64.1	67.1	3.0	Yes	No
18-4	Residential	B	64.4	67.6	3.2	Yes	No
19	Residential	B	64.1	66.4	2.3	Yes	No
19-2	Residential	B	71.0	74.1	3.1	Yes	No
19-3	Residential	B	72.1	75.5	3.4	Yes	No
19-4	Residential	B	72.3	75.7	3.4	Yes	No
20	Residential	B	64.1	66.5	2.4	Yes	No
20-2	Residential	B	71.0	73.8	2.8	Yes	No
20-3	Residential	B	72.3	75.6	3.3	Yes	No
20-4	Residential	B	72.4	75.8	3.4	Yes	No
21	Residential	B	55.7	57.7	2.0	No	No
21-2	Residential	B	61.9	64.6	2.7	No	No
21-3	Residential	B	64.5	67.9	3.4	Yes	No
21-4	Residential	B	64.8	68.4	3.6	Yes	No
22	Residential	B	53.6	56.6	3.0	No	No
22-2	Residential	B	59.1	60.5	1.4	No	No
22-3	Residential	B	61.2	63.6	2.4	No	No
22-4	Residential	B	66.5	69.6	3.1	Yes	No
23	Residential	B	63.6	66.2	2.6	Yes	No
23-2	Residential	B	70.6	72.7	2.1	Yes	No
23-3	Residential	B	72.0	75.3	3.3	Yes	No
23-4	Residential	B	72.3	75.6	3.3	Yes	No
24	Residential	B	52.4	55.2	2.8	No	No
24-2	Residential	B	55.2	57.8	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 17 – Villas at Verona Noise Model Results without Mitigation (cont 3)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
24-3	Residential	B	58.7	61.6	2.9	No	No
24-4	Residential	B	65.4	68.4	3.0	Yes	No
25	Residential	B	52.0	55.0	3.0	No	No
25-2	Residential	B	53.0	56.4	3.4	No	No
25-3	Residential	B	56.8	60.0	3.2	No	No
25-4	Residential	B	65.3	68.0	2.7	Yes	No
26	Residential	B	53.7	56.0	2.3	No	No
26-2	Residential	B	56.4	57.9	1.5	No	No
26-3	Residential	B	58.6	61.1	2.5	No	No
26-4	Residential	B	65.3	67.9	2.6	Yes	No
27	Residential	B	55.2	57.1	1.9	No	No
27-2	Residential	B	59.2	59.9	0.7	No	No
27-3	Residential	B	61.0	62.8	1.8	No	No
27-4	Residential	B	65.8	68.3	2.5	Yes	No
28	Residential	B	62.6	64.2	1.6	No	No
29	Residential	B	53.7	57.1	3.4	No	No
29-2	Residential	B	56.4	59.1	2.7	No	No
29-3	Residential	B	59.1	61.8	2.7	No	No
24-4	Residential	B	61.3	63.5	2.2	No	No
30	Residential	B	54.2	57.8	3.6	No	No
30-2	Residential	B	57.3	59.8	2.5	No	No
30-3	Residential	B	60.0	62.3	2.3	No	No
30-4	Residential	B	62.0	64.2	2.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 18 – Villas at Verona Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
1-2	Residential	B	69.5	64.5	5.0
1-3	Residential	B	73.6	66.1	7.5
1-4	Residential	B	73.7	67.4	6.3
2-2	Residential	B	72.3	64.0	8.3
2-3	Residential	B	74.8	65.8	9.0
2-4	Residential	B	74.9	68.3	6.6
3-3	Residential	B	67.0	54.7	12.3
3-4	Residential	B	69.3	59.6	9.7
4-2	Residential	B	72.8	62.1	10.7
4-3	Residential	B	75.0	64.0	11.0
4-4	Residential	B	75.2	67.5	7.7
5-2	Residential	B	72.8	62.0	10.8
5-3	Residential	B	75.1	64.0	11.1
5-4	Residential	B	75.2	67.7	7.5
6-2	Residential	B	73.4	62.0	11.4
6-3	Residential	B	75.1	64.2	10.9
6-4	Residential	B	75.3	68.1	7.2
7-2	Residential	B	73.4	61.9	11.5
7-3	Residential	B	75.2	64.2	11.0
7-4	Residential	B	75.3	68.1	7.2
8	Residential	B	65.7	59.5	6.2
8-2	Residential	B	73.2	61.1	12.1
8-3	Residential	B	74.8	63.5	11.3
8-4	Residential	B	74.9	67.8	7.1
10-3	Residential	B	66.1	54.9	11.2
10-4	Residential	B	66.5	58.0	8.5
11	Residential	B	67.9	60.4	7.5
11-2	Residential	B	73.7	62.3	11.4
11-3	Residential	B	74.9	65.0	9.9
11-4	Residential	B	75.0	69.1	5.9
12	Residential	B	66.2	60.3	5.9
12-2	Residential	B	74.3	62.2	12.1
12-3	Residential	B	75.4	65.0	10.4
12-4	Residential	B	75.5	69.3	6.2
13	Residential	B	66.4	60.3	6.1
13-2	Residential	B	74.4	62.3	12.1
13-3	Residential	B	75.5	65.2	10.3
13-4	Residential	B	75.6	69.6	6.0
V14	Residential	B	66.9	60.6	6.3
14-2	Residential	B	74.4	62.5	11.9
14-3	Residential	B	75.5	65.6	9.9
14-4	Residential	B	75.6	70.2	5.4

Table 18 – Villas at Verona Impacted Receptors with Mitigation (cont 1)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
15	Residential	B	66.7	60.7	6.0
15-2	Residential	B	74.6	62.7	11.9
15-3	Residential	B	75.6	65.9	9.7
15-4	Residential	B	75.7	70.7	5.0
16	Residential	B	65.8	60.7	5.1
16-2	Residential	B	74.2	62.7	11.5
16-3	Residential	B	75.6	65.7	9.9
16-4	Residential	B	75.8	70.5	5.3
17-2	Residential	B	65.4	53.7	11.7
17-3	Residential	B	67.4	56.1	11.3
17-4	Residential	B	67.8	59.0	8.8
18-3	Residential	B	67.1	57.2	9.9
18-4	Residential	B	67.6	60.6	7.0
19	Residential	B	66.4	61.3	5.1
19-2	Residential	B	74.1	63.7	10.4
19-3	Residential	B	75.5	67.1	8.4
19-4	Residential	B	75.7	72.0	3.7
20	Residential	B	66.5	61.6	4.9
20-2	Residential	B	73.8	64.2	9.6
20-3	Residential	B	75.6	67.9	7.7
20-4	Residential	B	75.8	72.9	2.9
21-3	Residential	B	67.9	57.4	10.5
21-4	Residential	B	68.4	60.6	7.8
22-4	Residential	B	69.6	68.1	1.5
23	Residential	B	66.2	61.4	4.8
23-2	Residential	B	72.7	63.8	8.9
23-3	Residential	B	75.3	68.0	7.3
23-4	Residential	B	75.6	73.4	2.2
24-4	Residential	B	68.4	65.8	2.6
25-4	Residential	B	68.0	65.9	2.1
26-4	Residential	B	67.9	67.0	0.9
27-4	Residential	B	68.3	67.6	0.7
			Total dB(A) Reduction (5 dB(A) or greater)		**647.8**

In summary, the Villas at Verona area has seventy-four receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

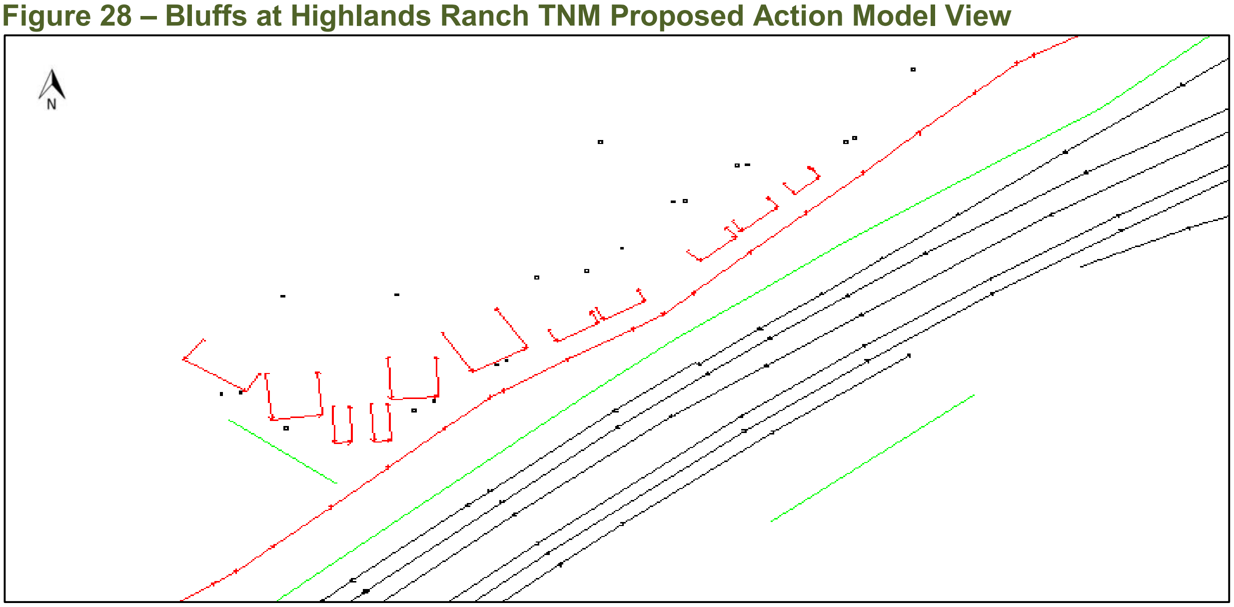
Bluffs at Highlands Ranch

Bluffs at Highlands Ranch is a multi-storied residential complex north of C-470 between Broadway and Santa Fe Drive as shown in **Figure 22**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 27. Figure 28** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 38 receptor locations for both existing and Proposed Action conditions and are shown in **Table 19.**

Figure 27 – Bluffs at Highlands Ranch Receptor Locations (each site has multiple levels)

Note: Impacted receptors are shaded green

Figure 28 – Bluffs at Highlands Ranch TNM Proposed Action Model View



Bluffs at Highlands Ranch Noise Impact Assessment

Table 19 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 27** and **Table 28.** Twenty-eight receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 76.9 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Bluffs at Highlands Ranch Noise Mitigation Assessment

The optimal wall, shown in **Figure 27**, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,200 feet long and 17.7 feet tall. Some third and fourth story receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. However, the design goal reduction of 7 dB(A) or more was met by at least one receptor. The insertion losses are presented in **Table 20**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$955,800	(Cost of wall = 1,200 feet long x 17.7 feet tall x $45/sf = $955.800)
÷ 151.3	(Total dB(A) reduction for 28 receptors with equal to or greater than 5 dB(A) reduction)
$6,317	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 19 – Bluffs at Highlands Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	64.9	68.4	3.5	Yes	No
2	Residential	B	71.1	74.4	3.3	Yes	No
3	Residential	B	65.3	68.6	3.3	Yes	No
4	Residential	B	71.3	74.4	3.1	Yes	No
5	Residential	B	63.0	65.6	2.6	Yes	No
6	Residential	B	69.3	72.4	3.1	Yes	No
7	Residential	B	62.6	65.3	2.7	No	No
8	Residential	B	68.8	71.9	3.1	Yes	No
9	Residential	B	61.6	65.0	3.4	No	No
10	Residential	B	69.9	72.9	3.0	Yes	No
11	Residential	B	61.8	64.9	3.1	No	No
12	Residential	B	69.6	72.6	3.0	Yes	No
13	Residential	B	63.6	67.6	4.0	Yes	No
14	Residential	B	70.3	73.1	2.8	Yes	No
15	Residential	B	63.0	65.7	2.7	Yes	No
16	Residential	B	68.8	71.6	2.8	Yes	No
17	Residential	B	70.9	75.6	4.7	Yes	No
18	Residential	B	73.5	76.9	3.4	Yes	No
19	Residential	B	70.9	75.5	4.6	Yes	No
20	Residential	B	73.5	76.9	3.4	Yes	No
21	Residential	B	70.8	75.5	4.7	Yes	No
22	Residential	B	73.4	76.9	3.5	Yes	No
23	Residential	B	70.5	75.3	4.8	Yes	No
24	Residential	B	73.3	76.8	3.5	Yes	No
25	Residential	B	60.8	67.9	7.1	Yes	No
26	Residential	B	68.8	72.9	4.1	Yes	No
27	Residential	B	70.9	74.3	3.4	Yes	No
28	Residential	B	57.1	64.9	7.8	No	No
29	Residential	B	63.8	68.7	4.9	Yes	No
30	Residential	B	67.4	70.9	3.5	Yes	No
31	Residential	B	57.4	65.2	7.8	No	No
32	Residential	B	64.0	69.1	5.1	Yes	No
33	Residential	B	67.9	71.4	3.5	Yes	No
34	Residential	B	55.1	58.9	3.8	No	No
35	Residential	B	59.0	63.4	4.4	No	No
36	Residential	B	62.4	66.5	4.1	Yes	No
37	Residential	B	57.5	59.6	2.1	No	No
38	Residential	B	61.9	64.7	2.8	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 20 – Bluffs at Highlands Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
10	Residential	B	72.9	67.6	5.3
12	Residential	B	72.6	67.2	5.4
13	Residential	B	67.6	60.6	7.0
14	Residential	B	73.1	66.5	6.6
15	Residential	B	65.7	60.0	5.7
16	Residential	B	71.6	66.3	5.3
17	Residential	B	75.6	63.7	11.9
18	Residential	B	76.9	71.5	5.4
19	Residential	B	75.5	63.7	11.8
20	Residential	B	76.9	71.4	5.5
21	Residential	B	75.5	63.4	12.1
22	Residential	B	76.9	71.5	5.4
23	Residential	B	75.3	63.1	12.2
24	Residential	B	76.8	71.0	5.8
25	Residential	B	67.9	62.2	5.7
26	Residential	B	72.9	64.7	8.2
27	Residential	B	74.3	68.2	6.1
29	Residential	B	68.7	63.6	5.1
30	Residential	B	70.9	65.9	5.0
32	Residential	B	69.1	64.0	5.1
33	Residential	B	71.4	66.2	5.2
36	Residential	B	66.5	61.0	5.5
				Total dB(A) Reduction (5 dB(A) or greater)	**151.3**

In summary, the Bluffs at Highlands Ranch has 28 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and therefore mitigation is recommended.

4.6 Broadway to University Boulevard

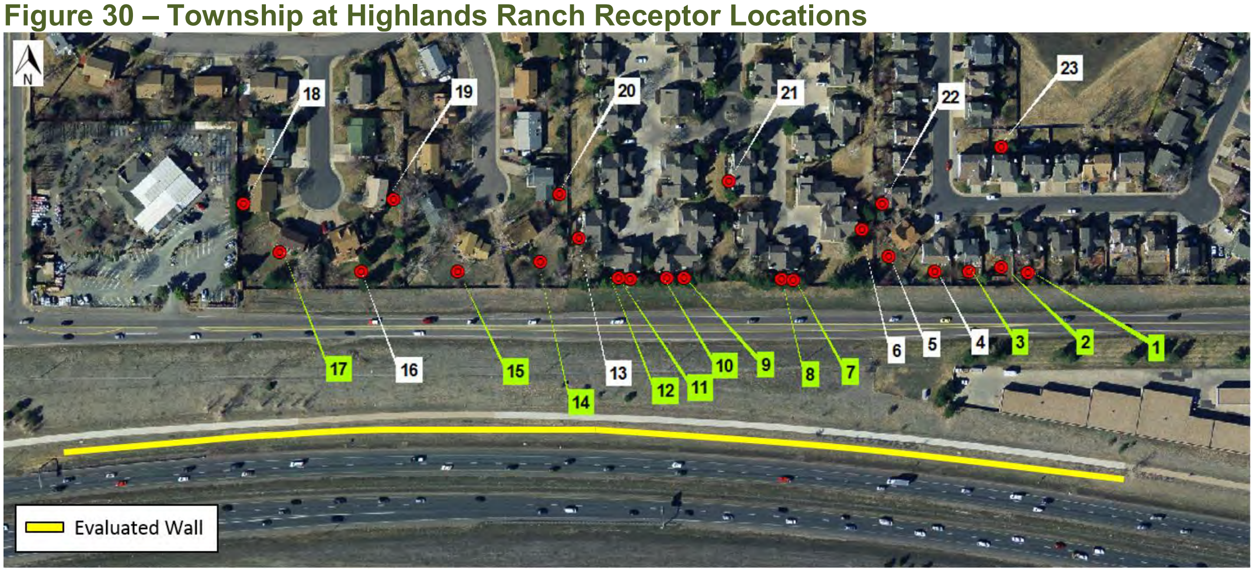
The Broadway to University Boulevard area includes the communities of Township at Highlands Ranch and Highlands Ranch Dad Clark as shown in **Figure 29**.

Figure 29 – Broadway to University Boulevard

Township at Highlands Ranch

Township at Highlands Ranch is a single-family residential development north of C-470 and County Line Road between University Boulevard and Broadway as shown in **Figure 29**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 30. Figure 31** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 21.**

Figure 30 – Township at Highlands Ranch Receptor Locations



Note: Impacted receptors are shaded green.

Figure 31 – Township at Highlands Ranch TNM Proposed Action Model View

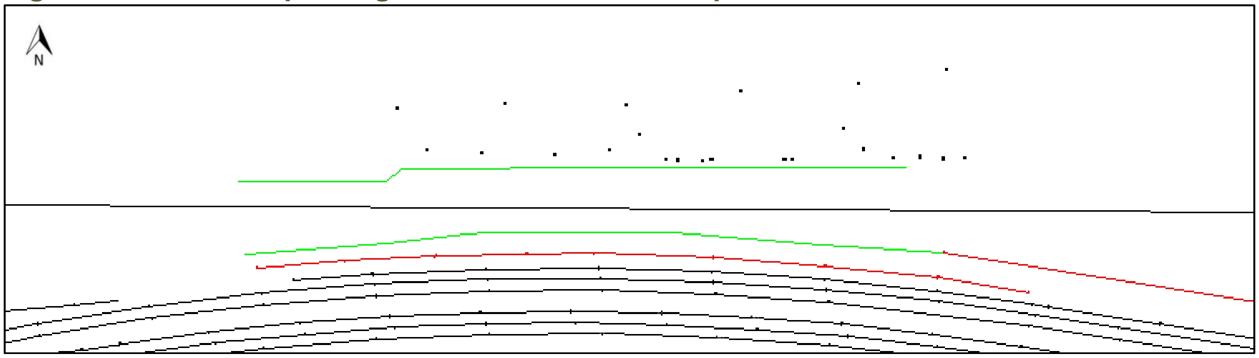


Table 21 – Township at Highlands Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	62.6	66.1	3.5	No	No
2	Residential	B	62.5	66.5	4.0	No	No
3	Residential	B	62.3	65.9	3.6	No	No
4	Residential	B	61.1	63.5	2.4	No	No
5	Residential	B	59.7	63.0	3.3	No	No
6	Residential	B	57.8	61.7	3.9	No	No
7	Residential	B	62.5	66.6	4.1	Yes	No
8	Residential	B	63.0	67.0	4.0	Yes	No
9	Residential	B	64.8	68.3	3.5	Yes	No
10	Residential	B	65.0	68.5	3.5	Yes	No
11	Residential	B	64.9	68.5	3.6	Yes	No
12	Residential	B	63.9	67.9	4.0	Yes	No
13	Residential	B	63.8	66.9	3.1	No	No
14	Residential	B	62.6	66.1	3.5	Yes	No
15	Residential	B	62.6	66.3	3.7	Yes	No
16	Residential	B	62.3	62.8	0.5	No	No
17	Residential	B	62.3	65.9	3.6	Yes	No
18	Residential	B	58.1	61.1	3.0	No	No
19	Residential	B	58.0	60.8	2.8	No	No
20	Residential	B	58.5	61.6	3.1	No	No
21	Residential	B	56.9	59.6	2.7	No	No
22	Residential	B	56.6	60.6	4.0	No	No
23	Residential	B	56.8	59.4	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Township at Highlands at Highlands Ranch Noise Impact Assessment

Table 21 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 30** and **Table 21.** Twelve receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 68.3 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Township at Highlands Ranch Noise Mitigation Assessment

A 1,700 feet long and 20 feet tall wall was evaluated along C-470 right-of-way. This wall was predicted to not provide the design goal of 7 dB(A) noise reduction or the minimum of 5 dB(A) of noise reduction (insertion loss) for any receptors. The lack of acoustic efficiency of the wall along C-470 is primarily due to the County Line Road traffic noise generated at a far closer proximity to the residences than C-470. Insertion losses are presented in **Table 22**. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

This wall would cost $1,530,000. Because this wall does not provide the design goal noise reduction of 7 dB(A) or even 5 dB(A) reduction to any receptors, there is no Benefit Cost Index for this wall within CDOT ROW. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 22 – Township at Highlands Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
1	Residential	B	66.1	65.2	0.9
2	Residential	B	66.5	65.3	1.2
3	Residential	B	65.9	64.5	1.4
7	Residential	B	66.6	63.0	3.6
8	Residential	B	67.0	63.2	3.8
9	Residential	B	68.3	65.0	3.3
10	Residential	B	68.5	65.5	3.0
11	Residential	B	68.5	65.9	2.6
12	Residential	B	67.9	65.8	2.1
13	Residential	B	66.9	62.7	4.2
14	Residential	B	66.1	65.0	1.1
15	Residential	B	66.3	65.7	0.6
17	Residential	B	65.9	65.5	0.4
				Total dB(A) Reduction (5dB(A) or greater)	**0**

In summary, the Township at Highlands Ranch area has 13 impacted receptors that would not benefit from noise mitigation. Mitigation is not recommended.

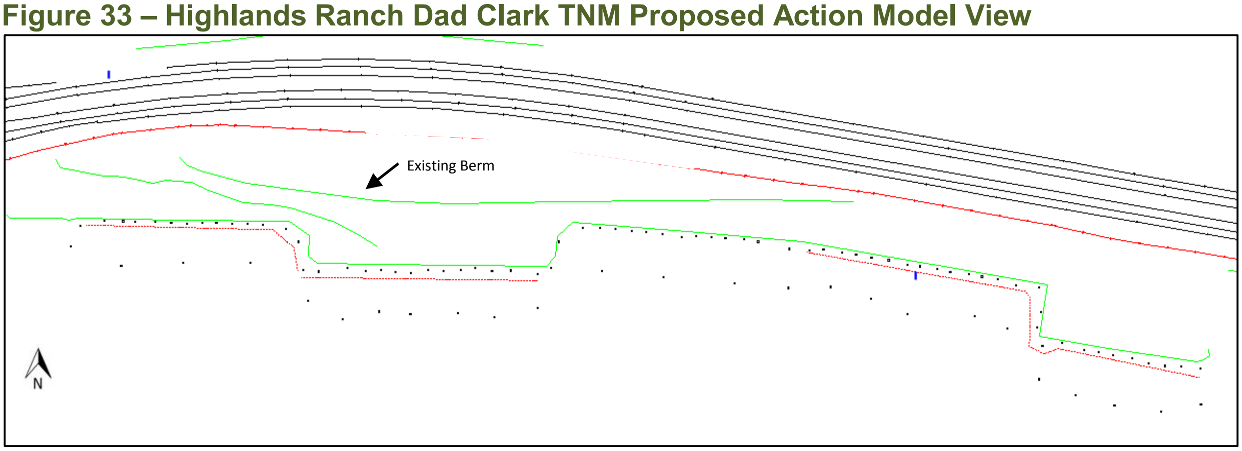
Highlands Ranch Dad Clark

Highlands Ranch Dad Clark area is a single-family residential development south of C-470 between University Boulevard and Broadway as shown in **Figure 29**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 32. Figure 33** shows a screen shot of the TNM model of the Proposed Action. While this is one neighborhood, the existing berm located in the middle of the neighborhood frontage splits these homes from a noise perspective, as shown in in **Figure 32. T**hus in an effort to focus on the specific needs of each area the evaluation was split into the western and eastern sections. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Tables 23 and 25.**

Figure 32 – Highlands Ranch Dad Clark Receptor Locations

Note: Impacted receptors are shaded green

Figure 33 – Highlands Ranch Dad Clark TNM Proposed Action Model View



WESTERN

Figure 34 – Western Highlands Ranch Dad Clark Receptor Locations

Note: Impacted receptors are shaded green

Table 23 – Western Highlands Ranch Dad Clark Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	53.7	59.4	5.7	No	No
2	Residential	B	55.1	59.9	4.8	No	No
3	Residential	B	56.1	63.8	7.7	No	No
4	Residential	B	55.7	61.9	6.2	No	No
5	Residential	B	55.4	61.5	6.1	No	No
6	Residential	B	55.5	61.6	6.1	No	No
7	Residential	B	55.6	61.0	5.4	No	No
8	Residential	B	56.6	61.7	5.1	No	No
9	Residential	B	58.0	62.5	4.5	No	No
10	Residential	B	58.0	63.3	5.3	No	No
11	Residential	B	57.9	63.1	5.2	No	No
12	Residential	B	58.0	62.6	4.6	No	No
13	Residential	B	57.8	62.4	4.6	No	No
14	Residential	B	57.3	61.5	4.2	No	No
15	Residential	B	56.1	60.1	4.0	No	No
16	Residential	B	55.7	59.5	3.8	No	No
17	Residential	B	55.6	59.2	3.6	No	No
18	Residential	B	55.6	59.2	3.6	No	No
19	Residential	B	55.9	59.3	3.4	No	No
20	Residential	B	56.0	59.3	3.3	No	No
21	Residential	B	56.4	60.0	3.6	No	No
22	Residential	B	56.7	60.5	3.8	No	No
23	Residential	B	57.1	61.1	4.0	No	No
24	Residential	B	57.2	61.4	4.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 23 – Western Highlands Ranch Dad Clark Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
25	Residential	B	57.4	61.5	4.1	No	No
26	Residential	B	57.9	62.4	4.5	No	No
27	Residential	B	59.4	63.8	4.4	No	No
28	Residential	B	61.2	65.2	4.0	No	No
29	Residential	B	58.5	60.5	2.0	No	No
30	Residential	B	59.7	64.3	4.6	No	No
31	Residential	B	60.9	65.8	4.9	Yes	No
32	Residential	B	62.0	67.0	5.0	Yes	No
33	Residential	B	63.0	67.7	4.7	Yes	No
34	Residential	B	63.8	68.3	4.5	Yes	No
35	Residential	B	64.4	68.7	4.3	Yes	No
36	Residential	B	64.9	69.3	4.4	Yes	No
37	Residential	B	65.4	69.7	4.3	Yes	No
38	Residential	B	66.0	70.1	4.1	Yes	No
39	Residential	B	66.4	70.5	4.1	Yes	No
40	Residential	B	65.7	70.1	4.4	Yes	No
41	Residential	B	65.9	70.2	4.3	Yes	No
42	Residential	B	66.4	70.6	4.2	Yes	No
43	Residential	B	67.9	71.5	3.6	Yes	No
44	Residential	B	66.8	70.6	3.8	Yes	No
45	Residential	B	67.1	70.8	3.7	Yes	No
46	Residential	B	66.7	70.0	3.3	Yes	No
47	Residential	B	63.7	67.3	3.6	Yes	No
48	Residential	B	59.9	63.6	3.7	No	No
49	Residential	B	59.0	62.9	3.9	No	No
50	Residential	B	57.2	61.0	3.8	No	No
51	Residential	B	56.4	60.4	4.0	No	No
52	Residential	B	55.0	58.8	3.8	No	No
53	Residential	B	54.6	58.1	3.5	No	No
54	Residential	B	54.0	58.0	4.0	No	No
55	Residential	B	56.1	60.3	4.2	No	No
56	Residential	B	55.1	59.4	4.3	No	No
57	Residential	B	53.9	59.5	5.6	No	No
58	Residential	B	53.4	57.8	4.4	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Western Highlands Ranch Dad Clark Noise Impact Assessment

Table 23 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 34** and **Table 23.** Seventeen receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.5 dB(A) at receptor 43. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Western Highlands Ranch Dad Clark Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,400 feet long and averaging 16.5 feet tall. With this optimized wall impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 8.6 dB(A), achieving the design goal of 7 dB(A) insertion loss. The insertion losses are presented in **Table 24**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,039,500	(Cost of wall = 1,400 feet long x 16.5 feet tall x $45/sf = $1,039,500)
÷ 112.2	(Total dB(A) reduction for the 18 receptors with equal to or greater than 5 dB(A) reduction)
$9,265	(Cost Benefit Index, cost per dB(A) per receptor)

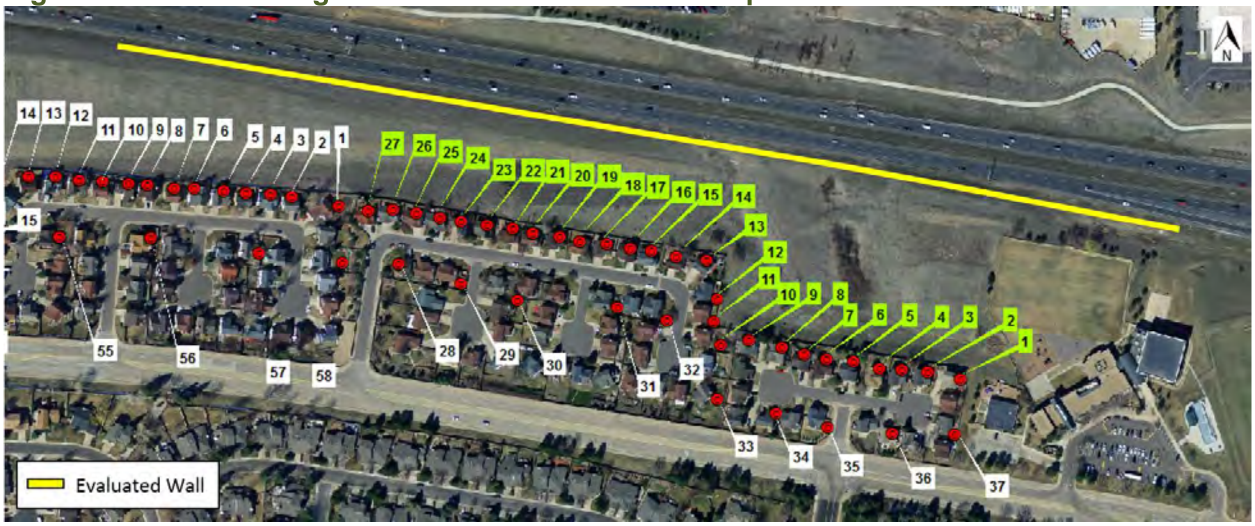
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 24 – Western Highlands Ranch Dad Clark Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
31	Residential	B	65.8	60.7	5.1
32	Residential	B	67.0	61.5	5.5
33	Residential	B	67.7	61.8	5.9
34	Residential	B	68.3	62.1	6.2
35	Residential	B	68.7	62.4	6.3
36	Residential	B	69.3	62.7	6.6
37	Residential	B	69.7	63.1	6.6
38	Residential	B	70.1	63.4	6.7
39	Residential	B	70.5	63.7	6.8
40	Residential	B	70.1	64.0	6.1
41	Residential	B	70.2	64.2	6.0
42	Residential	B	70.6	64.5	6.1
43	Residential	B	71.5	65.8	5.7
44	Residential	B	70.6	65.6	5.0
45	Residential	B	70.8	62.9	7.9
46	Residential	B	70.0	61.5	8.5
47	Residential	B	67.3	61.1	6.2
Other Benefitted	Residential	B			5.0
				Total dB(A) Reduction (5dB(A) or greater)	**112.2**

EASTERN

Figure 35 – Eastern Highlands Ranch Dad Clark Receptor Locations



Note: Impacted receptors are shaded green

Table 25 – Eastern Highlands Ranch Dad Clark Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	62.7	67.3	4.6	Yes	No
2	Residential	B	62.5	67.3	4.8	Yes	No
3	Residential	B	62.0	67.1	5.1	Yes	No
4	Residential	B	61.9	67.0	5.1	Yes	No
5	Residential	B	61.9	67.2	5.3	Yes	No
6	Residential	B	61.8	67.1	5.3	Yes	No
7	Residential	B	61.9	67.2	5.3	Yes	No
8	Residential	B	62.7	67.3	4.6	Yes	No
9	Residential	B	64.6	67.8	3.2	Yes	No
10	Residential	B	60.9	65.3	4.4	No	No
11	Residential	B	61.6	65.7	4.1	Yes	No
12	Residential	B	63.0	67.8	4.8	Yes	No
13	Residential	B	66.1	70.6	4.5	Yes	No
14	Residential	B	65.7	70.3	4.6	Yes	No
15	Residential	B	65.7	70.4	4.7	Yes	No
16	Residential	B	65.6	70.5	4.9	Yes	No
17	Residential	B	65.3	70.4	5.1	Yes	No
18	Residential	B	64.6	70.1	5.5	Yes	No
19	Residential	B	64.3	69.7	5.4	Yes	No
20	Residential	B	62.4	68.9	6.5	Yes	No
21	Residential	B	61.4	68.0	6.6	Yes	No
22	Residential	B	60.4	67.4	7.0	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 25 – Eastern Highlands Ranch Dad Clark Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
23	Residential	B	60.3	67.2	6.9	Yes	No
24	Residential	B	60.3	67.3	7.0	Yes	No
25	Residential	B	61.0	67.7	6.7	Yes	No
26	Residential	B	61.3	68.0	6.7	Yes	No
27	Residential	B	60.9	68.0	7.1	Yes	No
28	Residential	B	58.4	63.7	5.3	No	No
29	Residential	B	55.2	58.2	3.0	No	No
30	Residential	B	56.3	60.2	3.9	No	No
31	Residential	B	60.6	64.1	3.5	No	No
32	Residential	B	60.7	63.7	3.0	No	No
33	Residential	B	57.2	59.4	2.2	No	No
34	Residential	B	57.6	60.8	3.2	No	No
35	Residential	B	55.0	57.9	2.9	No	No
36	Residential	B	57.4	60.6	3.2	No	No
37	Residential	B	60.2	63.7	3.5	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Eastern Highlands Ranch Dad Clark Noise Impact Assessment

Table 25 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 35** and **Table 25.** Twenty-seven receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.4 dB(A) at receptor 16. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Eastern Highlands Ranch Dad Clark Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, is 1,900 feet long and averaging 18.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 8.8 dB(A), achieving the design goal of 7 dB(A). The insertion losses are presented in **Table 26**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,581,750	(Cost of wall = 1,900 feet long x 18.5 feet tall x $45/sf = $1,581,750)
÷ 163.5	(Total dB(A) reduction for the 26 receptors with equal to or greater than 5 dB(A) reduction)
$9,674	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in **Appendix B**.

Table 26 – Eastern Highlands Ranch Dad Clark Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
1	Residential	B	67.3	64.1	3.2
2	Residential	B	67.3	63.5	3.8
3	Residential	B	67.1	62.9	4.2
4	Residential	B	67.0	62.5	4.5
5	Residential	B	67.2	62.2	5.0
6	Residential	B	67.1	61.9	5.2
7	Residential	B	67.2	61.9	5.3
8	Residential	B	67.3	61.9	5.4
10	Residential	B	67.8	61.9	5.9
11	Residential	B	65.7	59.7	6.0
12	Residential	B	67.8	60.4	7.4
13	Residential	B	70.6	61.8	8.8
14	Residential	B	70.3	61.8	8.5
15	Residential	B	70.4	61.9	8.5
16	Residential	B	70.5	62.1	8.4
17	Residential	B	70.4	62.1	8.3
18	Residential	B	70.1	61.9	8.2
19	Residential	B	69.7	61.9	7.8
20	Residential	B	68.9	61.4	7.5
21	Residential	B	68.0	61.0	7.0
22	Residential	B	67.4	60.8	6.6
23	Residential	B	67.2	61.1	6.1
24	Residential	B	67.3	61.6	5.7
25	Residential	B	67.7	62.0	5.7
26	Residential	B	68.0	62.5	5.5
27	Residential	B	68.0	63.0	5.0
				Total dB(A) Reduction (5dB(A) or greater)	**163.5**

In summary, the Highlands Ranch Dad Clark combined area (eastern and western) has 44 receptors that could benefit from noise mitigation. However, the CBI is over CDOT's cost threshold and mitigation is not recommended.

4.7 University Boulevard to Colorado Boulevard

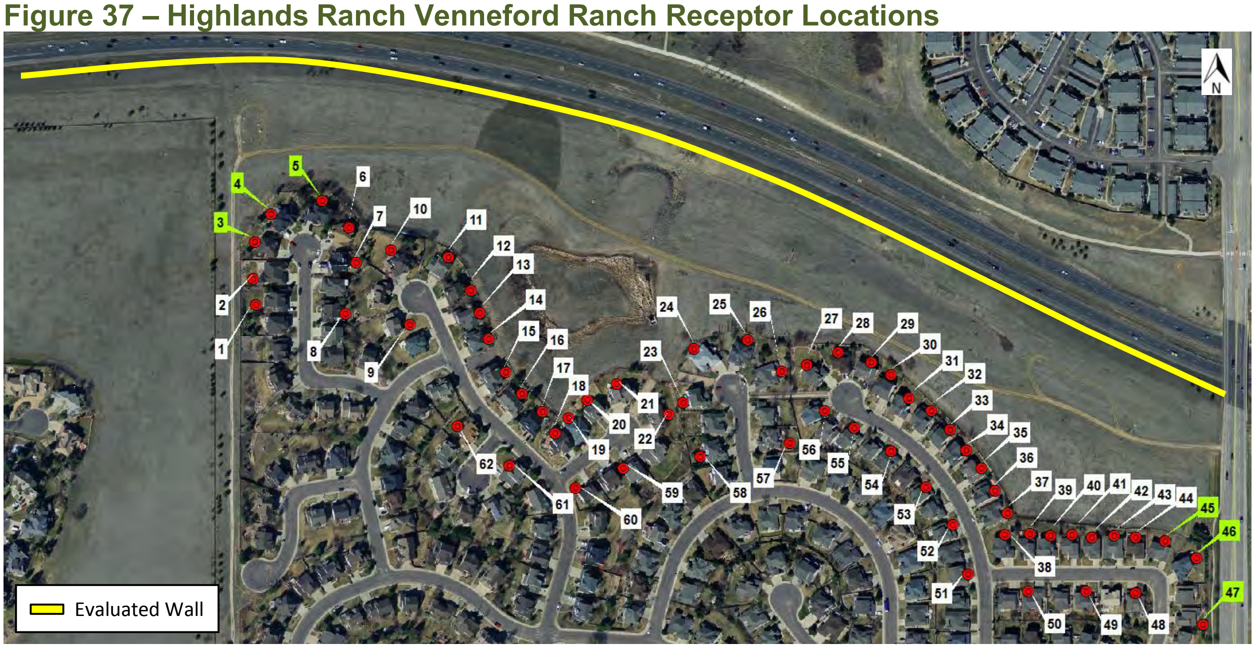
The Broadway to University Boulevard area includes the communities of Highlands Ranch Venneford Ranch, Autumn Chase, Copper Canyon, and Canyon Ranch as shown in **Figure 36**.

Figure 36 – University Boulevard to Colorado Boulevard

Highlands Ranch Venneford Ranch

Highlands Ranch Venneford Ranch is a single-family residential development south of C-470 between Colorado Boulevard and University Avenue as shown in **Figure 36**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 37**. **Figure 38** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 27.**

Figure 37 – Highlands Ranch Venneford Ranch Receptor Locations



Note: Impacted receptors are shaded green

Figure 38 – Highlands Ranch Venneford Ranch TNM Proposed Action Model View

Table 27 – Highlands Ranch Venneford Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	56.5	59.9	3.4	No	No
2	Residential	B	58.2	61.9	3.7	No	No
3	Residential	B	60.3	65.5	5.2	Yes	No
4	Residential	B	64.4	68.8	4.4	Yes	No
5	Residential	B	64.9	69.0	4.1	Yes	No
6	Residential	B	61.3	65.4	4.1	No	No
7	Residential	B	59.3	62.9	3.6	No	No
8	Residential	B	56.9	59.7	2.8	No	No
9	Residential	B	58.1	61.0	2.9	No	No
10	Residential	B	60.5	64.5	4.0	No	No
11	Residential	B	62.2	65.3	3.1	No	No
12	Residential	B	60.8	64.2	3.4	No	No
13	Residential	B	59.6	63.2	3.6	No	No
14	Residential	B	58.7	62.1	3.4	No	No
15	Residential	B	57.4	60.9	3.5	No	No
16	Residential	B	58.2	61.5	3.3	No	No
17	Residential	B	58.9	62.0	3.1	No	No
18	Residential	B	56.5	60.0	3.5	No	No
19	Residential	B	57.2	60.6	3.4	No	No
20	Residential	B	58.6	61.8	3.2	No	No
21	Residential	B	60.7	63.6	2.9	No	No
22	Residential	B	57.9	60.9	3.0	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 27 – Highlands Ranch Venneford Ranch Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
23	Residential	B	59.4	62.5	3.1	No	No
24	Residential	B	62.7	65.4	2.7	No	No
25	Residential	B	62.1	65.2	3.1	No	No
26	Residential	B	61.3	64.3	3.0	No	No
27	Residential	B	61.2	64.4	3.2	No	No
28	Residential	B	60.5	63.4	2.9	No	No
29	Residential	B	58.5	61.4	2.9	No	No
30	Residential	B	58.0	60.8	2.8	No	No
31	Residential	B	56.5	59.5	3.0	No	No
32	Residential	B	56.2	59.2	3.0	No	No
33	Residential	B	57.7	61.3	3.6	No	No
34	Residential	B	60.9	63.4	2.5	No	No
35	Residential	B	59.0	60.5	1.5	No	No
36	Residential	B	58.8	59.6	0.8	No	No
37	Residential	B	58.3	59.7	1.4	No	No
38	Residential	B	58.5	60.2	1.7	No	No
39	Residential	B	59.3	60.6	1.3	No	No
40	Residential	B	60.2	61.3	1.1	No	No
41	Residential	B	60.8	61.7	0.9	No	No
42	Residential	B	61.8	62.5	0.7	No	No
43	Residential	B	63.0	63.7	0.7	No	No
44	Residential	B	64.4	65.3	0.9	No	No
45	Residential	B	68.0	68.6	0.6	Yes	No
46	Residential	B	72.7	73.0	0.3	Yes	No
47	Residential	B	73.2	73.4	0.2	Yes	No
48	Residential	B	60.6	61.2	0.6	No	No
49	Residential	B	55.0	56.1	1.1	No	No
50	Residential	B	53.5	55.6	2.1	No	No
51	Residential	B	56.1	57.7	1.6	No	No
52	Residential	B	55.8	58.2	2.4	No	No
53	Residential	B	56.3	59.3	3.0	No	No
54	Residential	B	57.3	60.5	3.2	No	No
55	Residential	B	58.0	60.8	2.8	No	No
56	Residential	B	58.8	61.6	2.8	No	No
57	Residential	B	58.2	61.1	2.9	No	No
58	Residential	B	57.0	60.0	3.0	No	No
59	Residential	B	55.3	58.6	3.3	No	No
60	Residential	B	54.4	57.8	3.4	No	No
61	Residential	B	55.0	58.8	3.8	No	No
62	Residential	B	56.2	59.5	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Highlands Ranch Venneford Ranch Noise Impact Assessment

Table 27 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 37** and **Table 27.** Six receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 73.4 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Highlands Ranch Venneford Ranch Noise Mitigation Assessment

A 3,330 feet long and 20 feet tall wall was evaluated along C-470 right-of-way from Colorado Boulevard west. This wall was predicted to be the optimal wall providing the most positive Cost Benefit Index calculation for the impacted receptors in addition to providing benefits to approximately 20 additional non-impacted residences which improved the Cost Benefit Index calculation. The insertion losses for the impacted receptors are presented in **Table 28**. However, the maximum wall did not provide the design goal of 7 dB(A) for any receptors and several impacted receptors did not receive the minimum 5 dB(A) insertion loss. Receptors 45, 46, and 47, located along Colorado Boulevard, received inaudible reductions of 0.5, 0.1 to 0.0 dB(A) respectively with a 20 foot high wall. The reason for the minimal insertion loss for these impacted receptors is because these homes along Colorado Boulevard are roughly 500 feet from C-470 and receive a majority of their traffic noise from the adjacent Colorado Boulevard. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$2,997,000	(Cost of wall = 3,330 feet long x 20.0 feet tall x $45/sf = $2,997,000)
÷ 119.4	(Total dB(A) reduction for the 22 receptors with equal to or greater than 5 dB(A) reduction)
$25,101	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier and the design goal of 7 dB(A) was not achieved with the 20 foot wall. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Venneford Rand receptors were evaluated for potential reflective noise from the wall recommended for the Autumn Chase, Copper Canyon and Canyon Ranch neighborhood. The recommended wall is roughly 500 feet plus north of Venneford Ranch across C-470. Predicted noise levels for Venneford Ranch receptors were unchanged with the Autumn Chase, Copper Canyon and Canyon Ranch recommended wall from when the wall was removed. The Autumn Chase, Copper Canyon and Canyon Ranch recommended wall will not change the noise environment for Venneford Ranch receptors.

Table 28 – Highlands Ranch Venneford Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
3	Residential	B	65.5	61.1	4.4
4	Residential	B	68.8	63.5	5.3
5	Residential	B	69.0	63.8	5.2
44	Residential	B	68.6	68.1	0.5
45	Residential	B	73.0	72.9	0.1
47	Residential	B	73.4	73.4	0.0
Additional Benefitted Receptors that were not Impacted					
9	Residential	B	61.0	56.0	5.0
11	Residential	B	65.3	60.1	5.2
12	Residential	B	64.2	58.4	5.8
13	Residential	B	63.2	57.6	5.6
14	Residential	B	62.1	56.7	5.4
15	Residential	B	60.9	55.8	5.1
16	Residential	B	61.5	56.4	5.1
17	Residential	B	62.0	56.5	5.5
18	Residential	B	60.0	54.9	5.1
19	Residential	B	60.6	55.4	5.2
20	Residential	B	61.8	56.4	5.4
21	Residential	B	63.6	57.2	6.4
22	Residential	B	60.9	55.9	5.0
23	Residential	B	62.5	57.2	5.3
24	Residential	B	65.4	58.9	6.5
25	Residential	B	65.2	59.5	5.7
59	Residential	B	58.6	53.3	5.3
60	Residential	B	57.8	52.4	5.4
61	Residential	B	58.8	53.4	5.4
62	Residential	B	59.5	54.0	5.5
				Total dB(A) Reduction (5dB(A) or greater)	119.4

In summary, the Highlands Ranch Venneford Ranch area has three impacted receptors and 20 additional receptors that could benefit from noise mitigation. However, with the maximum height wall the 7 dB(A) design goal was not met and the CBI is over CDOT's cost threshold. Mitigation is not recommended.

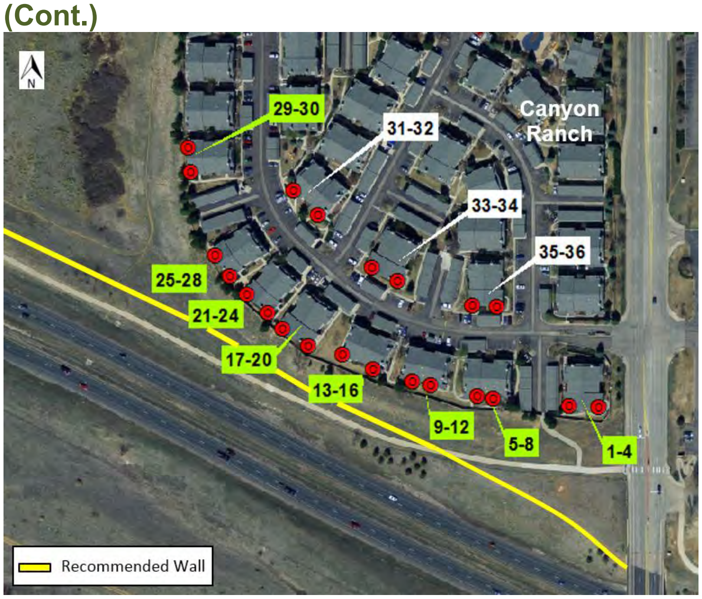
Autumn Chase, Copper Canyon, and Canyon Ranch (ACC)

Autumn Chase, Copper Canyon and Canyon Ranch are a series of multi-storied residential complexes north of C-470, extending from Colorado Boulevard approximately 3,800 feet west as shown in **Figure 36**. Based on the close proximity of these complexes the mitigation for these sites is interrelated and thus they were evaluated together. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 39. Figure 40** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 113 receptor locations for both existing and Proposed Action conditions and are shown in **Table 29.**

Figure 39 – Autumn Chase, Copper Canyon and Canyon Ranch Receptor Locations

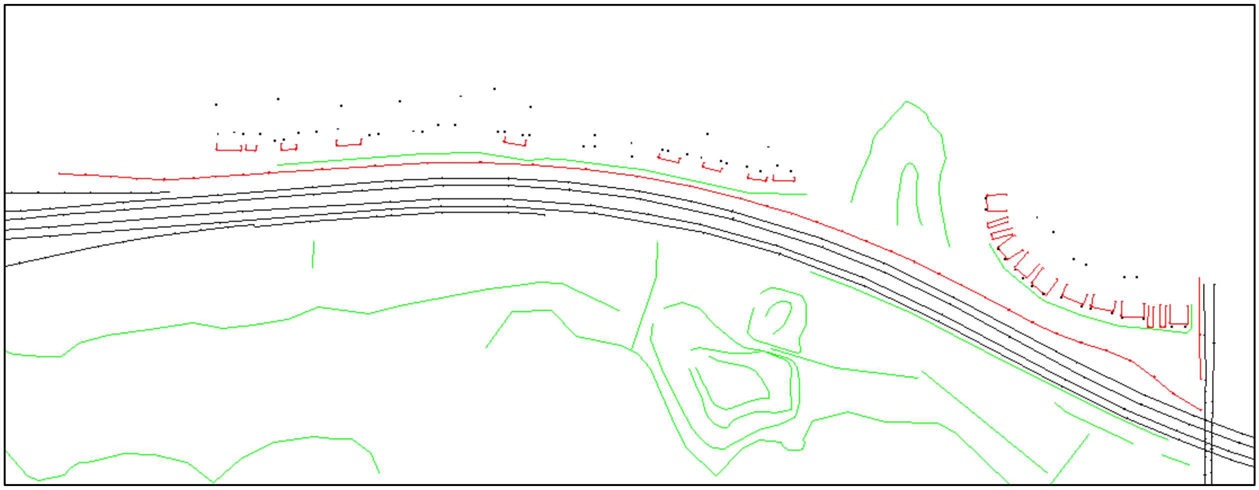
Note: Impacted receptors are shaded green

Figure 39 – Autumn Chase, Copper Canyon and Canyon Ranch Receptor Locations (Cont.)



Note: Impacted receptors are shaded green

Figure 40 – Autumn Chase, Copper Canyon and Canyon Ranch TNM Proposed Action Model View



Autumn Chase, Copper Canyon and Canyon Ranch Noise iAssessment
Table 29 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 39** and **Table 29.** One hundred receptors equal or exceed CDOT Impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 76.8 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Autumn Chase, Copper Canyon and Canyon Ranch Noise Mitigation Assessment
The optimal combination of walls providing the greatest noise reduction for impacted receptors per square foot of wall, was a 4,330 feet long and 15.75 feet tall wall north of C-470 and a 390 foot long 8 feet high wall west of Colorado Boulevard all within CDOT ROW. With these optimized walls most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 12.6 dB(A). The design goal reduction of 7 dB(A) or more was met by at least one receptor. The insertion losses are presented in **Table 30**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$3,068,888	(Cost of wall = 4,330 feet long x 15.75 feet tall x $45/sf = $3,068,888)
÷ 724.5	(Total dB(A) reduction for the 87 receptors with equal to or greater than 5 dB(A) reduction)
$4,236	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 29 – Autumn Chase, Copper Canyon and Canyon Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Canyon Ranch							
1	Residential	B	72.6	73.2	0.6	Yes	No
2	Residential	B	73.7	74.7	1.0	Yes	No
3	Residential	B	69.4	70.6	1.2	Yes	No
4	Residential	B	71.6	73.5	1.9	Yes	No
5	Residential	B	63.4	66.3	2.9	Yes	No
6	Residential	B	69.9	72.4	2.5	Yes	No
7	Residential	B	68.0	70.9	2.9	Yes	No
8	Residential	B	71.9	74.9	3.0	Yes	No
9	Residential	B	68.2	71.1	2.9	Yes	No
10	Residential	B	72.0	75.0	3.0	Yes	No
11	Residential	B	71.0	73.1	2.1	Yes	No
12	Residential	B	72.9	75.8	2.9	Yes	No
13	Residential	B	70.3	72.9	2.6	Yes	No
14	Residential	B	72.9	75.9	3.0	Yes	No
15	Residential	B	71.9	74.2	2.3	Yes	No
16	Residential	B	73.1	76.0	2.9	Yes	No
17	Residential	B	72.6	75.1	2.5	Yes	No
18	Residential	B	73.7	76.7	3.0	Yes	No
19	Residential	B	72.5	74.9	2.4	Yes	No
20	Residential	B	73.5	76.5	3.0	Yes	No
21	Residential	B	71.6	74.1	2.5	Yes	No
22	Residential	B	73.1	76.1	3.0	Yes	No
23	Residential	B	71.1	73.6	2.5	Yes	No
24	Residential	B	72.8	75.8	3.0	Yes	No
25	Residential	B	70.1	72.6	2.5	Yes	No
26	Residential	B	72.4	75.4	3.0	Yes	No
27	Residential	B	69.2	71.8	2.6	Yes	No
28	Residential	B	71.9	74.9	3.0	Yes	No
29	Residential	B	66.1	68.3	2.2	Yes	No
30	Residential	B	65.6	67.4	1.8	Yes	No
31	Residential	B	59.1	61.5	2.4	No	No
32	Residential	B	56.0	58.5	2.5	No	No
33	Residential	B	56.9	60.6	3.7	No	No
34	Residential	B	56.4	59.6	3.2	No	No
35	Residential	B	57.6	57.8	0.2	No	No
36	Residential	B	57.5	57.6	0.1	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 29 – Autumn Chase, Copper Canyon and Canyon Ranch Noise Model Results without Mitigation (cont 1)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Copper Canyon							
1	Residential	B	62.6	64.9	2.3	No	No
2	Residential	B	71.1	72.9	1.8	Yes	No
3	Residential	B	63.3	65.3	2.0	No	No
4	Residential	B	71.0	72.9	1.9	Yes	No
5	Residential	B	63.2	65.5	2.3	Yes	No
6	Residential	B	72.1	74.4	2.3	Yes	No
7	Residential	B	66.0	66.9	0.9	Yes	No
8	Residential	B	72.1	74.5	2.4	Yes	No
9	Residential	B	66.3	67.1	0.8	Yes	No
10	Residential	B	72.3	75.3	3.0	Yes	No
11	Residential	B	64.7	66.4	1.7	Yes	No
12	Residential	B	72.2	75.2	3.0	Yes	No
13	Residential	B	68.7	69.6	0.9	Yes	No
14	Residential	B	72.5	75.6	3.1	Yes	No
15	Residential	B	68.4	69.3	0.9	Yes	No
16	Residential	B	72.4	75.5	3.1	Yes	No
17	Residential	B	62.0	65.5	3.5	Yes	No
18	Residential	B	72.2	75.4	3.2	Yes	No
19	Residential	B	62.2	66.8	4.6	Yes	No
20	Residential	B	72.2	75.3	3.1	Yes	No
21	Residential	B	65.3	69.4	4.1	Yes	No
22	Residential	B	63.2	67.7	4.5	Yes	No
23	Residential	B	62.9	66.8	3.9	Yes	No
24	Residential	B	61.7	65.8	4.1	Yes	No
25	Residential	B	63.0	68.4	5.4	Yes	No
26	Residential	B	65.2	67.0	1.8	Yes	No
27	Residential	B	64.1	66.1	2.0	Yes	No
Autumn Chase							
1	Residential	B	60.9	64.8	3.9	No	No
2	Residential	B	72.1	74.1	2.0	No	No
3	Residential	B	60.3	63.9	3.6	No	No
4	Residential	B	72.1	74.2	2.1	No	No
5	Residential	B	63.0	67.8	4.8	No	No
6	Residential	B	71.9	74.7	2.8	No	No
7	Residential	B	63.3	69.2	5.9	No	No
8	Residential	B	71.9	74.6	2.7	No	No
9	Residential	B	67.2	69.2	2.0	No	No
10	Residential	B	71.8	75.0	3.2	No	No
11	Residential	B	67.4	69.7	2.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 29 – Autumn Chase, Copper Canyon and Canyon Ranch Noise Model Results without Mitigation (cont 2)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Autumn Chase (cont.)							
12	Residential	B	72.0	75.1	3.1	No	No
13	Residential	B	68.8	71.0	2.2	No	No
14	Residential	B	72.8	75.9	3.1	No	No
15	Residential	B	73.2	76.8	3.6	No	No
16	Residential	B	68.5	70.7	2.2	No	No
17	Residential	B	72.8	75.8	3.0	No	No
18	Residential	B	73.1	76.7	3.6	Yes	No
19	Residential	B	64.7	68.7	4.0	Yes	No
20	Residential	B	73.0	76.0	3.0	Yes	No
21	Residential	B	64.1	68.4	4.3	Yes	No
22	Residential	B	73.0	76.0	3.0	Yes	No
23	Residential	B	64.6	68.2	3.6	Yes	No
24	Residential	B	72.4	75.4	3.0	Yes	No
25	Residential	B	63.1	66.1	3.0	Yes	No
26	Residential	B	72.4	75.2	2.8	Yes	No
27	Residential	B	61.0	64.8	3.8	No	No
28	Residential	B	72.4	75.2	2.8	Yes	No
29	Residential	B	62.3	65.8	3.5	Yes	No
30	Residential	B	72.5	75.4	2.9	Yes	No
31	Residential	B	62.3	65.8	3.5	Yes	No
32	Residential	B	73.1	76.0	2.9	Yes	No
33	Residential	B	73.3	76.6	3.3	Yes	No
34	Residential	B	61.9	65.9	4.0	Yes	No
35	Residential	B	73.1	76.0	2.9	Yes	No
36	Residential	B	73.3	76.6	3.3	Yes	No
37	Residential	B	62.7	66.1	3.4	Yes	No
38	Residential	B	72.5	75.3	2.8	Yes	No
39	Residential	B	62.9	66.2	3.3	Yes	No
40	Residential	B	72.4	75.2	2.8	Yes	No
41	Residential	B	63.5	66.7	3.2	Yes	No
42	Residential	B	72.3	75.0	2.7	Yes	No
43	Residential	B	65.3	68.3	3.0	Yes	No
44	Residential	B	62.0	64.6	2.6	No	No
45	Residential	B	59.9	63.2	3.3	No	No
46	Residential	B	59.7	63.9	4.2	No	No
47	Residential	B	61.1	64.8	3.7	No	No
48	Residential	B	60.2	64.1	3.9	No	No
49	Residential	B	59.4	63.1	3.7	No	No
50	Residential	B	59.2	63.0	3.8	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 30 – Autumn Chase, Copper Canyon and Canyon Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Canyon Ranch					
1	Residential	B	73.2	64.6	8.6
2	Residential	B	74.7	69.6	5.1
3	Residential	B	70.6	64.7	5.9
4	Residential	B	73.5	68.1	5.4
5	Residential	B	66.3	60.2	6.1
6	Residential	B	72.4	65.0	7.4
7	Residential	B	70.9	64.5	6.4
8	Residential	B	74.9	68.1	6.8
9	Residential	B	71.1	64.3	6.8
10	Residential	B	75.0	68.1	6.9
11	Residential	B	73.1	66.0	7.1
12	Residential	B	75.8	70.0	5.8
13	Residential	B	72.9	65.1	7.8
14	Residential	B	75.9	69.1	6.8
15	Residential	B	74.2	65.3	8.9
16	Residential	B	76.0	70.3	5.7
17	Residential	B	75.1	65.5	9.6
18	Residential	B	76.7	69.5	7.2
19	Residential	B	74.9	65.9	9.0
20	Residential	B	76.5	70.1	6.4
21	Residential	B	74.1	65.4	8.7
22	Residential	B	76.1	68.7	7.4
23	Residential	B	73.6	65.6	8.0
24	Residential	B	75.8	68.8	7.0
25	Residential	B	72.6	65.6	7.0
26	Residential	B	75.4	68.1	7.3
27	Residential	B	71.8	65.8	6.0
28	Residential	B	74.9	67.9	7.0
29	Residential	B	68.3	62.7	5.6
30	Residential	B	67.4	61.7	5.7
Copper Canyon					
2	Residential	B	72.9	65.1	7.8
4	Residential	B	72.9	64.7	8.2
5	Residential	B	65.5	60.8	4.7
6	Residential	B	74.4	65.4	9.0
7	Residential	B	66.9	61.0	5.9
8	Residential	B	74.5	65.0	9.5
9	Residential	B	67.1	61.9	5.2
10	Residential	B	75.3	64.8	10.5

Table 30 – Autumn Chase, Copper Canyon and Canyon Ranch Impacted Receptors with Mitigation (cont 1)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Copper Canyon (cont.)					
11	Residential	B	66.4	62.0	4.4
12	Residential	B	75.2	64.8	10.4
13	Residential	B	69.6	62.4	7.2
14	Residential	B	75.6	64.8	10.8
15	Residential	B	69.3	61.9	7.4
16	Residential	B	75.5	64.3	11.2
17	Residential	B	65.5	60.6	4.9
18	Residential	B	75.4	63.5	11.9
19	Residential	B	66.8	60.9	5.9
20	Residential	B	75.3	63.3	12.0
21	Residential	B	69.4	61.6	7.8
22	Residential	B	67.7	61.3	6.4
23	Residential	B	66.8	61.2	5.6
24	Residential	B	65.8	60.8	5.0
25	Residential	B	68.4	60.7	7.7
26	Residential	B	67.0	62.0	5.0
27	Residential	B	66.1	62.2	3.9
Autumn Chase					
2	Residential	B	74.1	62.8	11.3
4	Residential	B	74.2	62.8	11.4
5	Residential	B	67.8	61.4	6.4
6	Residential	B	74.7	63.3	11.4
7	Residential	B	69.2	61.5	7.7
8	Residential	B	74.6	63.3	11.3
9	Residential	B	69.2	62.2	7.0
10	Residential	B	75.0	64.1	10.9
11	Residential	B	69.7	62.3	7.4
12	Residential	B	75.1	64.3	10.8
13	Residential	B	71.0	62.8	8.2
14	Residential	B	75.9	64.9	11.0
15	Residential	B	76.8	68.9	7.9
16	Residential	B	70.7	62.7	8.0
17	Residential	B	75.8	64.8	11.0
18	Residential	B	76.7	68.6	8.1
19	Residential	B	68.7	61.8	6.9
20	Residential	B	76.0	63.9	12.1
21	Residential	B	68.4	61.6	6.8
22	Residential	B	76.0	63.7	12.3
23	Residential	B	68.2	61.7	6.5
24	Residential	B	75.4	63.6	11.8

Table 30 – Autumn Chase, Copper Canyon and Canyon Ranch Impacted Receptors with Mitigation (cont 2)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Autumn Chase (cont.)					
25	Residential	B	66.1	61.3	4.8
26	Residential	B	75.2	63.2	12.0
28	Residential	B	75.2	62.7	12.5
29	Residential	B	65.8	61.1	4.7
30	Residential	B	75.4	63.2	12.2
31	Residential	B	65.8	59.9	5.9
32	Residential	B	76.0	63.4	12.6
33	Residential	B	76.6	66.0	10.6
34	Residential	B	65.9	59.5	6.4
35	Residential	B	76.0	63.5	12.5
36	Residential	B	76.6	66.1	10.5
37	Residential	B	66.1	61.5	4.6
38	Residential	B	75.3	63.9	11.4
39	Residential	B	66.2	62.0	4.2
40	Residential	B	75.2	64.4	10.8
41	Residential	B	66.7	62.2	4.5
42	Residential	B	75.0	64.7	10.3
43	Residential	B	68.3	62.7	5.6
Other Benefitted	Residential	B			5.2
			Total dB(A) Reduction (5 dB(A) or greater)		**724.5**

In summary, the Autumn Chase, Copper Canyon and Canyon Ranch area has 87 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

4.8 Colorado Boulevard to Quebec

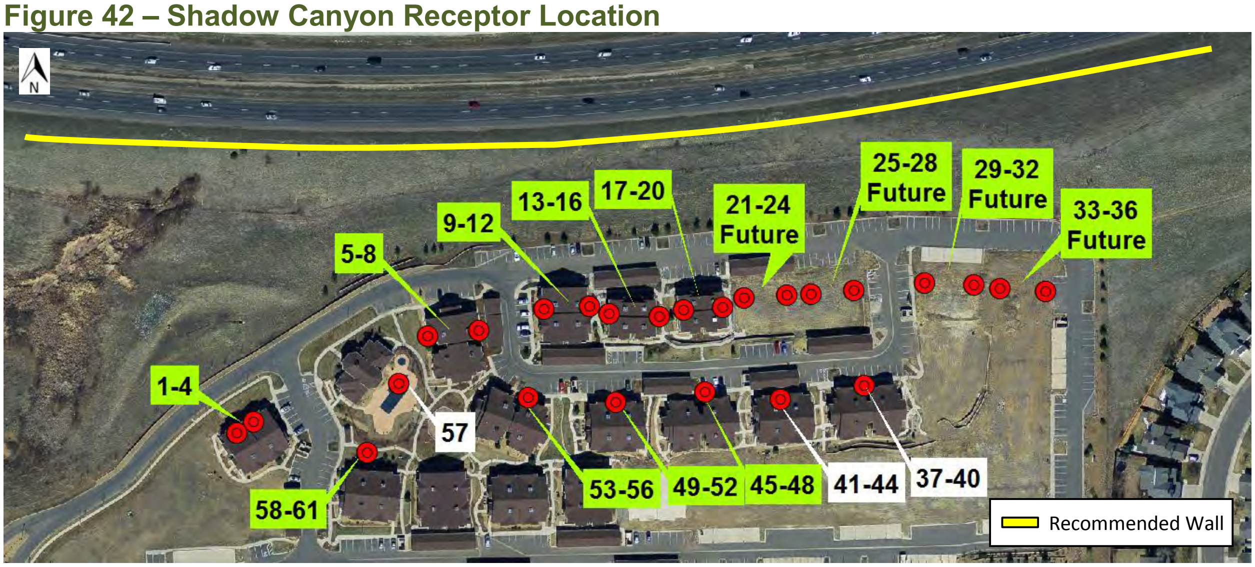
The Colorado Boulevard to Quebec area includes the communities of Highlands Ranch Shadow Canyon, Gleneagles Village, and Palomino Park as shown in **Figure 41**.

Figure 41 – Colorado Boulevard to Quebec

Shadow Canyon

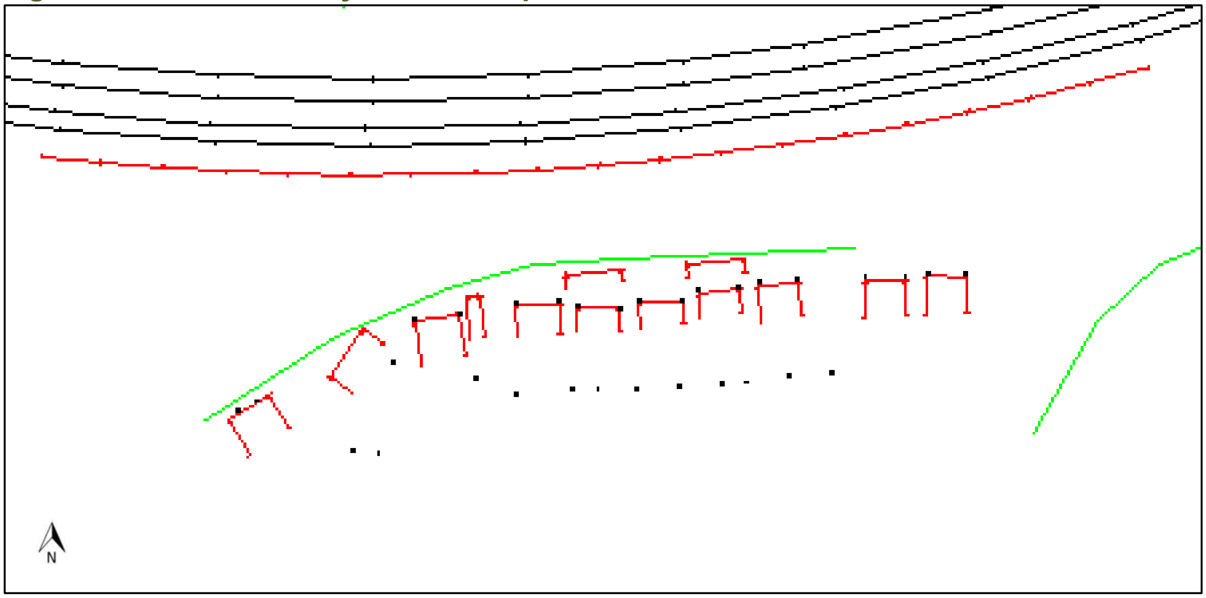
Shadow Canyon is a multi-storied residential complex south of C-470 between Colorado Boulevard and Quebec as shown in **Figure 41**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 42. Figure 43** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 61 receptor locations for both existing and Proposed Action conditions and are shown in **Table 31.**

Figure 42 – Shadow Canyon Receptor Location



Note: Impacted receptors are shaded green

Figure 43 – Shadow Canyon TNM Proposed Action Model View



Shadow Canyon Noise Impact Assessment

Table 31 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 42** and **Table 31.** Forth-one receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 74.6 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Shadow Canyon Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,700 feet long and averaging 18.7 feet tall. With this optimized wall many impacted property are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 9.2 dB(A), achieving the design goal of 7 dB(A). This meets the design goal reduction of 7 dB(A) or more for at least one receptor. The insertion losses are presented in **Table 32**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,430,550	(Cost of wall = 1,700 feet long x 18.7 feet tall x $45/sf = $1,430,550)
÷ 251.7	(Total dB(A) reduction for the 39 receptors with equal to or greater than 5 dB(A) reduction)
$5,684	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 31 – Shadow Canyon Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	60.9	64.1	3.2	No	No
2	Residential	B	65.5	69.7	4.2	Yes	No
3	Residential	B	61.5	65.1	3.6	No	No
4	Residential	B	66.1	70.2	4.1	Yes	No
5	Residential	B	64.1	68.1	4.0	Yes	No
6	Residential	B	69.9	73.6	3.7	Yes	No
7	Residential	B	63.5	67.6	4.1	Yes	No
8	Residential	B	70.0	73.3	3.3	Yes	No
9	Residential	B	67.2	71.2	4.0	Yes	No
10	Residential	B	71.3	74.6	3.3	Yes	No
11	Residential	B	69.1	73.0	3.9	Yes	No
12	Residential	B	71.6	74.8	3.2	Yes	No
13	Residential	B	68.4	72.1	3.7	Yes	No
14	Residential	B	71.4	74.6	3.2	Yes	No
15	Residential	B	66.3	69.9	3.6	Yes	No
16	Residential	B	71.2	74.3	3.1	Yes	No
17	Residential	B	66.1	70.1	4.0	Yes	No
18	Residential	B	71.3	74.5	3.2	Yes	No
19	Residential	B	64.7	69.0	4.3	Yes	No
20	Residential	B	70.9	74.0	3.1	Yes	No
21	Residential	B	62.9	66.5	3.6	Yes	No
22	Residential	B	70.1	73.1	3.0	Yes	No
23	Residential	B	58.2	62.9	4.7	Yes	No
24	Residential	B	66.7	69.7	3.0	Yes	No
25	Residential	B	60.9	66.2	5.3	Yes	No
26	Residential	B	69.4	72.7	3.3	Yes	No
27	Residential	B	60.3	64.7	4.4	Yes	No
28	Residential	B	70.0	73.5	3.5	Yes	No
29	Residential	B	65.5	70.3	4.8	Yes	No
30	Residential	B	70.9	73.8	2.9	Yes	No
31	Residential	B	65.7	70.5	4.8	Yes	No
32	Residential	B	70.6	73.7	3.1	Yes	No
33	Residential	B	66.0	70.6	4.6	Yes	No
34	Residential	B	70.6	73.8	3.2	Yes	No
35	Residential	B	65.5	70.2	4.7	Yes	No
36	Residential	B	70.3	73.5	3.2	Yes	No
37	Residential	B	57.6	60.5	2.9	No	No
38	Residential	B	62.2	65.4	3.2	No	No
39	Residential	B	54.3	57.8	3.5	No	No
40	Residential	B	59.6	62.9	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 31 – Shadow Canyon Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
41	Residential	B	55.5	59.2	3.7	No	No
42	Residential	B	60.1	63.5	3.4	No	No
43	Residential	B	56.5	60.1	3.6	No	No
44	Residential	B	61.0	64.1	3.1	No	No
45	Residential	B	58.1	61.1	3.0	No	No
46	Residential	B	62.9	65.9	3.0	Yes	No
47	Residential	B	59.9	63.3	3.4	No	No
48	Residential	B	64.1	67.2	3.1	Yes	No
49	Residential	B	61.1	64.5	3.4	No	No
50	Residential	B	63.5	66.7	3.2	Yes	No
51	Residential	B	62.5	65.7	3.2	Yes	No
52	Residential	B	64.4	67.5	3.1	Yes	No
53	Residential	B	59.4	63.0	3.6	No	No
54	Residential	B	66.1	69.5	3.4	Yes	No
55	Residential	B	56.9	60.1	3.2	No	No
56	Residential	B	64.7	68.3	3.6	Yes	No
57	Residential	B	59.2	62.7	3.5	No	No
58	Residential	B	56.6	59.9	3.3	No	No
59	Residential	B	61.1	65.3	4.2	No	No
60	Residential	B	56.8	60.6	3.8	No	No
61	Residential	B	62.1	66.0	3.9	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 32 – Shadow Canyon Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
SC2	Residential	B	69.7	66.1	3.6
SC4	Residential	B	70.2	66.2	4.0
SC5	Residential	B	68.1	63.1	5.0
SC6	Residential	B	73.6	65.2	8.4
SC7	Residential	B	67.6	62.4	5.2
SC8	Residential	B	73.3	64.6	8.7
SC9	Residential	B	71.2	64.6	6.6
SC10	Residential	B	74.6	66.7	7.9
SC11	Residential	B	73.0	66.4	6.6
SC12	Residential	B	74.8	68.6	6.2
SC13	Residential	B	72.1	66.0	6.1
SC14	Residential	B	74.6	68.3	6.3
SC15	Residential	B	69.9	64.7	5.2

Table 32 – Shadow Canyon Impacted Receptors with Mitigation (cont)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
SC16	Residential	B	74.3	67.5	6.8
SC17	Residential	B	70.1	64.2	5.9
SC18	Residential	B	74.5	67.2	7.3
SC19	Residential	B	69.0	62.2	6.8
SC20	Residential	B	74.0	66.8	7.2
SC21	Residential	B	66.5	60.6	5.9
SC22	Residential	B	73.1	66.3	6.8
SC24	Residential	B	69.7	64.1	5.6
SC25	Residential	B	66.2	59.4	6.8
SC26	Residential	B	72.7	64.5	8.2
SC28	Residential	B	73.5	64.3	9.2
SC29	Residential	B	70.3	64.4	5.9
SC30	Residential	B	73.8	66.8	7.0
SC31	Residential	B	70.5	65.2	5.3
SC32	Residential	B	73.7	67.4	6.3
SC33	Residential	B	70.6	65.6	5.0
SC34	Residential	B	73.8	67.8	6.0
SC35	Residential	B	70.2	65.6	4.6
SC36	Residential	B	73.5	67.9	5.6
SC46	Residential	B	65.9	63.0	2.9
SC48	Residential	B	67.2	64.5	2.7
SC50	Residential	B	66.7	64.3	2.4
SC51	Residential	B	65.7	62.6	3.1
SC52	Residential	B	67.5	64.3	3.2
SC54	Residential	B	69.5	64.0	5.5
SC56	Residential	B	68.3	62.1	6.2
SC61	Residential	B	66.0	62.5	3.5
Other Benefitted	Residential	B			44.9
			Total dB(A) Reduction (5 dB(A) or greater)		**251.7**

In summary, the Shadow Canyon area has 39 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

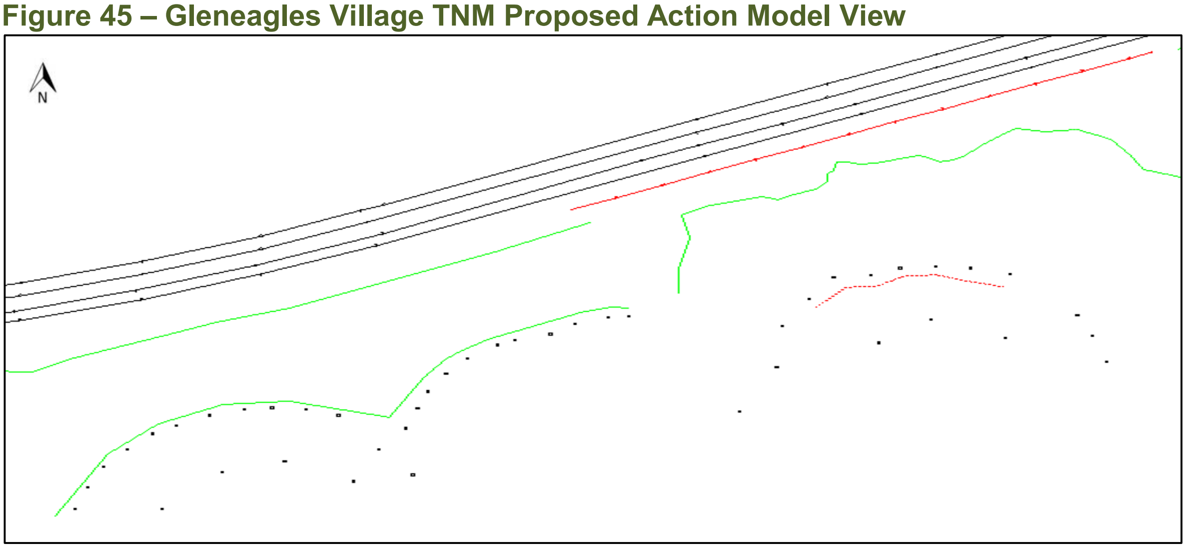
Gleneagles Village

Gleneagles Village is a single-family residential development south of C-470 between Colorado Boulevard and Quebec as shown in **Figure 41**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 44. Figure 45** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 33.**

Figure 44 – Gleneagles Village Receptor Locations

Note: Impacted receptors are shaded green

Figure 45 – Gleneagles Village TNM Proposed Action Model View



Gleneagles Village Noise Impact Assessment

Table 33 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 45** and **Table 33.** Seven receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 67.9 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Gleneagles Village Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,100 feet long and averaging 16.9 feet tall. With this optimized wall many impacted property are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 7.0 dB(A), achieving the design goal of 7 dB(A) insertion loss. The insertion losses are presented in **Table 34**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$836,550	(Cost of wall = 1,100 feet long x 16.9 feet tall x $45/sf = $836,550)
÷ 54.6	(Total dB(A) reduction for the 9 receptors with equal to or greater than 5 dB(A) reduction)
$15,321	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 33 – Gleneagles Village Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	55.1	59.4	4.3	No	No
2	Residential	B	54.5	58.7	4.2	No	No
3	Residential	B	55.7	59.5	3.8	No	No
4	Residential	B	57.9	61.7	3.8	No	No
5	Residential	B	58.2	61.9	3.7	No	No
6	Residential	B	58.5	62.4	3.9	No	No
7	Residential	B	59.1	63.0	3.9	No	No
8	Residential	B	59.3	63.1	3.8	No	No
9	Residential	B	59.3	63.2	3.9	No	No
10	Residential	B	59.5	63.6	4.1	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 33 – Gleneagles Village Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
11	Residential	B	59.6	63.4	3.8	No	No
12	Residential	B	58.8	63.0	4.2	No	No
13	Residential	B	58.3	62.6	4.3	No	No
14	Residential	B	57.9	62.2	4.3	No	No
15	Residential	B	57.3	61.2	3.9	No	No
16	Residential	B	56.0	60.2	4.2	No	No
17	Residential	B	55.9	60.1	4.2	No	No
18	Residential	B	57.4	61.3	3.9	No	No
19	Residential	B	58.4	62.4	4.0	No	No
20	Residential	B	58.5	62.5	4.0	No	No
21	Residential	B	59.1	63.0	3.9	No	No
22	Residential	B	59.3	63.3	4.0	No	No
23	Residential	B	59.8	63.9	4.1	No	No
24	Residential	B	59.9	64.2	4.3	No	No
25	Residential	B	60.2	64.8	4.6	No	No
26	Residential	B	60.5	65.3	4.8	No	No
27	Residential	B	60.3	65.1	4.8	No	No
28	Residential	B	60.1	65.1	5.0	No	No
29	Residential	B	56.5	61.5	5.0	No	No
30	Residential	B	58.1	63.2	5.1	No	No
31	Residential	B	60.1	65.2	5.1	No	No
32	Residential	B	61.5	66.5	5.0	Yes	No
33	Residential	B	63.0	67.9	4.9	Yes	No
34	Residential	B	63.0	67.9	4.9	Yes	No
35	Residential	B	62.9	67.9	5.0	Yes	No
36	Residential	B	62.7	67.7	5.0	Yes	No
37	Residential	B	62.3	67.3	5.0	Yes	No
38	Residential	B	61.0	66.3	5.3	Yes	No
39	Residential	B	58.1	63.3	5.2	No	No
40	Residential	B	57.4	62.4	5.0	No	No
41	Residential	B	56.5	61.3	4.8	No	No
42	Residential	B	57.7	62.6	4.9	No	No
43	Residential	B	59.6	65.1	5.5	No	No
44	Residential	B	59.4	64.6	5.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 34 – Gleneagles Village Impacted Receptors with Mitigation

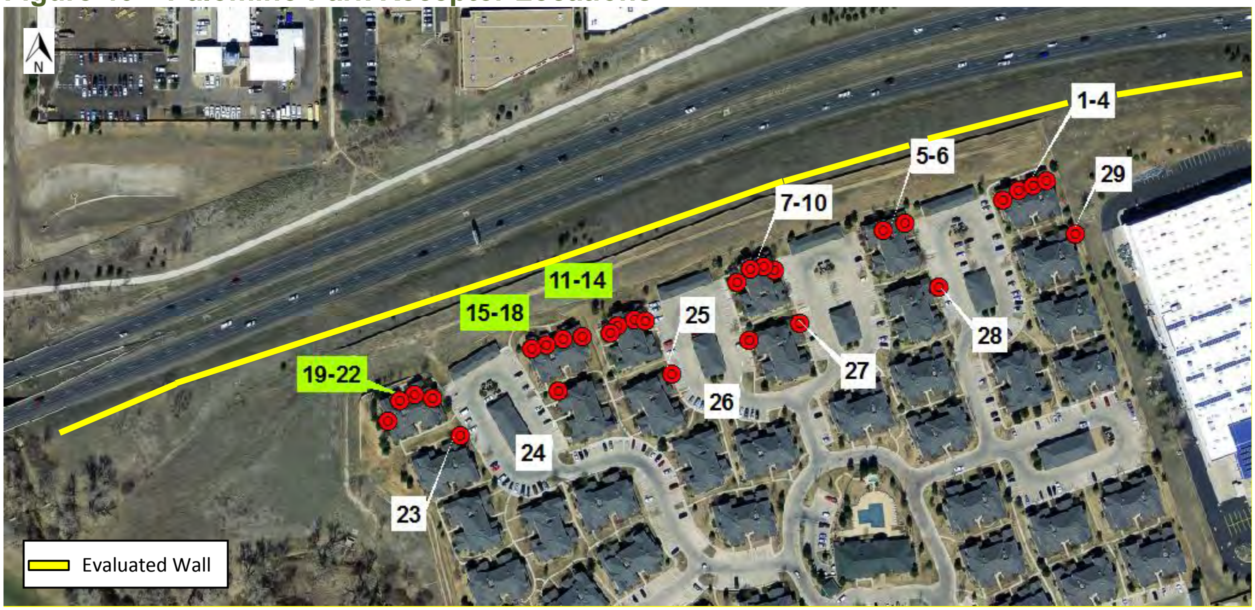
Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
32	Residential	B	66.5	60.3	6.2
33	Residential	B	67.9	60.9	7.0
34	Residential	B	67.9	61.2	6.7
35	Residential	B	67.9	61.0	6.9
36	Residential	B	67.7	61.4	6.3
37	Residential	B	67.3	61.8	5.5
38	Residential	B	66.3	61.3	5.0
Other Benefitted	Residential	B			11.0
				Total dB(A) Reduction (5 dB(A) or greater)	54.6

In summary, the Gleneagles Village area has nine receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. However, the CBI is over CDOT's cost threshold and mitigation is not recommended.

Palomino Park

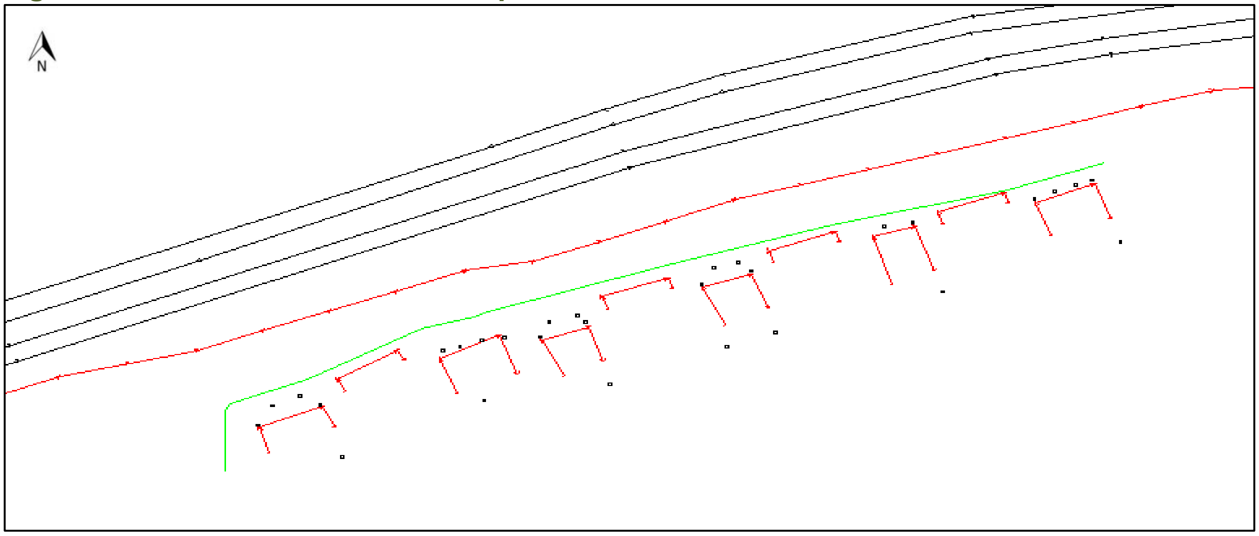
Palomino Park is a multi-storied residential complex south of C-470 between Colorado Boulevard and Quebec as shown in **Figure 41**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 46**. **Figure 47** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 38 receptor locations for both existing and Proposed Action conditions and are shown in **Table 35.**

Figure 46 – Palomino Park Receptor Locations



Note: Impacted receptors are shaded green

Figure 47 – Palomino Park TNM Proposed Action Model View



Palomino Park Noise Impact Assessment

Table 35 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 46** and **Table 35.** Eight receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 74.3 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Palomino Park Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 800 feet long and 17.5 feet tall. With this optimized wall many impacted property is predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one receptor receiving 7.2 dB(A) insertion loss, achieving the design goal of 7 dB(A) insertion loss. Some second level receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. The insertion losses are presented in **Table 36**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$630,000	(Cost of wall = 800 feet long x 17.5 feet tall x $45/sf = $630,000)
÷ 42.0	(Total dB(A) reduction for the 8 receptors with equal to or greater than 5 dB(A) reduction)
$15,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 35 – Palomino Park Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	59.2	63.7	4.5	No	No
2	Residential	B	58.7	63.1	4.4	No	No
3	Residential	B	58.3	62.5	4.2	No	No
4	Residential	B	57.9	61.9	4.0	No	No
5	Residential	B	57.9	61.6	3.7	No	No
6	Residential	B	58.6	62.5	3.9	No	No
7	Residential	B	58.1	61.8	3.7	No	No
8	Residential	B	59.4	63.5	4.1	No	No
9	Residential	B	60.0	64.0	4.0	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 35 – Palomino Park Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
10	Residential	B	59.3	63.2	3.9	No	No
11	Residential	B	59.2	63.7	4.5	No	No
12	Residential	B	61.0	65.5	4.5	Yes	No
13	Residential	B	62.2	66.7	4.5	Yes	No
14	Residential	B	60.0	64.7	4.7	No	No
15	Residential	B	55.5	59.8	4.3	No	No
16	Residential	B	60.2	65.0	4.8	No	No
17	Residential	B	60.7	65.5	4.8	Yes	No
18	Residential	B	61.3	66.1	4.8	Yes	No
19	Residential	B	66.2	71.0	4.8	Yes	No
20	Residential	B	68.9	73.0	4.1	Yes	No
21	Residential	B	70.6	74.3	3.7	Yes	No
22	Residential	B	70.0	73.7	3.7	Yes	No
23	Residential	B	59.3	63.2	3.9	No	No
24	Residential	B	56.4	60.2	3.8	No	No
25	Residential	B	53.9	57.7	3.8	No	No
26	Residential	B	53.3	57.1	3.8	No	No
27	Residential	B	53.0	57.0	4.0	No	No
28	Residential	B	53.7	58.0	4.3	No	No
29	Residential	B	57.4	62.3	4.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 36 – Palomino Park Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
12	Residential	B	65.5	63.1	2.4
13	Residential	B	66.7	63.3	3.4
17	Residential	B	65.5	60.3	5.2
18	Residential	B	66.1	60.4	5.7
19	Residential	B	71.0	65.7	5.3
20	Residential	B	73.0	66.3	6.7
21	Residential	B	74.3	67.1	7.2
22	Residential	B	73.7	67.6	6.1
				Total dB(A) Reduction (5 dB(A) or greater)	**42.0**

In summary, the Palomino Park has eight receptors that could benefit from noise mitigation. However, the CBI is not within CDOT's cost threshold and mitigation is not recommended.

4.9 I-25

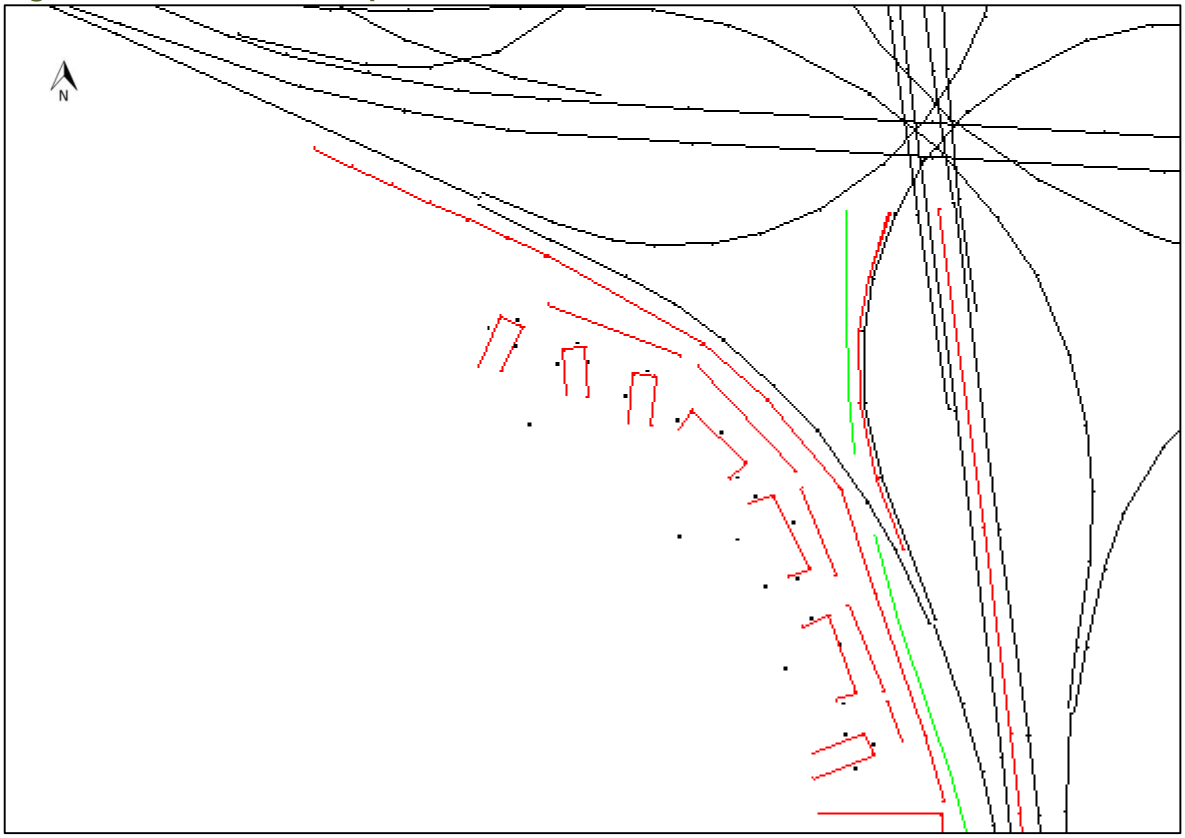
Crest

Crest is a multi-storied residential complex in the southwest quadrant of the C-470 and I-25 interchange as shown in **Figure 48**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 48. Figure 49** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted for both existing and Proposed Action conditions and are shown in **Table 37.**

Figure 48 – Crest Receptor Locations (each site has multiple levels)

Note: Impacted receptors are shaded green

Figure 49 – Crest TNM Proposed Action Model View



Crest Noise Impact Assessment

Table 37 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 48** and **Table 37.** Seventy-six receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 74.2 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Crest Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 2,300 feet long and 18.2 feet tall. Some impacted receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. However, the design goal reduction of 7 dB(A) or more was met by at least one receptor. The insertion losses are presented in **Table 38**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,883,700	(Cost of wall = 2,300 feet long x 18.2 feet tall x $45/sf = $1,883,700)
÷ 493.0	(Total dB(A) reduction for the 82 receptors with equal to or greater than 5 dB(A) reduction)
$3,821	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 37 – Crest Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B1-1-1	Residential	B	62.5	63.3	0.8	No	No
B1-1-2	Residential	B	66.5	67.6	1.1	Yes	No
B1-1-3	Residential	B	68.5	71.1	2.6	Yes	No
B1-2-1	Residential	B	61.9	63.3	1.4	No	No
B1-2-2	Residential	B	65.8	68.0	2.2	Yes	No
B1-2-3	Residential	B	67.0	69.6	2.6	Yes	No
B1-3-1	Residential	B	55.0	54.7	-0.3	No	No
B1-3-2	Residential	B	58.6	59.6	1.0	No	No
B1-3-3	Residential	B	62.5	65.0	2.5	No	No
B2 - 1 -1	Residential	B	60.3	62.4	2.1	No	No
B2 - 1 - 2	Residential	B	67.1	68.3	1.2	Yes	No
B2 - 1 - 3	Residential	B	69.1	71.5	2.4	Yes	No
B2 - 2 -1	Residential	B	60.0	60.4	0.4	No	No
B2 - 2 - 2	Residential	B	64.2	65.9	1.7	Yes	No
B2 - 2 - 3	Residential	B	64.9	67.0	2.1	Yes	No
B2 - 3 -1	Residential	B	55.7	56.5	0.8	No	No
B2 - 3 - 2	Residential	B	61.4	61.9	0.5	No	No
B2 - 3 - 3	Residential	B	66.3	68.7	2.4	Yes	No
B3-1- 1	Residential	B	60.8	62.4	1.6	No	No
B3-1- 2	Residential	B	67.4	69.4	2.0	Yes	No
B3-1 - 3	Residential	B	69.7	71.8	2.1	Yes	No
B3-1- 1	Residential	B	60.3	60.7	0.4	No	No
B3-1- 2	Residential	B	63.9	65.8	1.9	Yes	No
B3-1 - 3	Residential	B	64.6	66.8	2.2	Yes	No
B3-1- 1	Residential	B	57.1	57.0	-0.1	No	No
B3-1- 2	Residential	B	61.9	62.2	0.3	No	No
B3-1 - 3	Residential	B	65.2	67.3	2.1	Yes	No
B4-1 - 1	Residential	B	60.1	61.6	1.5	No	No
B4-1 - 2	Residential	B	65.8	68.0	2.2	Yes	No
B4-1- 3	Residential	B	69.1	71.5	2.4	Yes	No
B4-2 - 1	Residential	B	60.1	60.4	0.3	No	No
B4-2 - 2	Residential	B	64.6	66.8	2.2	Yes	No
B4-2- 3	Residential	B	66.4	68.4	2.0	Yes	No
B4-3 - 1	Residential	B	54.0	56.7	2.7	No	No
B4-3 - 2	Residential	B	57.8	61.2	3.4	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 37 – Crest Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B4-3- 3	Residential	B	62.4	66.1	3.7	Yes	No
B5-1 - 1	Residential	B	59.2	62.0	2.8	No	No
B5-1 - 2	Residential	B	65.3	69.8	4.5	Yes	No
B5-1- 3	Residential	B	68.4	72.7	4.3	Yes	No
B5-2 - 1	Residential	B	57.4	59.4	2.0	No	No
B5-2 - 2	Residential	B	62.6	65.6	3.0	Yes	No
B5-3 - 1	Residential	B	65.6	68.4	2.8	Yes	No
B5-3 - 2	Residential	B	62.2	68.1	5.9	No	No
B5-3- 3	Residential	B	64.8	71.0	6.2	Yes	No
B6-1- 1	Residential	B	58.5	63.0	4.5	No	No
B6-1- 2	Residential	B	65.0	70.8	5.8	No	No
B6-1- 3	Residential	B	67.8	74.2	6.4	Yes	No
B6-2- 1	Residential	B	57.5	62.5	5.0	No	No
B6-2- 2	Residential	B	60.8	66.9	6.1	No	No
B6-2- 3	Residential	B	63.2	68.9	5.7	Yes	No
B6-3- 1	Residential	B	58.6	61.7	3.1	No	No
B6-3- 2	Residential	B	63.0	67.8	4.8	Yes	No
B6-3- 3	Residential	B	65.4	72.4	7.0	Yes	No
B7-1- 1	Residential	B	61.4	64.6	3.2	No	No
B7-1- 2	Residential	B	65.5	71.3	5.8	No	No
B7-1- 3	Residential	B	68.4	75.1	6.7	Yes	No
B7-2- 1	Residential	B	57.5	61.6	4.1	No	No
B7-2- 2	Residential	B	61.7	68.3	6.6	No	No
B7-2- 3	Residential	B	64.0	71.0	7.0	Yes	No
B7-3- 1	Residential	B	60.0	62.6	2.6	No	No
B7-3- 2	Residential	B	62.5	67.4	4.9	Yes	No
B7-3- 3	Residential	B	64.9	71.7	6.8	Yes	No
B8 - 1	Residential	B	52.0	54.4	2.4	No	No
B8- 2	Residential	B	52.9	55.8	2.9	No	No
B8 - 3	Residential	B	55.6	58.8	3.2	No	No
B9 - 1	Residential	B	52.8	55.2	2.4	No	No
B9 - 2	Residential	B	54.2	57.3	3.1	No	No
B9 - 3	Residential	B	55.7	59.7	4.0	No	No
B10	Residential	B	54.3	58.4	4.1	No	No
B11- 1	Residential	B	52.4	55.0	2.6	No	No
B11- 2	Residential	B	54.2	56.9	2.7	No	No
B11- 3	Residential	B	56.0	59.0	3.0	No	No
B12 - 1	Residential	B	55.7	57.5	1.8	No	No
B12 -3	Residential	B	59.1	60.8	1.7	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 38 – Crest Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))			Receptor Represents X Residents
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels	
B1-1-2	Residential	B	67.6	62.0	5.6	2
B1-1-3	Residential	B	71.1	63.6	7.5	2
B1-2-2	Residential	B	68.0	62.4	5.6	2
B1-2-3	Residential	B	69.6	64.6	5.0	2
B2 - 1 - 2	Residential	B	68.3	61.6	6.7	2
B2 - 1 - 3	Residential	B	71.5	64.5	7.0	2
B2 - 2 - 2	Residential	B	65.9	57.6	8.3	2
B2 - 2 - 3	Residential	B	67.0	61.4	5.6	2
B2 - 3 - 3	Residential	B	68.7	59.5	9.2	2
B3-1- 2	Residential	B	69.4	62.0	7.4	2
B3-1 - 3	Residential	B	71.8	66.2	5.6	2
B3-1- 2	Residential	B	65.8	59.1	6.7	2
B3-1 - 3	Residential	B	66.8	61.3	5.5	2
B3-1 - 3	Residential	B	67.3	60.6	6.7	2
B4-1 - 2	Residential	B	68.0	62.6	5.4	4
B4-1- 3	Residential	B	71.5	67.0	4.5	4
B4-2 - 2	Residential	B	66.8	60.7	6.1	2
B4-2- 3	Residential	B	68.4	65.1	3.3	2
B4-3- 3	Residential	B	66.1	57.2	8.9	2
B5-1 - 2	Residential	B	69.8	64.5	5.3	4
B5-1- 3	Residential	B	72.7	69.3	3.4	4
B5-2 - 2	Residential	B	65.6	58.4	7.2	2
B5-2- 3	Residential	B	68.4	62.4	6.0	2
B5-3 - 2	Residential	B	68.1	64.2	3.9	2
B5-3- 3	Residential	B	71.0	69.8	1.2	2
B6-1- 2	Residential	B	70.8	65.2	5.6	4
B6-1- 3	Residential	B	74.2	72.7	1.5	4
B6-2- 2	Residential	B	66.9	61.5	5.4	2
B6-2- 3	Residential	B	68.9	67.8	1.1	2
B6-3- 2	Residential	B	67.8	61.7	6.1	2
B6-3- 3	Residential	B	72.4	65.8	6.6	2
B7-1- 2	Residential	B	71.3	64.2	7.1	2
B7-1- 3	Residential	B	75.1	68.5	6.6	2
B7-2- 2	Residential	B	68.3	61.4	6.9	2
B7-2- 3	Residential	B	71.0	66.3	4.7	2
B7-3- 2	Residential	B	67.4	61.2	6.2	2
B7-3- 3	Residential	B	71.7	65.3	6.4	2
Other Benefitted	Residential	B			84.0	
			Total dB(A) Reduction (5 dB(A) or greater)			**493.0**

In summary, the Crest area has 82 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and therefore mitigation is recommended.

4.10 Recreational Resources

Recreational resources are distributed across the entire C-470 corridor. These resources include a pool, golf courses, athletic fields, trails, playgrounds, and non-profit institutional offices. One receptors was identified for each location adjacent to C-470 where people congregate, e.g. golfing tee boxes, golfing greens, pools, benches, major path connections, and athletic fields. Using the prediction methodology described in Section 3.0, receptors were developed for these outdoor use areas as shown in **Figures 50 through 55**. Noise levels were predicted at each of 24 receptor locations for both existing and Proposed Action conditions and are shown in **Table 39**.

Table 39 – Recreational Resources Noise Model Results without Mitigation

Impacted Receptors				Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No. Receptors		Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Kipling to Wadsworth	1 Golf #15Green	Recreational	C	66.5	66.5	0.0	Yes	No
	2 Golf #15Tee	Recreational	C	68.9	68.9	0.0	Yes	No
	3 Track	Recreational	C	53.4	58.7	5.3	No	No
	4 Deer Crk Pool	Recreational	C	66.7	69.3	2.6	Yes	No
	5 Swingate Park	Recreational	C	55.2	58.9	3.7	No	No
Wadsworth to Platte Canyon	6 Massey Xing N	Recreational	C	64.2	65.1	0.9	No	No
	7 Massey Xing S	Recreational	C	61.5	63.0	1.5	No	No
	8 Trail stop	Recreational	C	73.9	76.9	3.0	Yes	No
	9 Dam	Recreational	C	56.7	59.2	2.5	No	No
Platte Canyon to Santa Fe	10 Park Trail	Recreational	C	63.3	69.1	5.8	Yes	No
	11 Trail N	Recreational	C	68.6	69.8	1.2	Yes	No
	12 Johnny's Pond	Recreational	C	64.9	65.9	1.0	Yes	No
	13 Fly'n B Dock	Recreational	C	58.7	59.7	1.0	No	No
	14 Highline Trail	Recreational	C	69.5	65.4	-4.1	No	No
Univ.	15 Baseball Field	Recreational	C	68.9	72.0	3.1	Yes	No
Colorado to Quebec	16 David Lorenz Field	Recreational	C	63.5	67.6	4.1	Yes	No
	17 Frisbee Hole	Recreational	C	59.2	62.4	3.2	No	No
	18 Frisbee Tee	Recreational	C	62.5	67.5	5.0	Yes	No
	19 Golf#5Tee	Recreational	C	69.3	74.1	4.8	Yes	No
	20 Golf#4Green	Recreational	C	65.8	70.3	4.5	Yes	No
	21 Golf#4Tee	Recreational	C	62.3	67.4	5.1	Yes	No
	22 Golf#5Green	Recreational	C	60.4	66.0	5.6	Yes	No
	23 Soccer Field	Recreational	C	69.2	73.6	4.4	Yes	No
Quebec to I-25	24 Willow Creek N	Recreational	C	60.2	64.2	4.0	No	No
	25 Willow Creek S	Recreational	C	65.1	67.3	2.2	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Kipling Parkway to Wadsworth Boulevard Area

Figure 50 – Recreational Receptor Locations in the Kipling Parkway to Wadsworth Boulevard Area

Note: Impacted receptors are shaded green

Kipling Parkway to Wadsworth Boulevard Area Noise Mitigation Assessment

The optimal walls, providing the greatest noise reduction for impacted receptors per square foot of wall, were developed for the impacted receptors.

Deer Creek Golf Course

A wall roughly 1530 feet long and 14.8 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. Receptor 1 achieved this goal. However, because of the proximity of receptor 2 to Kipling Parkway neither 7.0 dB(A) nor 5.0 dB(A) was achievable. The insertion losses are presented in **Table 40**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,018,980	(Cost of wall = 1,530 feet long x 14.8 feet tall x $45/sf = $1,018,980)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$145,568	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Deer Creek Pool

A wall roughly 1,250 feet long and 11.6 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 40**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$652,500	(Cost of wall = 1,250 feet long x 11.6 feet tall x $45/sf = $652,500)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$93,214	(Cost Benefit Index, cost per dB(A) per receptor)

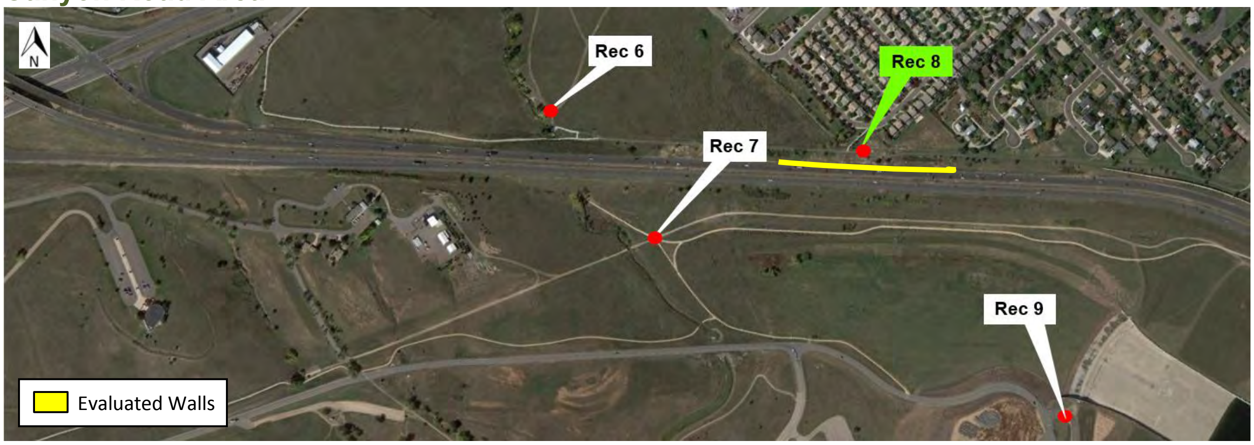
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 40 – Kipling Parkway to Wadsworth Boulevard Area Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Deer Creek Golf Course					
1	Recreational	C	66.5	59.5	7.0
2	Recreational	C	68.9	68.9	0.0
Deer Creek Pool					
4	Recreational	C	69.3	62.3	7.0

Wadsworth Boulevard to Platte Canyon Road Area

Figure 51 – Recreational Receptor Locations in the Wadsworth Boulevard to Platte Canyon Road Area



Note: Impacted receptors are shaded green

Wadsworth Boulevard to Platte Canyon Road Area Noise Mitigation Assessment

A wall roughly 200 feet long and 7 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 41**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$63,000	(Cost of wall = 200 feet long x 7 feet tall x $45/sf = $63,000)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$9,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 41 – Wadsworth Boulevard to Platte Canyon Road Area Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
8	Recreational	C	76.9	69.7	7.2

Platte Canyon Road to Santa Fe Drive Area

Figure 52 – Recreational Receptor Locations in the Platte Canyon Road to Santa Fe Drive Area

Note: Impacted receptors are shaded green

Platte Canyon Road to Santa Fe Drive Area Noise Mitigation Assessment

The optimal walls, providing the greatest noise reduction for impacted receptors per square foot of wall, were developed for the impacted receptors.

Park Trail (Rec 10)

A wall roughly 1,270 feet long and 17.5 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 42**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,000,125	(Cost of wall = 1,270 feet long x 17.5 feet tall x $45/sf = $1,000,125)
÷ 7.1	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$140,863	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Trail North (Rec 11)

A wall roughly 1,270 feet long and 17.3 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 42**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$ 988,695	(Cost of wall = 750 feet long x 17.3 feet tall x $45/sf = $583,825)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$ 141,242	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Johnny's Pond

A wall roughly 1,550 feet long and 20 feet tall provided 4.2 dB(A) insertion and was not able to provide the design goal of 7.0 dB(A) insertion loss for the receptor. Thus there is no Benefit Cost Index. The insertion losses are presented in **Table 42**.

Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated. However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 42 – Kipling Parkway to Wadsworth Boulevard Area Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Park Trail					
10	Recreational	C	69.1	62.0	7.1
Trail North					
11	Recreational	C	69.8	62.8	7.0
Johnny's Pond					
12	Recreational	C	65.9	61.7	4.2

University Boulevard Area

Figure 53 – Recreational Receptor Locations in the University Boulevard Area

Note: Impacted receptors are shaded green

University Boulevard Area Noise Mitigation Assessment

A wall roughly 1,290 feet long and 19 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 43**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,102,950	(Cost of wall = 1,290 feet long x 19 feet tall x $45/sf = $1,102,950)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$157,564	(Cost Benefit Index, cost per dB(A) per receptor)

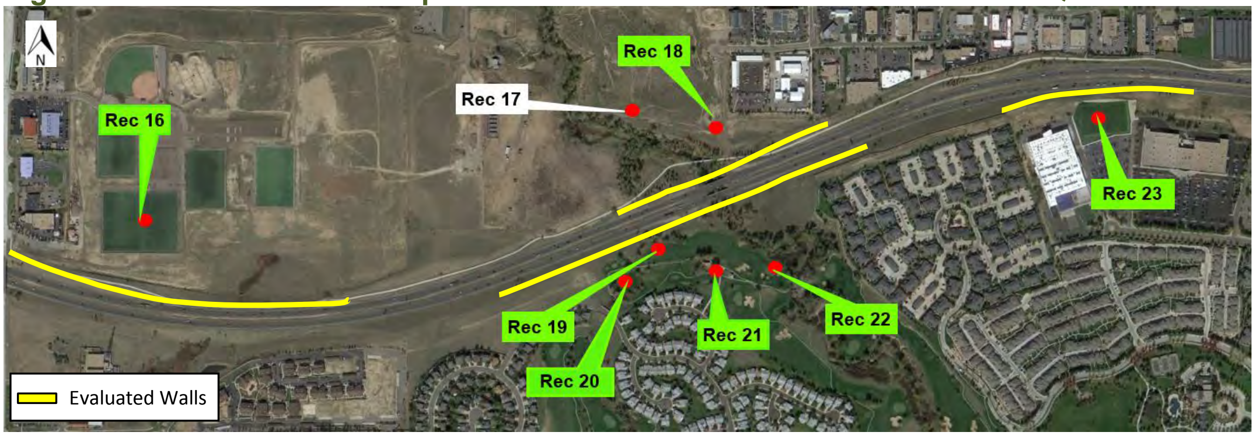
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 43 – University Boulevard Area Impacted Receptor with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
15	Recreational	C	72.0	65.0	7.0

Colorado Boulevard to Quebec Area

Figure 54 – Recreational Receptor Locations in the Colorado Boulevard to Quebec Area



Note: Impacted receptors are shaded green

Colorado Boulevard to Quebec Area Noise Mitigation Assessment

The optimal walls, providing the greatest noise reduction for impacted receptors per square foot of wall, were developed for the impacted receptors.

David Lorenz Park

A wall roughly 2,500 feet long and 20 feet tall was not able to provide the design goal of 7.0 dB(A) insertion loss for the receptor. Thus there is no Benefit Cost Index.

Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated. However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Frisbee Golf Course

A wall roughly 1,400 feet long and 15.2 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 44**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$957,600	(Cost of wall = 1,400 feet long x 15.2 feet tall x $45/sf = $957,600)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$136,800	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Gleneagles Golf Course

A wall roughly 1,000 feet long and 12 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 44**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$540,000	(Cost of wall = 1,000 feet long x 12 feet tall x $45/sf = $540,000)
÷ 12.3	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$43,902	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Skyview Soccer Field

A wall roughly 750 feet long and 18.5 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 44**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$624,375	(Cost of wall = 750 feet long x 18.5 feet tall x $45/sf = $624,375)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$89,196	(Cost Benefit Index, cost per dB(A) per receptor)

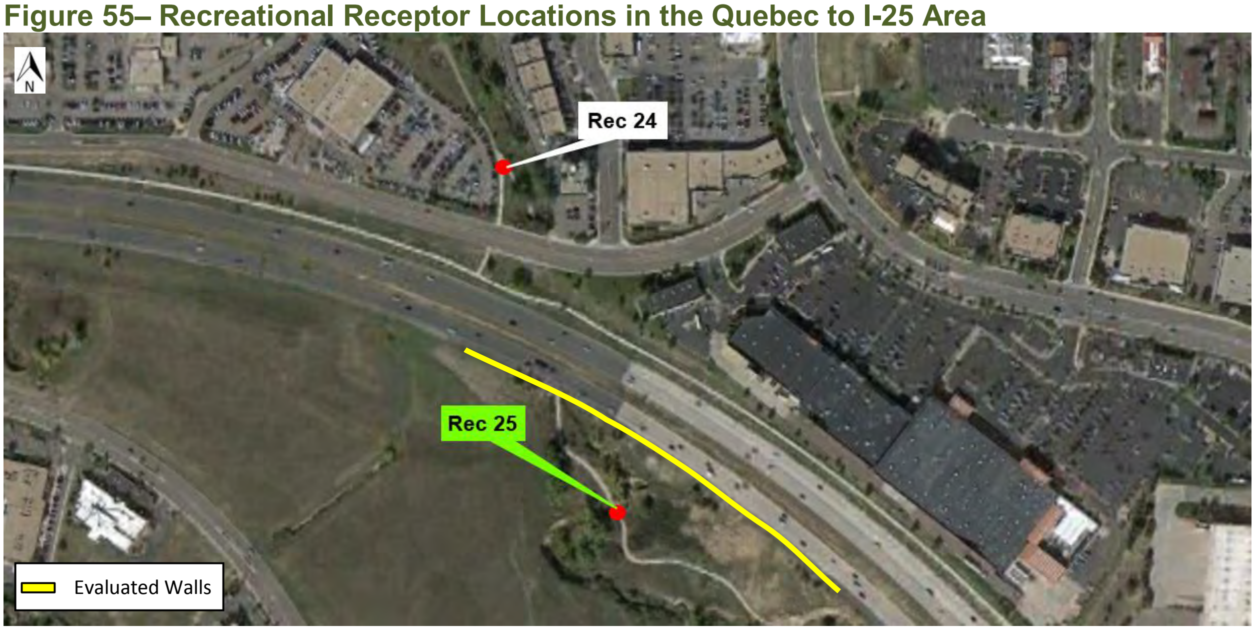
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 44 – Colorado Boulevard to Quebec Area Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
David Lorenz					
16	Recreational	C	67.6	61.1	6.5
Frisbee Golf					
17	Recreational	C	62.4	58.2	4.2
18	Recreational	C	67.5	60.5	7.0
Gleneagles Golf					
19	Recreational	C	74.1	66.9	7.2
20	Recreational	C	70.3	65.2	5.1
21	Recreational	C	67.4	64.0	3.4
22	Recreational	C	66.0	64.9	1.1
Skyview Soccer Field					
23	Recreational	C	73.6	66.6	7.0

Quebec to I-25 Area

Figure 55– Recreational Receptor Locations in the Quebec to I-25 Area



Note: Impacted receptors are shaded green

Willow Creek South

A wall roughly 1,670 feet long and 20 feet tall was not able to provide the design goal of 7.0 dB(A) insertion loss for the receptor. Thus there is no Benefit Cost Index. Insertion loss is presented in Table 45.

Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated. However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 45 – Quebec to I-25 Area Impacted Receptor with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
25	Recreational	C	67.3	60.5	6.8

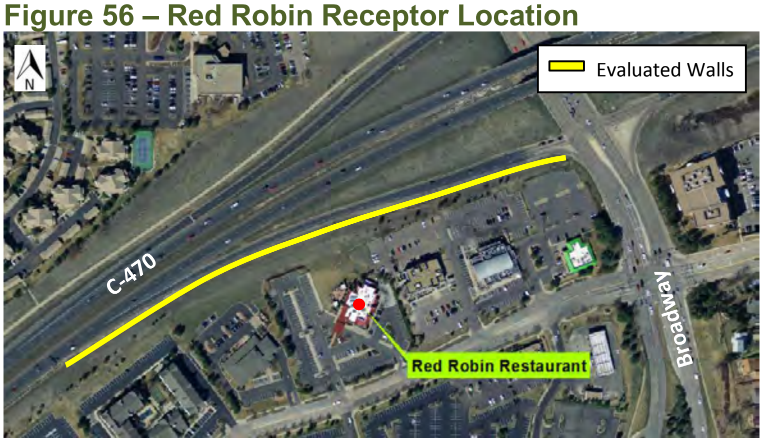
4.11 Noise Sensitive Commercial Properties

This corridor has mix of residential and commercial land uses along the entire length. CDOT guidelines call for a review of noise sensitive commercial properties. These properties can include restaurants, hotels, and other businesses that have a noise sensitive outdoor use. A review of the corridor identified four businesses with outdoor uses, restaurant seating, within 300 feet of the roadway. 300 feet was used as an initial screening based on the 71 dB(A) contour line being roughly 225-275 from the roadway. 71 dB(A) is considered to be an impact on these types of businesses.

The businesses identified below and shown in **Figures 56** and **57** are:

- Red Robin restaurant, south of C-470 and west of Broadway, which has an outdoor seating area;
- On the Border restaurant, south of C-470 and west of Quebec, which has an outdoor seating area;
- LODO restaurant, south of C-470 and west of Quebec, which has a roughly third level deck/seating area; and
- Brothers Bar & Grill restaurant, south of C-470 and east of Quebec, which has an elevated deck.

Figure 56 – Red Robin Receptor Location



Note: Impacted receptors are shaded green

Figure 57– On the Border, LODO, & Brothers Receptor Locations

Note: Impacted receptors are shaded green

Noise Sesitive Commercial Properties Noise Impact Assessment

Table 46 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 56, 57** and **Table 46.** Red Robin, LODO, and Brothers equal or exceeds CDOT impact criteria for commercial properties and thus per CDOT policy are considered impacted. The highest predicted future noise level is 72.1 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was not conducted. Per CDOT Noise abatement guidelines each outdoor use area is given one receptor.

Table 46 – Noise Sensitive Commercial Properties Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Red Robin	Restaurant	E	67.4	70.9	3.5	Yes	No
On the Border	Restaurant	E	63.2	66.8	3.6	No	No
LODO	Restaurant	E	67.8	71.4	3.6	Yes	No
Brothers	Restaurant	E	70.0	72.1	2.1	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Commercial Noise Mitigation Assessment

Walls were reviewed for each site. The maximum 20 feet high walls, provided the greatest noise reduction for impacted receptors but did not provide the design goal of 7 dB(A) for any of the sites. The insertion losses are presented in **Table 47**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

Red Robin - The Benefit Cost Index for the Red Robin wall location within CDOT ROW is calculated as:

$1,062,000	(Cost of wall = 1,180 feet long x 20 feet tall x $45/sf = $1,062,000)
÷ 6.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$177,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. A 20 feet high wall also does not meet the design goal of 7 dB(A) insertion loss. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

On the Border, LODO, & Brothers - The Benefit Cost Index for the combined wall location within CDOT ROW is calculated as:

$1,350,000	(Cost of wall = 1,500 feet long x 20 feet tall x $45/sf = $1,350,000)
$1,260,000	(Cost of wall = 1,400 feet long x 20 feet tall x $45/sf = $1,260,000)
$2,610,000	(Cost of combined walls)
÷ 11.6	(Total dB(A) reduction for the 2 receptors with equal to or greater than 5 dB(A) reduction)
$225,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. A 20 feet high wall also does not meet the design goal of 7 dB(A) insertion loss. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 47 – Noise Sensitive Commercial Properties Noise Model Results with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Red Robin	Restaurant	E	70.9	64.9	6.0
				Total dB(A) Reduction (5 dB(A) or greater)	6.0
On the Border	Restaurant	E	66.8	61.2	5.6
LODO	Restaurant	E	71.4	65.4	6.0
Brothers	Restaurant	E	72.1	69.1	3.0
				Total dB(A) Reduction (5 dB(A) or greater)	**11.6**

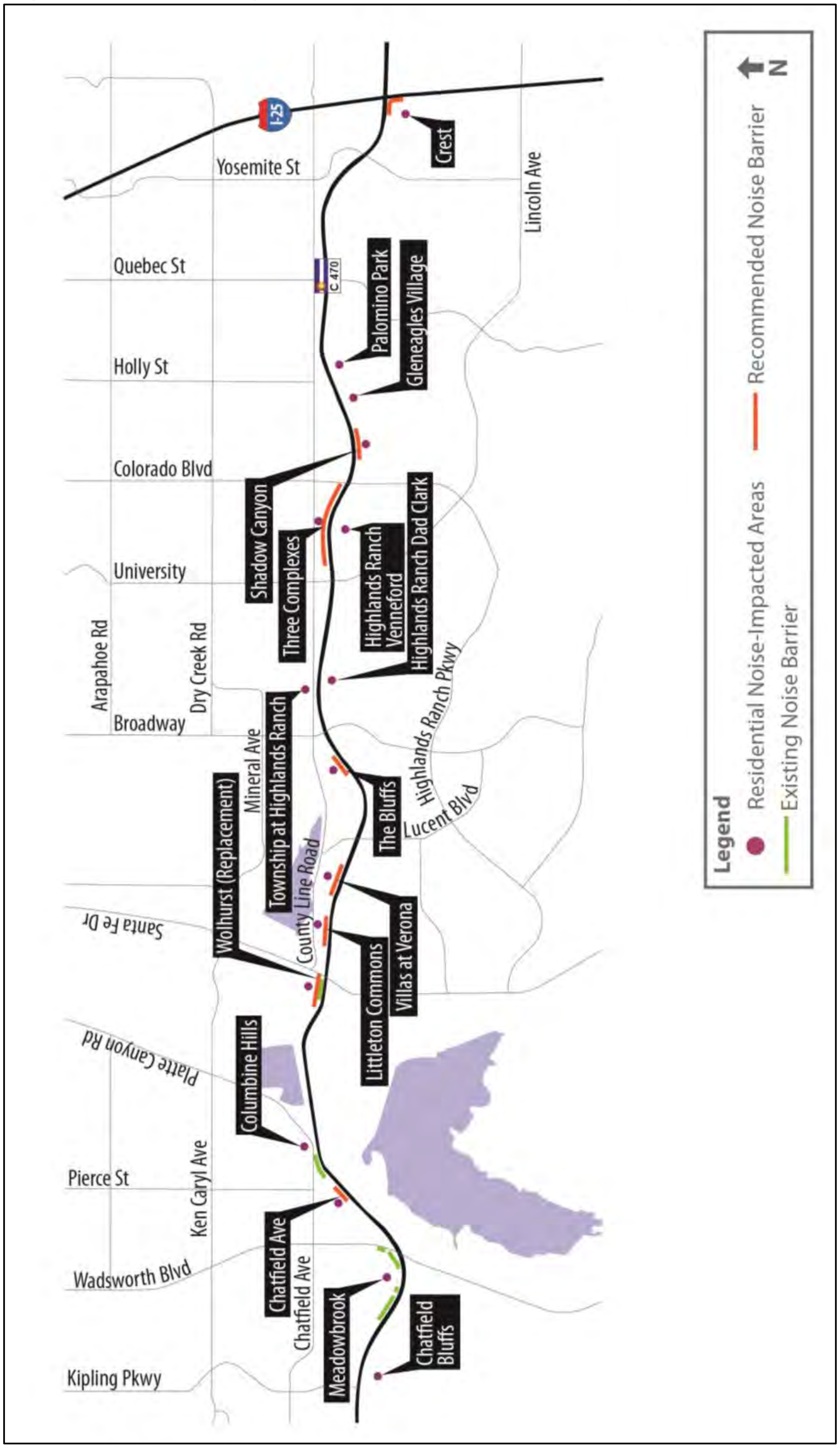
4.12 Statement of Likelihood and Summary of Recommendations

The feasibility and reasonableness of the mitigation recommendations in this document are based on the preliminary analysis using current level of design and available information. The ultimate feasibility and reasonableness determinations may change due to changes in final project design after approval of the environmental document. The preliminary location and physical description of noise abatement measures determined to be feasible and reasonable are described throughout this document and summarized in **Table 48** and shown in **Figure 58**. The final noise abatement decision will be made during the completion of the project's final design and the public involvement processes.

Table 48 – Summary of Recommended Noise Mitigation

Location	NAC	Type	Mitigation Type	Description (approximate)	Detailed Figure and Location
Chatfield Avenue	B	Single Family	Wall	900 feet long x 13.5 feet tall	Figure 16, page 30
Wolhurst (replacement)	B	Single Family	Wall	1,500 feet long x 15.5 feet tall	Figure 20, page 39
Littleton Commons	B	Multi-family	Wall	2,200 feet long x 7 feet tall	Figure 23, page 41
Villas at Verona	B	Multi-family	Wall	1,720 feet long x 18.5 feet tall	Figure 25, page 48
Bluffs at Highlands Ranch	B	Multi-family	Wall	1,200 feet long x 17.7 feet tall	Figure 27, page 55
Autumn Chase, Copper Canyon, and Canyon Ranch	B	Multi-family	Wall	4,330 feet long x 15.75 feet tall	Figure 39, page 74
Shadow Canyon	B	Multi-family	Wall	1,700 feet long x 18.7 feet tall	Figure 42, page 82
Crest	B	Multi-family	Wall	2,300 feet long x 18.2 feet tall	Figure 48, page 94

Figure 58 – Summary of Recommended Noise Mitigation



5.0 CONSTRUCTION NOISE IMPACTS

Construction of the project will generate noise from diesel-powered earth moving equipment such as dump trucks and bulldozers, back-up alarms on certain equipment, and compressors. Construction noise at off-site receptor locations will usually be dependent on the loudest one or two pieces of equipment operating at the moment. Noise levels from diesel-powered equipment range from 80 to 95 dB(A) at a distance of 50 feet. Impact equipment such as rock drills and pile drivers can generate louder noise levels. Construction noise, while temporary, can be mitigated by limiting work to daylight hours, requiring the contractor to use well-maintained equipment (particularly with respect to mufflers), and through the use of mitigation measures such as temporary noise barriers where applicable.

REFERENCES

CDOT. 2015. Colorado Department of Transportation Noise Analysis and Abatement Guidelines.

Appendix A

CDOT Noise Analysis and Abatement Guidelines

(January 15, 2015)

COLORADO DEPARTMENT OF TRANSPORTATION

NOISE ANALYSIS AND ABATEMENT GUIDELINES

JANUARY 15, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
Department of Transportation Development (DTD)
Environmental Programs Branch
4201 E. Arkansas Avenue, Denver, Colorado 80222
Noise Program (303) 757-9016

This document supersedes CDOT Noise Analysis and Abatement Guidelines dated February 8, 2013

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1. INTRODUCTION

Pursuant to requirements set forth by the Federal Highway Administration (FHWA), the Colorado Department of Transportation (CDOT) *Noise Analysis and Abatement Guidelines* provide the procedural and technical requirements for the evaluation of highway project traffic noise and consideration of noise mitigation alternatives where noise impacts are identified. The resultant goal of these guidelines is to provide the citizens of the State of Colorado with as compatible a relationship as possible between highway improvements and noise sensitive land uses. CDOT understands the importance of the issue of highway traffic noise and is committed to evaluating traffic noise impacts during the planning, design, and construction of highways and transportation improvements.

The following guidelines are intended to provide a consistent, equitable approach in addressing highway traffic noise and to foster a rational abatement decision-making process for highway projects within the State of Colorado. In addition, the guidelines include the protocol for providing thorough documentation of these activities in technical noise study reports as a part of National Environmental Policy Act (NEPA) documents.

These guidelines are based on currently accepted best management practices and procedures used by Federal and state transportation agencies and will be subject to review every three years. Interim amendments to these guidelines will be made on an as needed basis and will be considered, when approved, to be an integral part of these guidelines.

APPLICABILITY AND SCOPE

1.1 Purpose

The regulations that govern highway traffic noise for Federal-aid and Federal action projects are contained in Part 772 of Title 23 of the Code of Federal Regulations (23CFR772), which is the Federal highway noise standard. The CDOT guidelines describe the CDOT policy and program to implement 23CFR772. Where FHWA has given the highway agency flexibility in implementing the noise standard, these guidelines describe CDOT's approach to implementation.

1.2 Federal Requirements

The NEPA process provides broad authority and responsibility for evaluating and mitigating adverse environmental effects of transportation projects, including highway traffic noise, but it was the Federal-Aid Highway Act of 1970 that mandated FHWA develop noise standards for the mitigation of highway traffic noise.

23CFR772 describes the methods that must be followed in the evaluation and abatement of highway traffic noise in Federal-aid and Federal action highway projects. FHWA will not approve the plans and specifications for any federally-aided or Federal action highway project unless the project includes noise abatement measures that are deemed to be feasible and reasonable to adequately reduce noise impacts. When warranted, noise abatement is to be considered as an integral component of the total project development process and incorporated as such.

The final amended 23CFR772 requires each state highway agency to prepare and adopt written guidelines specific to that state which must demonstrate compliance with 23CFR772. State highway agencies are allowed flexibility to establish their own definitions and quantifications of different criteria and decision items that are used in the guidelines to make noise abatement determinations. All highway projects that are developed in conformance with the CDOT guidelines will be deemed to be in conformance with the Federal regulations and with FHWA noise standards.

1.3 State Requirements

In addition to the Federal regulatory requirements, the CDOT guidelines are also required to be in accordance with CDOT Policy Directive 1601, Interchange Approval Process. The 1601 process applies to governmental and quasi-governmental (e.g., E-470) entity projects which require a new interchange on the system or major modifications to an existing interchange. Included in the 1601 process is the provision that potential environmental impacts must be evaluated, including those from projected traffic noise. The noise regulation broadens the general definition of Type I projects as defined in Section 2.4.1, to include not only Federal-aid projects, but also state, local, and public-private partnership projects overseen by CDOT and requiring CDOT and FHWA approval. The 1601 process also requires compliance with NEPA.

To assure the citizens of Colorado are afforded consistent application and implementation of noise analyses and abatement consideration, the CDOT *Noise Analysis and Abatement Guidelines* includes not only Federal-aid and Federal action projects as Type I projects, but also includes state, local, and public-private partnership projects overseen by CDOT or requiring CDOT approval.

1.4 *Project Classification*

The following discussion describes which CDOT highway projects require a noise analysis.

1.4.1 Type I Projects

Under 23CFR772, it is mandatory for all states to comply with the regulations for projects that are classified as Type I projects that may result in increased noise levels at sensitive receptors. Some projects may cause noise reductions; however, analyses are required to assess the exact nature of noise level changes resulting from a Type I project. The CDOT guidelines are applicable to all Type I projects. Type I projects include, but are not limited to, the following activities:

- Construction of a roadway on a new location.
- Addition of through-travel lane(s) by new construction or restriping an existing highway. This includes the addition of a through-traffic lane that functions as a high-occupancy vehicle lane, high-occupancy toll lane, bus lane, or truck climbing lane.
- Addition to a highway of an auxiliary lane of accumulated length greater than 2500 feet, by new construction or restriping, including lanes that function as passing lanes or continuous access lanes, except for when the auxiliary lane is a turn lane. See **Appendix A** for lane-specific determinations and definitions.
- Addition of new interchanges or alterations of existing interchanges. This includes the addition or relocation of ramps, or ramps added to a quadrant to complete an existing partial interchange.
- A project which consists of a substantial change in vertical profile of 5 feet or more.
- A project which removes or alters shielding (either natural or man-made) thereby exposing the line-of-sight between the receptor and the traffic noise source. An example of this would be a case where, to improve sight distance on a highway, an existing earth berm or hillside is flattened, resulting in a direct line-of-sight between the highway and an existing residence. Vegetation does not have sufficient noise abatement properties, and thus cannot be considered for these shielding effects.
- Alteration of highways such that the horizontal distance between the nearest edge of travel lane and existing sensitive receptors is approximately halved.
- Addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot, or toll plaza.

In general, actions such as the above are considered to be Type I projects due to capacity increases, alignment changes, or addition of weigh stations, rest stops, ride-share lots, and toll plazas. In all cases in which a project is identified as Type I, a noise analysis study is required if noise sensitive receptors are present within the project study zone. It is important to stress that noise abatement must still be considered for Type I projects where impact level noise has been identified at noise-sensitive receptors, even though the project itself may not cause or contribute to an increase in traffic noise.

The study zone is defined as the area contained within the environmental study or a 500-foot distance in all directions from the proposed edge of traveled lane(s) throughout the extents of the project, whichever is larger. This 500-foot halo defines the extents for the noise analysis and shall include noise-sensitive receptors on all sides of the highway. The 500-foot study zone represents the minimal noise study zone, so that if there is a reasonable expectation that noise impacts would extend beyond that boundary, the study zone must be expanded to include those receptors. This concept also includes addressing upstream or downstream resultant traffic changes where at least a doubling of volume would occur as a result of the project, but are located outside the traditional study zone for noise. Case-by-case consideration can be given to expanded noise abatement measures for impacted neighborhoods located contiguous with the project mitigation. This should be interpreted to mean that a noise abatement measure should treat the most logical extent or break point of an existing impacted neighborhood and is not required to terminate at the 500 foot study boundary. Any length of extended abatement should be optimized to the least cost per most benefited receptors present in that contiguous neighborhood. Logical break points may include cross streets, alleys, commercial property, waterways, or other manmade and natural features interfering with the continuum of the barrier.

1.4.2 Type II Projects

23CFR772 defines Type II projects as projects that provide noise abatement on an existing highway (retrofit noise barrier) in a location where there will not be any new highway construction.

Type II noise abatement projects were constructed on an existing federal or federal-aid highway. Projects were proposed for federal-aid participation based upon the outcome of a noise analysis and prioritization, at the option of the highway department. The monies spent on the Type II abatement were be deducted from the funds which otherwise be available for highway construction. This was a voluntary program in which FHWA funded 80% of the cost of Type II barrier construction. The state portion of Type II projects are funded through the Colorado Transportation Commission.

The Colorado Transportation Commission had participated in the Type II Noise Barrier Program beginning in the 1970’s; however, state funding has been unavailable for this program since 1999. Thus, Colorado currently has no active Type II program or projects.

1.4.3 Type III Projects

All projects that do not meet the Type I or Type II criteria are Type III projects and are not required to undergo noise analysis. Such projects and activities would include many roadway maintenance operations, bridge rehabilitations, resurfacing or white-topping projects, adding shoulders, and ride-sharing programs that pair riders with carpools, commuting assistance, etc. Minor operational projects, such as the changing of a speed limit (that does not involve other construction activity), would not require a noise analysis.

Chain-up areas along highways are used to provide heavy trucks and vehicles with designated facilities for safe refuge to abide with state chain law requirements during inclement weather. These facilities in Colorado are consistently signed with 30 minute occupancy restrictions or are access controlled as needed. Due to the occupancy (idling) time restrictions and seasonal nature of chain-up area use, these facilities are considered both a temporary and infrequent use, and are therefore considered a Type III project.

The following template language should be used for Type III documentation:

> *This project meets the criteria for a Type III project established in 23CFR772. Therefore, the project requires no analysis for highway traffic noise impacts. Type III projects do not involve added capacity, construction of new through lanes or auxiliary lanes, other than those associated with a turn motion, changes in the horizontal or vertical alignment of the roadway, exposure of noise sensitive land uses to a new or existing highway noise source, or any other activity classified as a Type I or Type II project. CDOT acknowledges that a noise analysis is required if changes to the proposed project result in reclassification to a Type I project.*

1.5 Project Timing

Each state highway agency is required to identify when the public is officially notified of the adoption of a location of a proposed highway project. CDOT, within the scope of these guidelines, defines the "date of public knowledge" as the date on which the final environmental project document (signed CE Form 128, Finding of No Significant Impact, or Record of Decision) is approved. After this date, CDOT will be responsible for analyzing and documenting changes in traffic noise impacts, but will not be required to provide noise abatement for new development which occurs adjacent to the proposed highway project. Decisions concerning such noise abatement are left to the local government agencies and private developers. Section 7.2 contains further discussion concerning noise-compatible land use planning and development.

1.6 Noise Sensitive Receptors

A noise sensitive receptor is any location where highway traffic noise may be detrimental to the enjoyment and functional use of the property as defined by the Noise Abatement Criteria (NAC. The residential outdoor activity and areas of frequent human use, such as schools, parks, hotels, and commercial centers, are considered for evaluation (**Exhibit 1**). All dwelling units on all floors of multifamily dwellings that have an outdoor activity area, such as a balcony, and are exposed to traffic noise are considered to be noise sensitive receptors.

Normally, these uses must be in existence at the time of the project construction, but special provisions can apply to undeveloped lands if applicable (Section 2.6.2).

1.6.1 Currently Developed Lands

All properties within the study zone are to be considered as existing receptors in the noise analysis. Each property must be classified as to the type of land use and the extent of the activity (Section 4.1). As mentioned above, all sensitive receptors present within the defined study zone must be included in the analysis.

1.6.2 Permitted Development

Normally, the noise analysis does not consider lands that are not developed, except to provide noise impact contours for local planning agencies; however, noise analysis is required for undeveloped lands for which development has been permitted before the date of public knowledge. This indicates that a definite commitment, with official public knowledge, has been made to develop the property in question and has reached a point where the developer's plans can no longer be changed in a practical manner. Any area which fits this category must be treated in the noise analysis as though the development has already been constructed.

The State of Colorado will consider a proposed development as being permitted when a formal building permit has been issued to the developer by the local agency of authority. During the NEPA re-evaluation process, if undeveloped land was not permitted for development by the date of public knowledge, FHWA and CDOT financial participation in abatement measures will no longer be considered for that property.

For example, when a project re-evaluation for NEPA is undertaken after a project has been shelved for more than 3 years, noise impacts will be re-analyzed and will include any new receptors built or permitted after the original NEPA document date of public knowledge, however; no new abatement analysis will be required for those receptors built or permitted after the original date of public knowledge. FHWA and CDOT will participate in noise abatement only for those receptors that were previously identified in the original NEPA noise study. FHWA and CDOT will not participate in abatement measures for new receptors which were not in existence or permitted prior to the original NEPA document date of public knowledge.

If a re-evaluation initiates a new NEPA document with a second, new NEPA decision document, all receptors identified within the new study zone up to the second date of public knowledge, will be analyzed for traffic noise impacts and considered for abatement measures.

There is no date of public knowledge for a Tier I document. The date of public knowledge is considered in the Tier II stage of NEPA documentation. Tiered NEPA documents such as Tier I Environmental Impact Statements (EISs) are discussed in Section 5.8.

2. NOISE FUNDAMENTALS AND TRAFFIC NOISE IMPACT CRITERIA

Sound can be defined as mechanical energy generated by movement or vibration from a source that can be sensed by the ear. Noise, generally, is defined as unwanted sound, and is the description usually given to sound that emanates from highway traffic. Each sound (noise) can be expressed in terms of three primary characteristics: magnitude, frequency, and time element.

The magnitude of a sound event can be measured in terms of its acoustic pressure. Because the range of absolute pressure values can vary over several orders of magnitude, the unit typically used to describe sound levels is the decibel (dB), which is a relation of the sound pressure level to a standard reference pressure. This ratio is then converted to a more compact logarithmic scale.

Since sound travels in waves, there are also varying frequencies associated with each sound event. The human ear does not respond equally to all frequencies, however, and filtering of these frequencies must be done in order to obtain accurate measurements and descriptions of highway traffic noise, as this noise is comprised of many frequencies. The filtering (weighting of frequencies) of the "A" scale on sound-level meters most closely approximates the average frequency response of the human ear, and is the scale that is used for traffic noise analyses. Decibel units described in this manner are referred to as A-weighted decibels, or dBA.

As sound intensity tends to fluctuate with time, a method is required to describe a noise source, such as a highway, in a steady state condition. The descriptor most commonly used in environmental noise analysis is the equivalent steady state sound level, or Leq. This value is representative of the same amount of acoustic energy that is contained in a time-varying sound measurement over a specified period. For highway traffic noise analyses in Colorado that time period is one hour, and the value then reflects the hourly equivalent sound level, or Leq(h).

For highway projects that require noise analyses in Colorado, the accepted noise descriptor is the worst-hour Leq (h) for determining existing and future noise levels and impacts. The worst-hour is specified and defined as such to reflect the conditions that will produce the worst traffic noise. In general, this is highest traffic volume traveling at the highest possible speed. If traffic volume continues to increase past these conditions, the traffic is eventually forced to slow down, which in turn decreases the noise levels generated.

A traffic noise impact is considered to occur when any noise sensitive receptor is subjected to either 1) future noise levels that approach or exceed the Noise Abatement Criteria (NAC), or 2) future noise levels that substantially exceed the existing noise levels. Both of the above must be analyzed to adequately assess the noise impact of a proposed project. When noise sensitive receptors are present and are found, during the course of the analysis, to be impacted under either case, noise abatement measures must be considered and evaluated for those receptors under the feasibility and reasonableness factors as described in Sections 5.4 and 5.5.

2.1 *Approach or Exceed Noise Abatement Criteria*

The NAC are noise levels which are compared to existing or future levels to determine impact threshold. The levels that are specified are based on the certain types of existing activities that are present.

CDOT defines "approach" as noise levels that are 1 dBA less than the national NAC specified in 23CFR772. The values shown in **Exhibit 1** reflect the values that CDOT considers when evaluating noise levels for each corresponding activity category.

Any receptor that is subjected to noise levels that either currently reach or are predicted to reach the values stated in **Exhibit 1** are considered to be impacted by noise. It is important to note that these values do not have to be exceeded to result in an impact, and there is no difference in the severity of the impacts in either case.

The levels expressed in **Exhibit 1** are intended to strike a balance between noise levels that are desirable and those that are feasible. Numerous approaches were considered in establishing the criteria, to include hearing impairment, annoyance, sleep interference, and speech communication interference. Highway traffic noise levels do not normally reach the levels that result in hearing damage, and what constitutes an annoyance or hindrance to sleep is very difficult to quantify on a large scale. Speech impairment, however, was usefully applied as a condition that reflects a compromise between noise levels that are desirable and those that are achievable and was found not to be arbitrary or capricious.

It is very important to understand that the CDOT NAC are impact criteria only; the absolute threshold levels for which abatement consideration must take place. There is not a specific *absolute* noise level that abatement measures must reach for noise impacts to be considered successfully mitigated.

When evaluating abatement, the NAC activity category Leq(h) values are not to be considered as the goals for which abatement must be designed. The overall objective of mitigation is to obtain the noise reduction design goal (Section 5.5.1), which may or may not result in noise levels below the NAC levels.

NAC Activity Category A receptors are extremely rare and apply only to extraordinary special public needs where the existing environment is of a serene nature that needs to be preserved to allow the area to continue to serve its purpose. Determination of whether or not a specific receptor qualifies as a NAC Activity Category A will be made on a case-by-case basis in consultation with CDOT and FHWA.

Most sensitive receptors that will be encountered on highway traffic noise analysis efforts will be categorized as NAC Activity Category B (residential) receptors and NAC Activity Category C receptors, which are both subject to the 66 dBA approach criterion. NAC Activity Category D describes criteria for interior evaluations when all exterior analytical methods have been exhausted, and then only applies to certain NAC Activity Category C uses.

NAC Activity Category E describes lands that are commercial in nature, and exhibit characteristics less sensitive to traffic noise. It should be cautioned that hotels and motels often have permanent residential occupation and should be surveyed for such before designating the appropriate categorical criterion of NAC Activity Category C or E. NAC Activity Categories F and G receptors are non-sensitive to traffic noise or undeveloped land uses, and are not subject to a NAC value.

Exhibit 1. CDOT Noise Abatement Criteria

Activity Category	Activity Leq(h)*	Evaluation Location	Activity Description
A	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[1]	66	Exterior	Residential
C[1]	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[1]	71	Exterior	Hotels, motels, time-share resorts, vacation rental properties, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	NA	NA	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, ship yards, utilities (water resources, water treatment, electrical), and warehousing.
G	NA	NA	Undeveloped lands that are not permitted for development.

[1] Includes undeveloped lands permitted for this activity category.
* Hourly A-weighted sound level in dBA, reflecting a 1-dBA approach value below 23CFR772 values

When determining impacts, primary consideration is to be given to exterior areas of frequent human use where a lowered noise level will be of benefit. CDOT will consider interior noise abatement only for NAC Activity Category D facilities (Section 5.7).

2.2 Substantial Increase over Existing Noise Levels

The second manner in which a noise sensitive receptor can be impacted by highway traffic noise is to be subjected to a substantial increase of noise due to a highway project.

CDOT defines that a noise impact occurs if a receptor is to receive an increase in noise levels of at least 10 dBA over the existing noise levels. This impact criterion takes effect regardless of the absolute noise levels. For example, an increase of noise from an existing 45dBA to a predicted build condition of 57 dBA for a NAC Activity Category B receptor will result in a noise impact, as the net noise increase of 12 dBA is greater than the 10 dBA substantial increase threshold. A change in noise levels from 62 to 69 dBA for NAC Activity Categories B or C would not be an impact under the substantial increase criteria, but would still result in an impact as the NAC of 66 dBA has been exceeded.

As long as one of the impact criteria is met for a receptor, abatement must be considered for that receptor. No subjective descriptor terms are used to describe traffic noise impacts.

3. HIGHWAY TRAFFIC NOISE ANALYSIS

The main purpose of the highway traffic noise analysis is to identify noise sensitive receptors that will be subjected to traffic noise impacts. Any and all receptors that are identified as impacted must be considered for noise abatement. The abatement alternatives must be evaluated under the feasibility and reasonableness criteria. The noise analysis technical report (**Appendix B**) serves as proof that the analysis was performed and provides all necessary documentation as required by the regulations.

As early as is reasonably possible in the process, an initial assessment must be made to determine whether or not the project will require a detailed noise analysis as described in Section 4.1. This is best done in conjunction with the environmental scoping of the project.

The analysis consists of two major parts. The first consists of identification of noise sensitive receptors, assessment of the noise levels that these receptors are currently experiencing and are predicted to experience in the future, and determination of whether or not traffic noise impacts exist. If no traffic noise impacts are found, the analysis is then considered to be complete with no further evaluation required. If traffic noise impacts are expected, then the second part of the analysis, abatement consideration and evaluation, must be performed. The requirements for the first part of the analysis will be described below, while the mitigation consideration protocol will be discussed in Section 5.

Common misunderstandings arise when the subject and requirements of performing noise analyses are discussed. The requirement to perform a noise analysis, in and of itself, does not imply that impacts are present or that any other future actions are inevitable. The analysis will identify any noise impacts, which will then be considered for noise mitigation. Noise abatement will be provided if it is determined to be both feasible and reasonable.

3.1 Identification of Land Uses

The proper identification and quantification of the noise sensitive receptors adjacent to a highway improvement project is essential to the success of the analysis. Each receptor that is present within the extents of the project study zone must be examined in accordance with the regulations. The study zone has been defined to encompass the most likely area within which, a receptor may experience impacts resulting from project related traffic noise.

A project that does not border any existing or permitted noise sensitive land use area will not require a noise analysis. Receptors that are outside of the study zone of 500 feet around the extents of work for the individual project do not need to be considered for analysis, unless there is a reasonable expectation that noise impacts would extend beyond that boundary. The CDOT Environmental Programs Branch (EPB) noise specialist should be consulted for clarification as necessary.

The primary focus with the noise sensitive receptors is the exterior areas of frequent human use that are adjacent to the individual properties. For identified receptors, the consideration point will be the outside area that is immediately facing the highway, which in most cases will be the front/back yard, communal gathering/activity area, or porch area. To summarize the land-use activities that are present, each NAC Activity Category should be listed and the number of receptors identified in the project documentation.

The following metrics are intended to provide guidelines to facilitate statewide consistency of receptor identification. Coordination among CDOT, federal land management agencies and local jurisdictions is encouraged to provide appropriate context for and resolve identification of complex receptor-land use issues. (See **Exhibit 1** for tabulation of activity types and land uses.)

3.1.1 NAC Activity Category A

Determination of whether or not a specific receptor qualifies as a NAC Activity Category A will be made on a case-by-case basis in consultation with FHWA.

3.1.2 NAC Activity Category B

This NAC includes residential and multiple family dwellings, which includes mobile home parks and apartment buildings. All apartments that have an outdoor activity area, such as a balcony, and with exposure to traffic noise should be considered in the noise analyses – regardless of floor. Evaluation of the upper floors in multi-storied buildings is required to provide a basis for reasonable expectation of effective noise abatement for impacted receptors. Pragmatically, for a multi-storied residential building, the evaluation can be undertaken in multi-floor increments until no impacted dwelling is detected on that floor. Note that multi-family common areas belong to NAC Activity Category B. Special attention should be given to identify permanent or long-term residences that may be incorporated in hotels (NAC Activity Category E) or RV parks (NAC Activity Category C), as these should be evaluated under NAC Activity Category B.

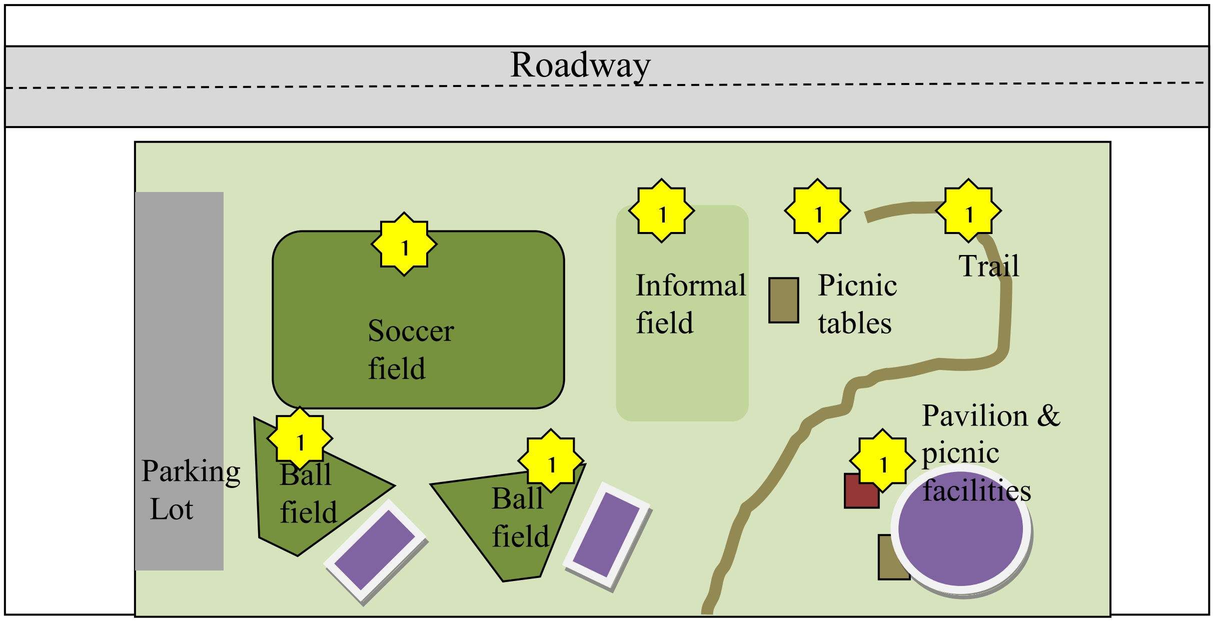
If a group of individual receptors share similar acoustical properties and settings, a representative, consolidated receptor site may be used in modeling. The total number of individual receptors represented by the consolidated receptor site must be clearly documented in the impact tables and reporting.

3.1.3 NAC Activity Category C

NAC Activity Category C land uses are identified as either individual sites, such as buildings, or can involve properties with multiple areas of diverse activity and usage characteristics, such as parks. The receptor identification metrics defined for NAC Activity Category C are purposely general to allow easy identification and inclusion of noise sensitive receptors, yet includes enough specific parameters to remove ambiguity in receptor site quantification.

This category follows an activity focused theme, using consolidated facilities and related uses as the basis of receptor identification. Communal or recreational properties may be divided into individual receptors based on individual activity areas (**Exhibit 2**); however multiple receptors must not be counted for individual pieces of a single common activity functional area. For activity areas that are spread across a property or for properties that lack defined facilities or formalized activity areas, a single generalized receptor should be placed within the property that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist. Consultation with the local jurisdiction is recommended to best resolve these issues.

Exhibit 2. Illustration of Park or Recreation Area Receptor Identification



Note: This hypothetical property would have a total of seven receptors based upon activity area identification.

<u>**Parks and Recreation Areas**</u> – Parks range in size and amenities from neighborhood pocket parks, to linear green belts accommodating drainages or trails, to large regional parks and natural preserves with multiple trails and outdoor use facilities. Recreation areas may also encompass multiple activity areas within a large parcel of land. Receptors should be located within the park or recreation area boundary for each area with a discrete outdoor activity as conceptually defined under this section. If the park or recreational area has no discernable formal activity areas (trails, camping facilities, picnic areas, ball fields, etc.) as defined within this section, a minimum of one (1) receptor should be sited to be representative of typical traffic noise on the property by using best professional judgment and by consultation with the jurisdictional authority for the property.

<u>**Picnic Areas and Fire Pits**</u> – One (1) receptor should be counted for each area of clustered tables and/or fireplaces which could be considered oriented or situated as a single functional area.

<u>**Campgrounds**</u> – One (1) receptor should be counted for each formal campsite or camping cabin capable of human occupation. Informal campsite areas located within formalized campgrounds should be counted as 1 collective receptor per separated area.

<u>**Pavilions**</u> – One (1) receptor should be counted for each complex of tables, outdoor cooking facilities, covered pavilions, gazebos; etc. that could be considered oriented or situated to provide a single use area.

<u>**Sporting fields**</u> – One (1) receptor should be counted for each formalized sporting field inclusive of its associated seating, access, pathways, and/or stadium complex which could be considered oriented or situated to facilitate use of the sporting field. Less formalized activity

areas such as grassy areas of a park or recreation area, which are commonly utilized for informal sporting activity, should be counted as one (1) receptor per area which has been observed or exhibits attributes that demonstrate common active use.

Golf Courses – One (1) receptor should be placed within each hole (tee-off areas or fairway-green combination) of the golf course that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist. If other outdoor activity areas exist within the course such as practice areas, picnic facilities, restaurant outdoor area, etc., each course segment and formalized activity area shall be identified with a separate receptor.

Jurisdictionally-Controlled Forests and Other Areas Officially Managed for Outdoor Recreational Activity – Jurisdictionally controlled managed areas generally are federal lands that must have a management plan including defined outdoor activity use. Receptors should be located within the activity managed area boundary for each identified management area that defines outdoor activity areas as conceptually defined under this section. If the management area has no discernable activity areas (trails, camping facilities, picnic areas, etc.) as defined within this section, a minimum of one (1) generalized receptor shall be placed no closer than 50 feet from the edge of pavement within the management area that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist. Consultation with the local jurisdiction is recommended to best resolve these issues.

Trails/Trail crossings – One (1) receptor should be counted for each formal trail crossing regardless of the pathway orientation. The receptor should be placed no closer than 50 feet from the edge of pavement on the trail that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist.

Individual trails should also be assigned receptors at all areas where user congregating would be expected along the trail, such as rest areas with benches or scenic viewing areas. Consultation with the local jurisdiction is recommended to best resolve these issues.

Community activity areas – Apartment and residential community common areas may include pools, ball courts, or other formalized outdoor activity areas. Each of these outdoor activity areas should be counted as one (1) receptor.

Cemetery – One (1) receptor should be counted for each area of a formalized memorial gathering facility. Individual grave sites, access ways, and informal activity areas are not considered individually sensitive receptors; however, each section of the cemetery as defined through consultation with the operator, may have formal gathering areas, and should be assigned a receptor. If there are no formalized gathering areas, then no receptor is required for the property.

Section 4(f) Sites – Section 4(f) sites encompass three types of sites – parks and recreation areas, wildlife refuges, and historic sites:

- Parks and Recreation Areas – addressed above.
- Wildlife Refuges – wildlife or wildfowl refuges or preserves typically have limited or no human activity area and thus would not be subject to noise analysis. However, on-site trails or observation areas should be considered under NAC Activity Category C as defined in this section.
- Historic Sites – For historic sites that have exterior areas with frequent human use (historic houses), one (1) receptor should be counted for each site with such use. For historic sites without frequent human use, no noise analysis is necessary. Coordination with staff historian is required for all historic Section 4(f) site receptor identification and reporting. Noise levels may be required for Section 106 purposes, which may differ from highway traffic noise requirements.

When no noise analysis is necessary for a site due to an absence of an exterior area with frequent human use, this finding should be documented in the project file or noise report.

3.1.4 NAC Activity Category D

This activity category includes the interior impact criteria for certain land use facilities. CDOT would conduct an indoor analysis only for Activity Category D receptors after first examining if there are potential exterior areas of frequent human use.

Unless an actual interior noise measurement has been taken, the interior building noise level predictions shall be calculated by subtracting noise reduction factors from the predicted exterior levels for the building in question, using the information in **Exhibit 3**. Noise analysts should take interior noise measurements for the final noise analysis and abatement design for locations where noise insulation is being considered as an abatement measure.

Exhibit 3. Building Noise Reduction Factors for Interior Noise Evaluation

Building Type	Window Condition	Noise Reduction Factor (Due to Exterior of Structure)
All	Open	10 dB
Light Frame	Ordinary Sash (closed)	20 dB
	Storm windows	25 dB
Masonry	Single Glazed	25 dB
	Double Glazed	30 dB

The windows shall be considered open unless there is firm knowledge that the windows are in fact closed almost every day of the year. See FHWA-DP-45-1R, *Sound Procedures for Measuring Highway Noise: Final Report*

Source: FHWA A-HEP-10-025 *Highway Traffic Noise: Analysis and Abatement Guidance* (2010)

3.1.5 NAC Activity Category E

This activity category contains receptors which are less sensitive to highway traffic noise. These include hotels, motels, time-share resort facilities, offices with outdoor noise-sensitive uses, and other developed lands not included in NAC Activity Categories A-D, and F. Special attention will be given to ascertain if motel/hotel properties could include permanent or long term residents, thus qualifying as NAC Activity Category B.

3.1.6 NAC Activity Category F

This activity category includes industrial, commercial and other land uses that are not sensitive to noise. Some examples are agricultural uses, airports, maintenance yards, warehousing, emergency services, mining, rail yards, and utility facilities (water treatment, water resources, electrical). These uses are not considered noise sensitive, and no noise analysis is required for these locations.

3.1.7 NAC Activity Category G

This activity category includes all undeveloped lands which do not have a building permit prior to the date of public knowledge. These uses are not considered noise sensitive, and no noise analysis is required for these locations. However, noise impact contours for these properties should be provided to the local jurisdictional agency, including local planning, zoning and/or building permit offices, and where applicable, metropolitan planning organizations and transportation planning regions, for future land use planning purposes.

3.2 *Determination of Existing Noise Levels*

The next step in the analysis is to quantify the existing noise environment by determining the noise levels that the identified receptors are currently experiencing. Determination of existing noise levels shall be made by field measurement and use of the most current version of the TNM noise prediction modeling software. Protocol for the use of TNM for CDOT projects can be found in the *Traffic Noise Model User's Guide for Colorado DOT Projects* (2006). All measurement procedures must be performed by an ANSI Type I or Type II integrating sound meter in accordance with report FHWA-PD-96-046, *Measurement of Highway Related Noise*.

Although TNM analytical results are expressed to the nearest tenth decimal, all noise levels shall be rounded to the nearest whole number for reporting purposes in the NEPA general document. Technical reports and modeling appendices including TNM output files should retain their original decimal data format.). The intention here is to be inclusive of near impact noise levels (greater than 65.4 dBA) in mitigation considerations.

3.2.1 New Roadway at New Location.

Data siting the proposed new alignment and construction footprint should be superimposed on a base map illustrating existing and permitted buildings, features and facilities to define the appropriate noise study zone and identify noise sensitive receptors. Field measurements will provide the basis of existing noise conditions for projects involving the construction of a new highway in a new location. Noise field measurements at existing and permitted receptors (or representative receptors) located within the study zone of the project will be taken to a) provide adequate context for existing noise levels and b) to provide sufficient information to compare sensitive receptor noise levels to future noise levels derived from analytical modeling for the purposes of defining substantial noise impacts along the proposed highway corridor study zone.

3.2.2 Modifications to Existing Roadways.

Field measurements should be sufficient to provide adequate definition of the existing noise condition to validate the TNM model for existing conditions (Section 4.2.1.).

A minimum of two (2) existing field measurements are required within the study zone. Field measurements should represent sensitive receptors best illustrating the existing traffic noise environment, as free from the influence of local non-traffic generated noise sources and shielding as practical. Measurements can be taken at any time; however, it is best to measure when traffic is relatively free flowing at or near the posted speed limit. For high-volume roads, a 10-minute sample is usually statistically accurate enough to obtain a good measurement, but sample times of 30 minutes but not more than 1 hour may be needed for measurements along lower volume roads. Two readings are recommended at each site. A directional count of all light duty vehicles, medium truck 2-axle and multi-axle heavy truck traffic should be taken for relevant roadways adjacent to the measurement site. Tabulation of motorcycle and bus counts is also desirable. Determination of the approximate speed that the vehicles were traveling can be determined by either driving a test vehicle through the traffic stream or by use of a radar gun. Posted speed limits may be used if actual travel speed readings are unavailable.

3.3 TNM Model Validation

Most often, the purpose for taking field measurements will be to gather data that is used to develop a comparison between those measurements and results obtained with the noise prediction model. This exercise is performed to validate the model so that it can be used with confidence to determine the worst-hour existing noise levels and predict the future noise levels. It is not required to perform measurements at each individual receptor; however, enough representative measurement locations (a minimum of two measurements) in the project area must be utilized in order to reasonably characterize conditions for the validation effort. Once these data have been collected, each of the locations is then input into the model for comparison purposes.

In order to arrive at a valid comparison between measured and modeled results, traffic and speed data must be collected at the measurement locations at the same time the noise measurements were taken. This will involve actual counting of vehicles, being sure that truck (heavy and medium) counts are taken separately, and a determination of the approximate speed that the vehicles were traveling. For the purposes of validation, field measurement data should be normalized to an hourly basis as that will be needed for input into the computer model. The collection of relevant data will allow the modeling of the same conditions as was observed during the measurement exercise and does not require the analyst to attempt to measure during the worst noise hour. This effort is to be thoroughly documented within the noise study report.

The maximum acceptable difference between the actual noise measurements and the modeling results is 3 dBA. If the difference between the measured and predicted levels is not within 3 dBA, an examination of the measured and modeled data shall be performed to determine the reason for the difference and shall be adequately explained in the noise technical report. This may require that a second measurement be taken in some instances. Standard validation practices are described in **Appendix C** and in *Traffic Noise Model: Frequently Asked Questions FAQs* at www.fhwa.dot.gov/environment/noise/traffic_noise_model/tnm_faqs/faqs06.cfm#miroadways1.

3.4 Noise Modeling for Existing Conditions

Unless the project involves the construction of a new highway on a new location, the worst-hour noise levels are determined by the validated TNM computer model.

In selecting model locations, each individual receptor does not have to be modeled separately. A modeling location can be chosen that represents several actual receptors. This is acceptable as long as all the identified sensitive receptors are represented in the analysis. The number of the actual modeling points that are used will vary depending on the nuances of the individual project. For each modeled location, a table that shows the location identification and exactly how many receptors are being represented by that location must be included in the noise study report. These locations are then modeled at a height of 5 feet (1.5 meters) above the ground level elevation to approximate the height of the average human ear. For analysis of areas above the ground level, those locations shall be modeled at a height 5 feet above the elevation level of the use area.

To perform the noise modeling for the existing conditions, the analyst will need to gather the following input data:

- Current roadway alignment for roadways in the immediate area which may contribute to the noise environment. For areas containing roadways of a minor residential nature, only throughways carrying substantial traffic volume need be modeled (on a professional judgment basis).
- Existing traffic volumes, which include a breakdown of numbers of automobiles, medium trucks (2-axle, 6-tire), and heavy trucks (3+ axles) for all roadways, and buses and motorcycles as possible.
- Current posted speed limit for all roadways.
- Receptor locations.
- Terrain features, such as natural berms.
- Other features which result in a shielding effect (i.e. buildings).
- Any existing noise barriers present.
- Other TNM parameters such as pavement type can be utilized as a TNM option in existing condition modeling; however, the default average pavement type must be utilized in future condition modeling.

To model the worst hour existing condition, the traffic data that shall be used are the highest volume of traffic that can travel at the highest relevant speed for the particular roadway. In the past, this situation has often been represented by the Design Hour Volume of the roadway modeled at the posted speed limit. A new approach was evaluated (**Appendix E**) to identify the worst-hour traffic noise that is based on methodology found in the *Highway Capacity Manual* (2000). **Exhibit 4** summarizes the highest traffic volumes per lane at various posted speed limits for different highway classifications that were found to produce the loudest noise conditions.

For TNM modeling, the estimated traffic volumes from the project traffic analysis are to be used if they are less than the volumes presented in **Exhibit 4**. Although not referenced in the TNM User's Guide, if the estimated traffic volumes for a project roadway are higher than the corresponding volumes shown in **Exhibit 4**, the traffic volumes from **Exhibit 4** are to be used in the noise analysis because added traffic would cause speeds to slow which in turn will reduce noise levels. Proper documentation of the source of the traffic volumes is required to be included in the noise study.

Exhibit 4. Suggested Maximum Traffic Volumes for Worst Noise Hour

Posted Speed Limit (MPH)	Maximum Traffic Volumes by Facility Type (vehicles/lane/hour)[1]		
	Freeway	Non-Freeway Multiple Lane	Two-lane Roadway
75 or above	1600	NA	NA
70	1700	NA	NA
65	1800	1700	1300
60	1900	1800	1300
55	2000	1900	1300
50	2100	2000	1400
45	2200	2100	1500
40	Not applicable	2200	1600
35 or below	Not applicable	2200	1600

[1] **Appendix E** contains technical support documentation for worst noise hour equivalent capacity.

It is critical in the TNM modeling to account for all features affecting the noise environment, such as existing noise walls, partial barriers, jersey barriers, solid panel bridge walls, landscape berms, and other features that contribute to reduction, shielding or reflection of traffic noise.

3.5 Existing Noise Barriers and Privacy Fences

A situation where a barrier is already present can be confusing. To be considered a noise barrier, the structure must be solid and designed specifically to abate noise. Wooden privacy fences, which are not normally constructed to abate noise, are not considered to be noise barriers, because they generally do not provide an appreciable amount of noise reduction. These fences contain many gaps, each of which allows transmission of noise, and often are not made of sufficiently dense material to provide negligible noise transmission through them. Privacy fences should not be included as a TNM barrier feature in analytical modeling unless they are constructed gap-free and provide a suitable transmission loss (add value).

When privacy or other development-related fences are present, consideration shall be given as to whether the fence is a continuous, double-sided-wooden, masonry or composite-material fence and whether the fence will remain in good condition over the life of the project (20 years for projected future noise levels). If there is doubt as to the durability of the fence, it should not be modeled as a barrier providing noise abatement. When a noise barrier is currently in place, the existing conditions noise model must have the barrier included. The noise levels that are then reported for the existing conditions are those calculated with the barrier included in the model.

Additionally, if the existing barrier can be shown to meet the 7-dBA noise reduction design goal (Section 5.5.1) for the affected receptors in the future by comparing to a no wall and existing wall conditions, then effective noise abatement has already been provided and no additional noise abatement is required from the proposed project.

If the existing barrier is to be demolished under a new project, a replacement barrier meeting current noise regulatory requirements must be constructed as a part of the project unless another abatement measure adequately accounts for the required design goal level reduction and equivalent area abatement, or unless the noise and/or land use setting has changed sufficiently that no noise impacts remain to be mitigated (Section 5.3). An example of an adequate abatement measure replacing the need for a recommended barrier might be a new roadway profile that substantially lowers the roadway elevations, thus reducing noise levels below impacted levels for the previously impacted receptors.

The language often used for replacement walls "in kind" is meant here to mean acoustically equivalent insertion loss for the impacted area, using adequate barrier materials to meet the design goal noise reductions. In kind does not mean that a demolished or unrepairable wooden wall must be replaced (or should be replaced) with another wooden barrier; upgraded materials are expected.

It is desirable for any replacement barrier to be aesthetically consistent with project designs and area context.

3.6 *Prediction of Future Noise Levels*

Once the existing noise levels have been determined, the future design-year noise levels for each receptor are calculated using TNM. The future model shall reflect the design year conditions (usually 20 years post-construction) into the future (traffic counts and speeds, roadway alignments, changes to terrain) for the worst-hour noise condition. Each alternative alignment being considered for the project must be examined, including the no-action alternative. Although no analysis of the future no action alternative is required by 23CFR772, for the purposes of NEPA, CDOT requires that a no action scenario noise analysis is conducted. For minor projects, there will likely only be one alternative, but in the cases of projects which are either part of an Environmental Assessment (EA) or EIS, there may be several alternatives to consider and analyze.

Although TNM analytical results are expressed to the nearest tenth decimal, noise values shall be rounded to the nearest whole number for reporting purposes (impact tables) in both the NEPA documentation and supporting technical reporting. (Technical modeling, Cost-Benefit Index calculations, and appendices including TNM output files should retain their original decimal format.)

The traffic projections that are used must be consistent with the applicable adopted long-range plan traffic model, if available. When a long-range plan traffic study is not available, the best available data shall be used. Annual average daily traffic volumes and truck compositions for most state highways are located at http://dtdapps.coloradodot.info/otis. In the absence of any better traffic data, the traffic volumes used shall be the applicable volumes from **Exhibit 4** at the recommended future posted speed conditions for the new highway design.

The same traffic noise prediction modeling software that was used in the determination of the existing conditions shall also be used for future modeling, with the modeled receptors in the same locations as they were for the existing model, as appropriate. Receptors which are identified as potential ROW takes will not normally need to be included in the future modeling, but do need to be included in the no-action case. As was the case in the existing condition evaluation, if a noise barrier is currently present it must also be included in the analysis of the future conditions, unless it will be demolished as part of future condition.

3.7 Determination of Traffic Noise Impacts

The final step in the first part of the noise study is to compare the future predicted noise levels to the applicable NAC and to the existing noise levels to determine traffic noise impacts. As discussed earlier, any receptor which either equals or exceeds the NAC (**Exhibit 1**) under the existing or future conditions or is subjected to a 10 dBA substantial increase in noise levels is considered to be impacted by highway traffic noise. This is to be done for each alternative, including the no-action alternative.

It is important to remember that the determination of traffic noise impacts only results in consideration of abatement for the receptors, which will be performed in the next part of the analysis. It is not a guarantee that abatement will be provided.

If no traffic noise impacts are identified under the future conditions for any of the proposed alternatives, as defined by the provisions set in these guidelines, the analysis is considered complete and further consideration of noise abatement is not required. This determination, if applicable, shall be stated as such in the final noise study report.

To provide for a detailed and thorough review of all noise modeling efforts and inclusion of analyses done to predict the future noise levels as described in Section 4.3, the noise study must either include a electronic media copy of the TNM model files or a computer printout of TNM input and results tables generated during the modeling analysis.

3.8 Noise Effect on Wildlife

Procedures for Abatement of Highway Traffic Noise and Construction Noise, requires the identification of noise impacts, consideration of noise abatement and the construction of feasible and reasonable noise abatement for humans. Traffic noise effects on wildlife populations are not considered under 23 CFR 772. Information describing the effect of traffic noise on wildlife populations is available at: http://www.fhwa.dot.gov/environment/noise/noise_effect_on_wildlife/. This report contains a summary of ongoing work on the effects of noise on wildlife populations to date. Additionally, this website provides links to data regarding bird collisions with transparent noise barriers.

4. EVALUATION OF HIGHWAY TRAFFIC NOISE ABATEMENT

Any and all receptors which were determined to be impacted by noise must be evaluated for traffic noise abatement. This requires that the overall social, economic, and environmental effects of the abatement be evaluated against the benefits. When determining abatement measures, primary consideration is to be given to exterior areas surrounding residential areas or areas of frequent human use for other uses such as parks and commercial districts where a reduced noise level would be of benefit. All feasible and reasonable mitigation measures are required to be included in the highway project. It is not considered to be a prudent investment of public funds to consider construction of a noise barrier that will not result in at least a readily perceptible noise reduction.

4.1 Abatement Options

The following are common abatement measures that may be incorporated in highway projects to reduce traffic noise impacts.

- Traffic management measures, such as lane-use restrictions, designated truck routes, and speed limit reductions. Measures such as these may or may not be beneficial or possible given the constraints of the project and the immediate area. While lesser speeds do decrease noise levels, it generally will take a reduction in speed of approximately 20 miles per hour to achieve a readily perceptible (5 dBA) reduction of noise at its source.
- Alteration of horizontal and vertical alignments to reduce noise impacts, where practical.
- Acquisition of undeveloped land for buffer zone creation. While buffer zones are a very good strategy in overall noise compatible land use planning, it is often not a practical solution, due to the large amount of land that must be purchased. In many instances, the existing developments already border the highway. Federal dollars cannot be used to purchase developed property for noise mitigation.Vegetation and/or landscaping are not considered viable abatement measures.
- Noise insulation, but for NAC Activity Category D structures only.
- Construction of noise barriers within highway right-of-way, or acquisition of property rights for construction of noise barriers outside of the highway right-of-way.

A related topic that has been researched for many years is the noise emissions that are due to the tire-pavement interaction. While it is accepted that different tires, pavements, and pavement surfacing textures do result in varying noise levels, it is difficult to forecast the overall pavement surface condition 20 years into the future. Due to this fact, and the requirement that noise mitigation must provide a readily perceptible reduction in noise levels over a long period of time (i.e., permanent), the use of different pavement types or surface textures cannot be considered as a noise abatement measure.

4.2 Noise Barriers

There are two common abatement measures employed by CDOT: the vertical noise wall and the earthen berm. Both barriers work by blocking the path of sound waves from the highway, forcing the sound to travel around or over the barrier. If a noise barrier is tall enough to break the line of sight between the highway and the receptor, constructed of sufficiently dense material (4 pounds per square foot minimum density), and does not have any openings or gaps, a noise reduction will be possible that will range from being readily perceptible to less than half as loud (5-15 decibels for most barriers) depending on the height and location of the barrier. CDOT has determined that a barrier design must achieve a minimum 7 dBA noise reduction design goal (Section 5.5.1) for at least one receptor and at least a readily perceptible noise reduction (5 decibels) at one or more receptors to be considered reasonable and feasible, respectively, for construction as a prudent investment of public funds.

The most common types of highway noise barriers are vertical walls, which can be constructed out of a variety of materials: concrete, masonry block, composite synthetic materials, as well as transparent acrylic/plastic products.

CDOT Research and Innovative Technology Branch conducted a worldwide scan of noise reduction strategies resulting in Technical Report 2013-11 An Investigation into Effective Traffic Noise Abatement Design Solutions for Mountain Corridors, which can be found at http://www.coloradodot.info/programs/research/pdfs/2013/mountain.pdf/view.

4.2.1 Reflected Noise

The primary purpose of traffic noise barriers is to reduce noise levels at sensitive receptors behind the barrier; however, under some conditions, barriers may reflect traffic noise and negatively affect the noise conditions at other nearby receptors. Generally, this occurs when there are receptors on the opposite side of the subject road from the noise barrier. In these circumstances, the barrier is acting as a secondary noise source because of the reflected sound. It is possible that reflective noise from a noise barrier could increase noise overall levels by as much as 3 dBA, but in practice will normally change noise levels by 1 dBA or less. Some of the more common situations where reflective barriers may be a concern include:

- Sensitive receptors are present across the subject road from a proposed barrier, but are not being considered for a separate noise barrier.
- A frontage road is located between the proposed barrier and the sensitive receptors.
- Parallel barriers would be present on each side of a road and the ratio of the distance between the barriers versus the height of the barriers is 10:1 or less (For more information please refer to **Appendix C** Traffic Noise Model User's Guide for Colorado DOT Projects.).
- A large building or other man-made reflective surface is immediately across the subject road from a proposed barrier may simulate a parallel barrier effect.
- A large rock cut or other natural reflective surface is immediately across the subject road from a proposed barrier may simulate a parallel barrier effect.

Decisions regarding modeling reflective noise should be made on a case-by-case basis, through consultation with the CDOT Noise Specialist(s).

4.2.2 Absorptive Treatments

In situations as described in Section 5.2.1, surface treatment of the proposed barrier to reduce reflections may be beneficial. Such treatments could include sound-absorptive surfacing or an irregular barrier surface. Therefore, CDOT will consider special barrier surface treatments for projects where a sensitive receptor or a large sound-reflecting object (natural outcrop, highly reflective building or man-made feature) is present across the subject road from a proposed noise barrier and at a distance no greater than 10 times the proposed barrier height. Absorptive noise barriers must be designed so that the absorptive portion on the highway side has a minimum noise reduction coefficient of 0.70 when measured in accordance with the requirements of ASTM C423-08 (ASTM, 2008a). Decisions regarding barrier materials and finishes will be made in compliance with CDOT's materials selection process.

Reflective and absorptive material criteria are defined in CDOT sound wall materials specifications, located at http://apps.coloradodot.info/apl/SearchRpt.cfm?cid=Environmental.

4.2.3 Berms

An earthen berm is essentially a linear natural or man-made soil or soil/debris mound. Berms, while more natural in appearance, do require a great deal of land and a very large footprint. Noise walls require much less space to be constructed, but may be subject to height limits due to structural and aesthetic reasons. Barriers have also been constructed by placing walls on top of berms to create a combination barrier. More detailed information concerning design, structural, and aesthetic considerations of noise barrier construction at CDOT can be found in the Chapter 18 of the CDOT Roadway Design Guide, 2005 at:
www.coloradodot.info/business/designsupport/bulletins_manuals/roadway-design-guide.

4.3 Noise Barrier Abatement Evaluation

Evaluations of possible noise barriers are to be conducted using the most current, FHWA approved TNM software using the future conditions data. Various locations and heights of barriers can be input into the model, which will calculate the noise levels with the barrier. The amount of reduction, also known as insertion loss, is defined as the future barrier noise levels subtracted from the future no-barrier condition.

Acoustically, the most effective noise barriers are generally located closest to the source (i.e. highway) or closest to the receptors. As a result, initial barrier placement should be considered and evaluated for either of these locations. In many cases, however, the CDOT right-of-way line is the most practical location for the barrier. Multiple barrier locations should be considered in the analysis if more than one effective location can be used within the right-of-way. Barrier locations should first be evaluated within the CDOT right-of-way. If effective noise reduction cannot be achieved by a barrier located within the right-of-way, adjacent or nearby land can be evaluated for placement of an abatement measure.

The overall length of barrier, different barrier heights, and design compensation for situations that require breaks in the barrier (overlapping or wrapped end-segment barriers) should also be considered in abatement analyses. Performing this evaluation is an iterative process, done by altering certain inputs and barrier siting. The best judgment of the noise analyst should be used to determine the optimal feasible and reasonable barrier dimensions and location. As always, this process needs to be documented in the noise analysis report.

Noise barriers are installed and maintained in perpetuity to protect the noise sensitive environment impacted by the roadway project. When a new project alters or proposes to alter the terrain with potential to remove or disrupt the ability of the existing barrier to abate as designed (Section 4.5), an assessment must be made of the existing barrier in terms of both effectiveness and remaining service life. The remaining service life of the existing barrier (either Type I or Type II) as defined within an engineering evaluation must also be considered to ensure that it is a permanent solution as required by FHWA. If an existing barrier poses ongoing functionality or maintenance problems, it should be replaced with currently acceptable materials either as a part of the Type I highway project or as a state funded noise wall replacement project.

An example case is where an older wooden noise barrier has been installed, but has deteriorated over time. An engineering assessment can determine that an acceptable service life remains with cost-effective repair. This would be an acceptable decision. The engineering assessment can determine that repair of the existing wall is not cost-effective and can replace the wall with suitable materials that furnish acoustically feasible and current design goal noise reductions. Decisions concerning these situations will be made on a case-by-case basis in consultation with CDOT and FHWA.

Federal funds can be used only if there will be impacts in design year caused by a Type I project and the replacement barrier is feasible and reasonable.

Effectiveness of the existing barrier will be assessed through the noise modeling software by calculating the noise reduction from the barrier for the project design year with the proposed improvements in place. If the existing barrier is found meet the noise reduction design goal, no further action is necessary for the existing barrier. If the barrier will not meet the design goal, examination of alterations to the existing barrier so that it will meet the current noise reduction design goal (Section 5.5.1) will be necessary and appropriate recommendations made to improve the barrier. If structural integrity, inadequate footing design, load carrying capacity, or other construction issues prevent the existing wall from being adequately modified and no remedy is readily found, consultation with FHWA and CDOT Project Management Team will determine whether a replacement wall shall be built to meet the 7 dBA noise reduction design goal. At a minimum, any existing noise barrier removed for construction of a new transportation project shall be replaced in kind (see Section 4.5) at a new location. All noise abatement analyses recommendations must be documented on a CDOT Form 1209, the Noise Abatement Determination Worksheet (**Appendix D**).

As noise abatement measures other than the construction of noise barriers are not usually practical, the following discussions concerning feasibility and reasonableness are presented in the context of considering noise barriers and noise barrier construction.

4.4 Feasibility

Feasibility criteria describe the physical considerations and concerns with the construction of an acoustically effective noise barrier at a particular site and project. If a noise barriers that has been evaluated for a particular location is deemed not to be feasible, an assessment of the reasonableness criteria is not required and the noise abatement analysis is considered complete. This analysis and decision is to be fully discussed and documented in the noise study technical report.

4.4.1 Noise Reduction

The major feasibility criterion that is to be considered is whether or not a substantial noise reduction can be obtained based on constraints that are inherent to the individual project. If a reduction of 5 dBA cannot be provided to at least one impacted receptor, the abatement measure is not considered a feasible mitigation and will not be recommended for inclusion in the project.

A very common issue to consider in this case is the ability to construct a continuous barrier for the entire length of the impacted area. A barrier is typically not effective if built with frequent breaks for driveways, sidewalks, streets, utilities, drainage facilities or streams as the resultant short wall lengths may drastically reduce the barrier's acoustic performance. One possible solution in a case such as this is to consider wrapping barrier end-segments or overlapping the barriers. The analysis indicating that a 5 dBA feasible noise reduction cannot be achieved must be documented in the technical report.

4.4.2 Safety and Maintenance Considerations

As is the case with any structure, there are obvious engineering, safety and maintenance issues that must be considered to determine its feasibility. If any of these issues are significant enough to cause a fatal flaw condition, then the barrier is deemed to not be feasible. The geographic setting and weather conditions inherent to Colorado dictate very different feasibility concerns when it comes to winter maintenance. Four-fifths of Colorado is non-urban/non-suburban in nature and most roadways are situated at altitudes from 4000 feet to 9800 feet. Many highly traveled roadways traverse terrain that is mountainous, steep valley sided with limited sun exposure. In these cases, there is little room to negotiate noise barrier locations within the physical constraints of the terrain.

Examples of situations which can be considered fatal flaws include, but are not limited to, the following:

- Excessive reduction of sight distance.
- Creation of a continuous shadowing condition that may cause excessive icing of driving lanes through the winter months.
- Inability to provide for adequate snow/debris removal or snow storage during winter months.

CDOT uses consultation with maintenance and traffic engineering staff to determine when these types of maintenance/safety issues can be redesigned to an acceptable level, can safely incorporate transparent barriers, or are severe enough to cause a feasibility fatal flaw to noise barrier installation at any project site.

4.4.3 Constructability

If reliable and common engineering practices could be employed to construct a noise barrier, then that barrier is considered feasible. If it is obvious that the constructability of a noise barrier due to location limitations, critical environmental factors or engineering considerations is not possible without major modifications to the site or technological efforts, or extraordinary costs, the barrier can be considered not to be feasible and no further analysis is required. However, this should only be used for situations that are very clear. Decisions such as these shall be thoroughly documented and justified in the noise study report.

A special constructability consideration is when the minimum barrier height required to achieve the noise reduction design goal (Section 5.5.1) for at least one receptor is found to be greater than 20 feet. CDOT has determined that for Colorado terrain and weather conditions, including common high wind events, 20 feet is the maximum allowable height without compromising structural integrity under typical construction design specifications. CDOT views this condition as infeasible and the barrier will be re-evaluated for feasibility at a lower wall height (possibly sited at a different location).

Feasible constructability extends to extraordinary costs related to implementation of engineering design, structural reinforcement, or right-of-way purchase for the purpose of noise abatement implementation. Typically these types of extraordinary costs are not identified until final design has been rendered.

4.4.4 Considerations for Berms

Most of the above feasibility discussions have focused on the construction of noise barrier walls. Berms, however, can be considered as an alternative to walls where possible, as they are generally more aesthetically pleasing and have a more natural appearance. Limitations with berms do need to be considered in the feasibility evaluation, because a much larger footprint is required. Ideally, berm flanks will be no steeper than a 3:1 slope. An earthen berm is deemed not feasible if the necessary slope ratio is steeper than 2.5:1 or adequate ROW cannot be acquired to construct the berm to safety or slope ratio specifications.

4.4.5 Considerations for Parallel Barriers

Due to multiple sound reflections, performance degradation of parallel barriers needs to be investigated if the width-to-height ratio is less than 10:1 (distance between the barriers is less than 10 times the height of the barriers) or if the barriers are closer together than 200 feet. Analysis of individual walls under these specific parallel configurations could lead to incorrect abatement calculations (**Appendix C**). Possible solutions include raising the height of the barriers to overcome the degradation or investigating the use of absorptive treatments on either or both barriers to reduce the reflections. In these cases, retaining walls or vertical rock face cut slopes, if they are present, should be treated as barriers in the analysis.

4.5 *Reasonableness*

Reasonableness of abatement measures evaluates the combination of environmental, economic, and social factors affected by the noise abatement measure. This analysis ensures a prudent use of public funds.

Reasonable noise abatement must at a minimum collectively achieve the criteria of the noise reduction design goal, the cost-benefit evaluation and the benefited receptors desire for an abatement measure. Failure to achieve all of these criteria (Sections 5.5.1 through 5.5.3) will result in the noise abatement measure to be deemed unreasonable.

4.5.1 Noise Reduction Design Goal

CDOT defines the noise reduction design goal as the insertion loss that is predicted to result from a barrier that results in a 7 dBA noise reduction at a minimum of one benefited receptor. The initial barrier evaluation shall be performed to determine what dimensions and siting will be required to achieve a 7 dBA reduction.

Barrier dimensions must be optimized in terms of overall noise reduction and cost-benefit, which are two of the factors for reasonableness. It is desirable that a design be identified where a potential noise barrier provides the best balance between cost and noise reduction benefit. This is not a trivial task, as the benefit versus cost relationship is not linear and a point of diminishing returns will be reached. An iterative process, however, can result in a barrier that will provide optimal benefit with a noise reduction design goal of at least 7 dBA.

A benefited receptor, whether impacted or not, is one that receives at least 5 dBA of noise reduction. This 5 dBA reduction is based on the addition of the noise barrier only, and is only considered after any shielding effects, such as for rows of buildings, are taken into account.

Often times, noise sources such as aircraft, rail, ground transit modes, or industrial noise contribute substantially to the noise environment. The quantitative context of these non-roadway noise sources is not addressed within the approved FHWA TNM modeling software. Therefore, in cases where substantial noise contribution is expected from other transportation (or non-transportation) noise sources, consultation among CDOT noise specialist(s), CDOT project manager, local agency project sponsor(s) (if applicable), and FHWA is required to resolve the noise impact and abatement evaluation methodologies.

Other considerations that need to be taken into account are situations where a barrier will shield a main highway, but not a frontage road. In these cases, the overall noise environment shall be the basis for the determination if the noise reduction design goal is possible.

4.5.2 Cost Benefit Index

In consideration of the cost of each potential noise barrier segment, the barrier cost benefit index shall be calculated based on an estimate of cost per receptor per decibel of reduction caused by the abatement. This will determine the cost-reasonableness of the abatement measure. To be considered reasonable, the cost benefit index must calculate to a dollar value no more than **$6,800** per receptor per decibel of reduction.

The cost benefit index, calculated as a ratio, is ***not*** intended to function as an accurate cost itemization for the design and construction of a noise barrier, but rather to provide a consistent level of consideration that will be used for CDOT noise abatement decision-making under these guidelines. The genesis of this cost-benefit baseline derives from the average wall dimensions necessary to provide prudent noise reduction benefit to a suburban/urban neighborhood housing density.

The cost benefit index value will be determined by dividing the approximate cost of the barrier (length * height * unit cost) by the total decibel reduction that is predicted to occur for all benefiting receptors of 5 dBA or more. For purposes of the abatement evaluation, the unit cost that will be used for this cost calculation will be a generic wall cost of $45 per exposed square foot (on one-side of feature), which approximates the typical costs in construction of a standard concrete/masonry barrier that does not require special site considerations. This cost is based on an average of 2005 to 2009 noise wall square footage costs collected from CDOT cost tabulations.

If berms are potentially feasible, use the unit cost of $15 per cubic yard of earth for the berm portion of the calculation. If the berm will be constructed utilizing on-site excess materials or recycled excess roadside sand, resulting in a trivial cost or a net benefit to the project, a unit cost of $2.50 per cubic yard shall be used in the calculation. It will be a matter of CDOT noise specialist discretion to determine which berm unit cost will be utilized in the cost-benefit calculation.

For example, consider a barrier 10 feet high and 1000 feet long to protect a development of 16 homes. If 6 receptors are predicted to receive a 5 dBA benefit and 10 are predicted to receive a 7 dBA benefit, the cost benefit index value will be calculated as follows:

- Cost = (10 ft. ht.) * (1000 ft. l.) * ($45/sq. ft) = $450,000;
- Benefit = (6 rec. * 5 dBA) + (10 rec. * 7 dBA) = 100 total dBA reduction;
- Cost-Reasonableness Value = $450,000/100 dBA = $4500/receptor/decibel.

This example barrier would be considered reasonable because when the cost of the barrier ($450,000) is divided by the total amount of decibel reductions for the 16 benefitted receptors (100 dBA), the cost per benefitted receptor, per dBA ($4,500) is less than the cost per benefitted receptors allowance of $6,800.

As mentioned earlier, receptor points that were used in the modeling usually represent several actual receptors. It is very important to properly quantify these receptors to obtain an accurate count of the benefits achieved and used for the calculation. For the calculation, each benefited individual residence, business, etc. is to be counted as one receptor. For multi-family residences, each dwelling unit adjacent to the highway should count as one receptor. If the multi-family structure is represented by a single modeled receptor and it is predicted to receive an overall benefit of 8 dBA, for example, but there are 4 separate units, then an overall benefit of 32 dBA (4*8) must be used in the calculation. Receptor identification for special land uses captured under the NAC is described in Section 4.1.

4.5.3 Benefited Receptor's Desires

The opinions and desires of the benefited community must be considered in the evaluation of reasonableness of a noise barrier. The decision to build or not build noise abatement measures recommended from noise mitigation analysis should result from a simple majority response consisting of greater than 50% of the responding benefited property owners and residents. The CDOT or consultant noise specialist shall identify the applicable benefited receptors within each abatement analysis. A benefited receptor is any property containing a noise sensitive receptor(s) that receives 5 dBA or more noise reduction caused by the abatement measure.

In order to take both owner and resident desires into account, each dwelling unit is provided two votes – one for the owner and one for the resident. For owner-occupied dwellings, both votes would be cast by the same individual(s). For owners of multiple dwelling units (e.g. apartment buildings), the owner would have the same number of votes as the number units that are benefited. Each residential unit would get one vote. In the instance with multiple owners or multiple residents of a single dwelling unit, a consensus is required.

NEPA Documentation

CDOT will evaluate and recommend feasible and reasonable noise abatement measures for the preferred alternative through the NEPA process and will use the public involvement process, which can include, but is not limited to, open houses, public hearings and/or neighborhood mailers, to inform the public of the recommended mitigation. A noise abatement station providing noise abatement displays and analyses adequate to inform the public on the recommendations should be present at NEPA-related public venues. Abatement recommendations will be documented in the NEPA noise technical documentation and Statement of Likelihood (Section 5.6). A statement disclosing that a Benefited Receptor Preference Survey will be conducted for benefited owners and residents affected at each recommended mitigation site at the time of final design of the construction project should be included in the Statement of Likelihood.

In the special case of the Categorical Exclusion project where there is typically only one build alternative under consideration, public involvement may be limited, and the timeframes between NEPA noise analyses, engineering design and construction are generally more compressed, the Benefited Receptor Preferences Survey can be solicited after the Final Office Review, but during the NEPA process.

Benefited Receptor Preference Survey

Once final design of the project and the re-evaluated abatement analyses are completed, a public involvement process shall be utilized to solicit the views of current residential occupants' and property owners' on whether to build noise abatement or not. This final design public involvement process shall be devised by CDOT Construction or Project Management and the CDOT noise specialist responsible for the re-evaluation analyses of the final abatement design. At a minimum, one attempt to contact each identified benefited receptor site (both property owner and resident, see Appendix A) must be made and documented – utilizing the US Postal Service or commercial mailing services, door-to-door contact, or other defensible, targeted means. Written and spoken communications will be in English and in the dominant secondary language of the community, if applicable. The benefited receptor preference survey process must be thoroughly documented and attached to the Form 1209 for that abatement measure. A vote of equal standing will be provided one resident and one owner per benefited dwelling unit as described above.

The noise barrier preference survey is normally based on residential areas; however, mitigation for commercial and special-use areas would be based on a survey of the business operators and property management/owners and/or the officials with jurisdiction.

Whichever preference option (for or against the abatement action) that receives the most votes will become the stated preference of the affected persons and determine whether or not the abatement measure is built. An example of a preference survey is included in **Appendix D**. If the preference survey results in a tie vote, it is understood that no majority has been reached, and therefore, no abatement action would be built.

Survey Results Example

As an example of the voting process, suppose an Environmental Assessment recommends sound walls at 2 different locations within the project area. The noise specialist identified 60 dwelling units benefited from Noise Wall #1 and 25 benefited dwelling units from Noise Wall #2. A Benefited Receptor Preference Survey was conducted after the final design noise analytical evaluation was completed. The survey resulted in 35 votes (25 affirmative, 10 negative) from benefited owners/residents received for Noise Wall #1 and only 5 affirmative and 11 negative votes received for Noise Wall #2.

The decisions would be as follows:

- Noise Wall #1 received 35 total responses- a total of 25 of 35 or 71% affirmative votes and 10 of 35 or 29% negative votes from benefited owners and residents. The decision would be to construct Noise Wall #1 as a part of the project.
- Noise Wall #2 received 16 total responses - a total of 5 of 16 or 31% affirmative votes and 11 of 16 or 69% negative votes from benefited owners and residents. The resulting decision is to not construct Noise Wall #2. This wall does not meet the required reasonableness criterion because of this vote and would not be built.

These decisions would be documented and attached to the appropriate CDOT Form 1209 in the project file and NEPA administrative archive.

4.6 *Statement of Likelihood*

The environmental document shall identify (1) locations where noise impacts are predicted to occur, (2) where noise abatement appears feasible and reasonable, (3) locations with impacts that have no feasible or reasonable noise abatement alternative, and (4) the recommendations for construction of noise abatement measures. For an environmental decision, this analysis shall be completed to the extent that design information is available at the time the environmental decision document is completed. A Statement of Likelihood shall be included in the environmental document since feasibility and reasonableness determinations may change due to changes in final project design after approval of the environmental document. The Statement of Likelihood shall include the preliminary location and physical description of noise abatement measures determined to be feasible and reasonable in the preliminary analysis. The final noise abatement decision will be made during the completion of the project's final design and the public involvement processes.

To aid in this documentation, completion of CDOT Form 1209 is required and is to be included within the noise study report (**Appendix D**). This form is to be filled out for each barrier segment or each distinct area of the project that were evaluated in the abatement analysis.

4.7 Special Insulation Abatement Considerations

Noise insulation of NAC Activity Category D land use facilities, such as places of worship and schools, may be considered for an abatement measure in accordance with 23CFR772.13(c)(5). This evaluation will be made on a case-by-case basis. Any decisions in this regard must be thoroughly and completely documented in the text of the noise report. Post-installation maintenance, repair and operational costs for noise insulation are not eligible for Federal-aid or CDOT funding.

4.8 Tiered Environmental Impact Statement

Tiered EIS documents are a special case requiring consultation with FHWA. The level of noise analyses required for a Tier 1 EIS would be more general in nature, deferring a Type I project noise analysis, as described herein, for a subsequent Tier 2 NEPA study. CDOT and FHWA will jointly determine the appropriate scope of noise analysis for the Tier 1 EIS. When the Tier 1 EIS is intended to narrow the range of alignment alternatives and/or modal alternatives, the Tier 1 EIS may provide more general estimates of existing noise levels and future noise level changes than a project-specific Tier 2 analysis. The Tier 2 analysis will include more detailed information about the design concept and scope and surrounding land uses than Tier 1. The Tier 2 document will include alternative specific impact and mitigation analyses.

4.9 Design-Build Project Implementation

The preliminary technical noise study shall document all considered and proposed noise abatement measures for inclusion in the NEPA document (EIS, EA or CE). Design-build noise abatement measures shall be based on the preliminary noise abatement design developed in the technical noise analysis for the Preferred Alternative design. Noise abatement measures shall be considered, developed, and constructed in accordance with this standard and in conformance with the provisions of 40CFR1506.5(c) and 23CFR636.109.

The following items should be included in all Type I design-build bid engineering design plan sets and/or specifications to provide consistency and clarity to the contractor. All items listed below must be compiled by the CDOT Project and Noise Teams and clearly documented in the Bid Package. A contractual mechanism shall be developed by CDOT Project Management and Contracts personnel to assure that the following elements are fulfilled as required or in cases of optional features, as best practicable:

- Definition of geographic siting, dimensions and material requirements of the recommended noise abatement measures.
  - Aesthetic treatments

- Absorptive treatment if required
- Materials selection
- Construction method (e.g. post and panel, pour in place)
- Any required structural element

- Definition of the alignment shifts and profile elevation tolerances triggering a re-analysis of noise impacts and abatement. Definition of process for re-evaluation of original recommended abatement in response to alignment shifts or profile changes.
    - Identification of required deliverables and submittals for potential changes in design
  - Identification of phasing issues where salient features such as existing noise walls or existing shielding once removed or significantly regraded during construction would trigger temporary noise abatement requirements during construction period until final abatement measure is re-evaluated and/or constructed.
- A ***Benefited Receptor Preference Survey*** shall be conducted for abatement recommended for the final alternative in the NEPA process as defined in Section 5.5.3. If new abatement is added to the design-build project, the Project Management Team in conjunction with the contractor noise analyst shall initiate a new ***Benefited Receptor Preference Survey*** for any new abatement measure(s).
- A final noise analysis will be conducted to determine effectiveness of constructed or proposed abatement measures. This includes evaluation of new impacts and new abatement as a result of design changes.
- Clear responsibility of contractor for monitoring and reporting of alignment and profile changes; communication chain and authority to instigate new noise impact and abatement evaluation.
- Clear responsibility of conducting, reporting, recommending, and documenting of new noise impact evaluation in the office.
- Clear responsibility for development, siting and communicating construction requirements for new abatement measures in the field.

As design-build project construction proceeds, noise abatement measures shall be carefully monitored by CDOT and contractor noise personnel to document barrier inclusion and barrier placement.

Noise abatement measures recommended by the NEPA decision document or the CDOT noise specialist cannot be removed or ‘value engineered’ from a project as a cost-savings device unless adequate replacement acoustic benefit is restored. Adequate abatement must be provided to sensitive receptors as identified in CDOT noise abatement analysis. Altered barrier conditions will be evaluated on an ongoing basis to assure that abatement is constructed that continues to meet noise 7 dBA reduction design goals at one receptor at each recommended feasible and reasonable barrier location. Alterations in dimensions and deviations from proposed siting plans should be well-documented. Larger or more complex projects, which are likely to result in modified roadway horizontal or vertical alignments during the design-build process, should develop an abatement verification procedure to formalize and document changes and alterations to the preliminary recommended abatement parameters and siting.

4.10 Noise Impact Compensation and Third Party Funding

Property owners or residents cannot receive Federal funds as monetary compensation in lieu of noise abatement. Neither can property owners and residents receive direct monetary compensation for unmitigated damages caused by highway traffic noise impacts.

Federal-Aid Project or Project in Interstate ROW

Private or third party funding can be used on projects to make functional enhancements to a noise abatement measure already determined to be feasible and reasonable, such as adding absorptive treatment, access doors, or aesthetic enhancements. Private or third party funding is not allowed on a Federal or Federal-aid Type I or Type II project to discount the cost of the noise abatement measure in order to influence the determination of feasible and/or reasonable. Private or third party funding cannot be used to augment the dimensions or change the cost-benefit index of abatement measures recommended on a federal-aid project. Other landscape or hardscape features may be constructed with private or third party funding as part of a non-federal aid project in interstate right of way that may provide some noise abatement without meeting the feasible and reasonable determination.

Non-Federal Aid Project on non-Interstate ROW

Local agency sponsored and non-CDOT, non-federally funded noise abatement can be constructed on CDOT right of way only if the local agency establishes that no other reasonable alternative to the use of public property is available, and meets the requirements of the CDOT Noise Analysis and Abatement Guidelines. Again, other landscape or hardscape features may be constructed with private or third party funding as part of a non-federal aid project that may provide some noise abatement without meeting the feasible and reasonable determination. (See **Section 7.3**)

5. CONSTRUCTION CONSIDERATIONS

The approach to this discussion in the project report should be general in scope and consider the temporary nature of construction activities. Included should be the types of activities that are expected to be performed and the equipment that will be used. If desired, noise levels that are associated with these activities can be researched through product or process literature and presented in the report. Computerized prediction models have been developed for the calculation of noise from construction but are very sophisticated and require a great deal of construction staging and planning input that is not available to CDOT during the NEPA process. As a result, use of these models to analyze construction noise is not required.

5.1 Construction Noise

All Type I and II projects will identify land uses or activities that may be affected by construction noise caused by the project. No detailed analysis is required; however, CDOT recommends use of the FHWA construction noise model and suggested mitigations, which can be found at www.fhwa.dot.gov/environment/noise/construction_noise. The noise analysis must at a minimum identify low-cost, readily implemented abatement measures that can be included on the project. Examples are limitations of work to daytime (or specified) hours, ensuring that equipment utilized properly maintained mufflers, modification of backup alarm systems, location of haul roads, and public outreach.

A construction noise plan may be developed to detail mitigation needs and abatement measures employed during construction activities, especially in large, complex projects in major urban areas that are anticipated to have duration of one year or more. In these cases, a more detailed discussion of the impacts and mitigation measures is necessary for the project. This type of mitigation plan could include, but is not limited to construction noise monitoring, heavy truck routing, temporary noise abatement measures, noise complaint hotlines, establishing project construction noise limits and violation procedures. This plan should be identified as a NEPA mitigation strategy for noise or construction, and be fully developed and approved prior to final project design implementation (pre-construction).

5.2 Construction Vibration

A vibration analysis is generally not necessary for construction activities unless there are vibration-sensitive businesses in the area and high vibration construction methods are proposed. Before construction begins, each vibration-sensitive area must be identified and a temporary vibration mitigation plan be developed.

5.3 Local Ordinances

Some local governments have passed local noise ordinances which may restrict the amount of noise that can be emitted from a construction operation during certain hours or in certain areas (i.e. residential neighborhoods). Although CDOT is ultimately responsible to assure that local noise ordinances are observed by the contractor, acquisition of noise related permits and variances required by the local ordinances are the responsibility of the contractor. This is something that may be needed if the work is envisioned to be very extensive or lengthy in nature. County, city or local noise ordinances and noise control plans should be investigated with local agencies and variances fully resolved with identified jurisdictional authorities, councils and/or boards prior to commencing work.

6. COMMUNITY CONSIDERATIONS

6.1 *Public Involvement*

Decisions concerning noise abatement should include involvement from the public, in particular the citizens who reside or perform business adjacent to the proposed noise barrier. Education should also be provided to members of the general public within the scope of public meetings and publications that describe noise, noise-related impacts, traffic noise mitigation, and enforcement issues. Various publications that explain many of these concepts are available on the FHWA web site www.fhwa.dot.gov/environment/noise.htm. Section 5.5.3 outlines the public involvement requirements for a Benefited Receptor Preference Survey.

6.2 *Coordination with Local Agencies*

Upon completion of the noise study technical report, information shall be provided to local government agencies within whose jurisdiction the highway project is located as to the traffic noise implications of the project on that particular local community in the future. The overall goal of this effort will be to prevent future traffic noise impacts on currently undeveloped lands and to promote noise compatible land use planning.

Proper noise compatible land use planning is very likely the best approach in dealing with the issue of highway traffic noise. The premise is very simple: Refrain from placing noise sensitive developments adjacent to highways. In reality, this is very difficult to do. As the jurisdiction over most of the land in these cases belongs to local governments, it is up to them to determine what activities to pursue in consideration of the best interests of their citizens. While the State of Colorado encourages local governments to plan their developments in such a manner to minimize the impacts of highway traffic noise, such as the creation of buffer zones or placing less sensitive land uses near the highway, there are no mandates currently in effect that prohibit noise sensitive development adjacent to highways.

Information shall be provided to the local officials as to the best estimation of future noise levels at various distances away from the centerline of the project for both un-developed and developed lands. In particular, the distance estimate of the projected 66 dBA contour (related to NAC Activity Categories B and C) should be emphasized. Noise contour maps of the project area clearly delineating the future 66 dBA and 71 dBA contours on the most current available base mapping or aerial photography of the CDOT project including the surrounding community shall be supplied to the local agency planning department, the zoning department and the building permit department. The noise study report should be forwarded to the local authorities, as well as any other explanation or information that will aid the local officials in planning for future traffic noise impacts, such as the FHWA publications *The Audible Landscape: A Manual for Highway Noise and Land Use* and *Guidelines for Considering Noise in Land Use Planning and Control*. Upon request, CDOT will provide additional available material and technical support and guidance which may be of assistance.

6.3 Non-CDOT, Non-federally Funded Noise Abatement on Public Right-of-Way

The purpose of this section is to establish consistent criteria regarding the review, evaluation and approval of requests for non-CDOT, non-federally funded projects that provide for the installation of noise barriers on state highway rights of way.

6.3.1 Policy Discussion

CDOT recognizes that "retrofitting" noise barriers on existing state highways (Type II Noise Program under 23 CFR Part 772) can be a desire of local residents and local officials. CDOT does not currently fund a Type II noise program but will consider approving non-CDOT, non-federally funded noise barrier projects provided that these projects meet criteria established by CDOT consistent with Federal Highway Administration (FHWA) guidance.

Non-CDOT, non-federally funded noise barrier projects should be placed on private property. Private property is not subject to CDOT's jurisdiction. Non-CDOT, non-federally funded noise barrier projects may be placed on public rights-of-way only if the applicant establishes that no other reasonable alternative to the use of public property is available. All requests for non-CDOT, non-federally funded noise barriers will be reviewed and evaluated in a fair and consistent manner, which balances the concerns of the general public at large and meets statutory requirements set forth in § 43-2-400, *et seq.,* C.R.S. and 2 CCR 601-17, Rules Regarding the Use of Waste Tires for Noise Mitigation Purposes Along Colorado State Highways pursuant to § 43-2-401, C.R.S. In evaluating each request, CDOT will consider justification of need based upon the appropriate criteria established in the following Procedural Requirements, the appropriate environmental documentation, plans for future transportation construction, and any other impacts or consequences of the proposed barrier.

6.3.2 Procedural Requirements

So that each non-CDOT, non-federally funded noise barrier request is treated fairly and consistently, the following general requirements apply to all proposals unless otherwise agreed to by CDOT:

1. All applicants for non-CDOT, non-federally funded noise barriers shall be governmental or quasi-governmental entities that have authority to issue local land use approvals. Co-applicants are permitted provided that a governmental entity with authority to issue local land use approvals is the primary applicant and all land use approvals are secured.

2. The governmental entity or agency, hereinafter referred to as the applicant, must notify CDOT and the applicable Transportation Planning Region (TPR) or Metropolitan Planning Organization (MPO) of its desire to initiate development of a noise barrier within the state highway right of way. Prior to submitting an application, the TPR or MPO shall approve the non-CDOT, non-federally funded noise barrier request. If CDOT

initiates the application for a non-CDOT, non-federally funded noise barrier, CDOT will be required to follow the same steps outlined in this procedure.

3. All costs for the development of the proposal including all studies, engineering design, ROW, and construction, will be the responsibility of the applicant. The application shall include a financial plan that identifies the responsible parties for all costs associated with the project. A decision will be made on a case-by-case basis whether to seek reimbursement for the cost of CDOT's review and coordination. Costs consistent with a typical permit review will be absorbed by CDOT.

4. The application shall include a study documenting the justification; need and effectiveness of the proposed noise barrier consistent with the criteria and requirements defined in Sections 3.0 through 5.0 of this document.

5. The application shall justify why placement of the noise barrier on the state highway right of way is necessary.

6. The application shall identify environmental actions required for the proposed noise barrier pursuant to 23 CFR Part 771 http://www.coloradodot.info/programs/environmental/nepa-program/nepa-manual and shall identify a plan and schedule for completion of environmental actions by the applicant and final approval by CDOT and FHWA. All environmental actions shall include a public meeting held by the applicant.

7. All applications for a non-CDOT, non-federally funded noise barrier shall include a design of the proposed barrier, which shall contain the endorsement seal of a Professional Engineer registered in the State of Colorado. CDOT will approve final design of the proposed noise barrier. The design shall include all geometric, structural, and materials details and comply with the most recent CDOT Standard Specifications for Road and Bridge Construction. Designs shall not impair the highway nor interfere with the free and safe flow of traffic. CDOT will provide at no cost to applicants, standard noise barrier specifications, noise abatement guidelines, and noise barrier standard drawings and details.

8. All applications for a non-CDOT, non-federally funded noise barrier shall be subject to approval by CDOT. CDOT's approval of a non-CDOT, non-federally funded noise barrier shall expire after three years unless actual construction of the project has been initiated, and unless otherwise agreed to by CDOT.

9. In addition to CDOT's approval, all noise barriers located on the interstate highway system shall be separately reviewed and approved by the FHWA.

10. CDOT and the applicant shall agree to ownership of the proposed barrier including responsibility for all repair and maintenance in an intergovernmental agreement. All noise barriers located on interstate highway rights-of-way shall be owned by CDOT.

    All non-CDOT, non-federally funded noise barrier applications approved by CDOT shall be subject to execution of an intergovernmental agreement that identifies, at a minimum:

    - The applicant's responsibility for all costs, including, as discussed above, CDOT's costs from initial application review through project management and completion.

    - Ownership, repair and maintenance responsibility for the noise barrier following completion of construction.

    - The applicant's responsibility to obtain all applicable permits, including a permit from CDOT.

6.3.3 Application Submittal

It is deemed necessary that proposals for non-CDOT, non-federally funded noise barriers be submitted and includes all required information to the appropriate CDOT Region Land Management and Access/Permitting Unit management. It will be the responsibility of the CDOT Land Management and Access/Permitting staff to coordinate with Region Engineering, Region Right-of-Way, and EPB and/or Region Noise Specialist(s) to determine CDOT project management of the non-CDOT, non-federally funded noise wall request. State statute C.R.S. 43-4-402 and 403 should be consulted for details of application criteria and timing (see http://www.coloradodot.info/programs/environmental/noise).

CDOT Roles and Responsibilities

Region Land Management and/or Access Management & Permitting of the CDOT Region where the proposed noise abatement measure and the local sponsoring agency are located is considered to be the first contact for requests from local agencies and interested citizens. As such, the Land Management and/or Access Management and Permitting Unit is responsible to provide a timely receipt notification and forward a copy of the formal application or the application request to each of the following intra-agency entities for that Region: Right-of-Way, Engineering Residency, Environmental Noise Specialist and/or DTD Environmental Programs Branch noise manager.

The EPB and/or Region Noise Specialist will provide the applicant (local agency) with technical environmental and noise analysis coordination. All noise impact and abatement analysis will be coordinated and quality assured through this staff prior to engineering, right-of-way and access and permit approvals of abatement measure construction.

7. NEPA DOCUMENT REQUIREMENTS

All Type I projects, regardless of which level of documentation (CE, EA, or EIS) is being used for that particular project, a detailed noise study report will be required to be submitted for CDOT review and comment. This finalized report will be submitted and included with all project information and documentation.

For all highway traffic noise evaluations on a CDOT project or a project requiring CDOT approval, the noise analyst performing the highway traffic noise evaluation must, at a minimum, hold a certificate of completion from an FHWA approved training course for use of TNM. An educational background including principals of highway traffic noise, such as NHI Principals of Highway Noise, and FTA transit noise screening evaluation (as appropriate) are the expected minimum threshold of understanding for all noise specialists on CDOT projects.

7.1 *Categorical Exclusions*

For CE projects, there is usually no published environmental document. Rather, CDOT CE Form 128 is used to document the environmental decisions, to include noise. Completion of the detailed noise technical report, which has addressed the comments and concerns of the CDOT environmental review process, will suffice as far as project documentation is concerned. This documentation can be used in the public desires survey and for notification of public planning agencies and departments of future noise levels on undeveloped lands. The date that the noise analysis and abatement analysis have been accepted will be noted on the CE Form 128. The final approval of the CE Form 128 represents the date of public knowledge.

7.2 *Environmental Assessments and Environmental Impact Statements*

EAs and EISs will provide a summary of the noise technical report within the body of the document. In particular, this summary will include the existing noise condition, impacts that are expected and an evaluation of any potential abatement measures. Although final design information is not available at the early stages of the environmental analysis and documentation effort, every effort must be made to make an initial determination of impacts and evaluation of abatement measures, even though final decisions will not be made until the final design process for the project.

Before the adoption of the decision document, noise abatement measures which are reasonable and feasible and are likely to be incorporated into the project and noise impacts for which no apparent solution is available must be identified by a Statement of Likelihood (Section 5.6). This information should be included to the extent practicable in all NEPA documentation, and must be included in the final environmental document. The purpose of this requirement is that the intentions concerning noise abatement must be made as early as possible in the process. If it is determined that mitigation cannot be provided, the decision must be thoroughly documented with strong supporting evidence provided. (See **Appendix B**.)

The noise study report shall be available for review within the technical appendix section of the environmental document. The noise study report must be finalized and approved by the CDOT EPB noise specialist before the environmental decision document is approved and signed.

7.3 *Noise Abatement Measure Reporting*

In accordance with 23CFR772.13(f), prescribed FHWA requirements to report a triennial inventory of noise abatement measures and their characteristics, each project shall report the following information on all constructed noise abatement measures. Each region shall report the following information to CDOT EPB noise specialist as each project incorporating a noise abatement measure is constructed.

The inventory shall include the following parameters:

- Type of abatement (wall, berm, composite);
- Cost (overall cost, unit cost per square foot);
- Average height (feet);
- Length (feet);
- Location (county, city, route, and GPS coordinates with identified datum and projection system if appropriate, for wall end points);
- Year of construction;
- Average noise reduction as reported by the model in the noise analysis;
- NAC Activity Category(s) protected;
- Material(s) used (precast concrete, berm, block, cast in place concrete, brick, metal, wood, fiberglass, combination, plastic [transparent, opaque, other]);
- Features (absorptive, reflective, surface texture);
- Foundation (ground mounted, on structure);
- Project type (Type I, Type II, and optional project types such as State funded, county funded, toll way/turnpike funded, experimental, unknown).

CDOT will report this information to FHWA every three years, in accordance with Office of Management and Budget's Information Collection Requirements.

APPENDIX A
DEFINITIONS

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23CFR772—Title 23, Code of Federal Regulations, Part 772 (the FHWA Noise Regulation).

Abatement—Measures used to substantially reduce traffic noise levels.

Applicant – A homeowner or renter residing in an eligible area, or the operator of a temporary housing facility or public housing facility located in an eligible area, who submits an application [for non-CDOT, non-federally funded noise mitigation] to the transportation commission in accordance with C.R.S. 43-2-401.

Approach—Noise levels which are within 1 dBA of the Noise Abatement Criteria for a corresponding NAC Activity Category.

Automobiles—All vehicles with 2 axles and 4 tires. Includes passenger cars, vans, and light panel and pick-up trucks.

Auxiliary Lane – Auxiliary lanes are not intended to increase road capacity, but to facilitate the operations of the roadway. Examples include, but are not limited to, any lanes that connect the on-ramp of one interchange with the off-ramp of the next interchange, truck climbing lanes, passing lanes, acceleration and deceleration lanes, and turn lanes. Auxiliary lanes which are turn lanes are exempt from Type I projects (see turning lane definition).

Background Noise—The total of all noise in a system or situation, independent of the presence of the source of interest (ambient noise).

Benefited Receptor— A receptor that is calculated to receive a noise reduction of at least 5 dBA from an abatement action.

Berm— An earthen mound constructed for use as a noise barrier.

CDOT— Colorado Department of Transportation.

CDOT Form 1209—Noise abatement determination worksheet is required to be filled out for each noise analysis for CDOT projects.

C.R.S. 43-2-401 – Colorado Revised Statute, Title 43. Transportation Highways and Highway Systems, Article 2. State, County, and Municipal Highways, Part 4. Noise Mitigation. The state noise mitigation sections 401 through 404 define the general parameters for noise mitigation measures, privately funded noise mitigation, and noise related rule-making authority.

Cost Benefit Index—A value used to determine the cost-reasonableness of noise abatement based on an average barrier cost per unit area.

Date of Public Knowledge—The date of approval of the appropriate environmental decision document for a highway project (signed CE Form 128, FONSI, or ROD).

Decibel—The basic unit for measuring the difference of sound pressure levels of a sound event from a reference pressure. To approximate the range of frequencies of sound most audible to the human ear, an A-weighting factor is applied. Sound levels are usually reported in A-weighted decibels, abbreviated dBA.

Department – The Colorado Department of Transportation.

Design Year—The future year used to estimate the probable traffic volume for which a highway is designed (usually 20 years from start of construction). This year is used as the basis for calculating the predicted future noise levels.

Eligible Area – According to state statute C.R.S. 43-2-401, an eligible area [for non-CDOT, non-federally funded noise mitigation] means a residential area that a) is located adjacent to a state highway; b) existed as a residential area before the state highway was constructed or widened; and c) is located within the boundaries of a local government that, as of the date of the application [for noise mitigation], has adopted an ordinance or resolution to mitigate the effects of noise in the future residential or other noise-sensitive development adjacent to the state highways within the boundaries of the local government.

Existing Noise Levels—The level of noise measured or modeled at a receptor for the pre-construction condition of the highway project area.

Feasibility - The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure.

Federal Action – A Federal action includes actions with effects that potentially subject Federal control and responsibility to projects, programs, funding, or regulatory application.

FHWA —Federal Highway Administration.

Heavy Trucks—Any vehicle with three or more axles.

Impacted Receptor—Any receptor which, under future conditions, is either subjected to noise levels that approach or exceed the noise abatement criteria or a substantial increase in noise levels.

Insertion Loss—The predicted reduction in noise levels resulting from implementation of noise abatement measures.

Leq(h)—Hourly Equivalent Noise Level; the equivalent steady-state sound level that contains the same amount of acoustic energy as the time-varying sound level over a one hour period; the noise descriptor that is used for all traffic noise analyses for CDOT projects.

Local government – A city, town, county or city and county. *See* § 43-2-401(4), C.R.S.

Loudness—The perceived assessment of the intensity of sound/noise.

Medium Trucks—Any vehicle with 2 axles and 6 tires.

Multifamily Dwelling - A residential structure containing more than one residence. All dwelling units on all floors of multifamily dwellings that have an outdoor activity area, such as a balcony, and are exposed to traffic noise, are considered noise sensitive receptors.

NEPA—National Environmental Policy Act.

Noise—Unwanted sound; any sound that is generally considered annoying or offensive.

Noise Abatement Criteria (NAC)—Absolute noise levels used to determine that a noise impact occurs when the level is equaled or exceeded.

Noise Barrier—A solid structure (wall or berm) constructed between a noise source and noise impacted receptors to abate the highway traffic noise.

Noise Reduction Design Goal - The optimum desired dBA noise reduction determined from calculating the difference between future build noise levels with abatement, to future build noise levels without abatement. The noise reduction design goal shall be at least 7 dBA.

Parallel Barriers—Two barriers which face each other on opposite sides of a highway.

Permitted—Planned development on currently undeveloped land that has obtained a formal building permit.

Predicted Noise Levels—Post-construction noise levels as determined via use of a traffic noise prediction model for the design year.

Privacy Fence—Fence constructed on private property or edge of development that is primarily used to separate individual lots from a roadway, and not constructed for noise abatement purposes.

Property Owner - An individual or group of individuals that holds a title, deed, or other legal documentation of ownership of a property or a residence.

Quasi-Governmental Entity -- For the purposes of this Guidance, shall mean an entity with authority to issue local land use approvals.

Reasonableness - The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

Receptor—Any location of an outdoor area where frequent human activity occurs that may be impacted by highway traffic noise and may benefit from reduced noise levels.

Resident – A resident occupies a primary home or place of abode, in which a person's habitation is fixed. The intended distinction between a resident and a property owner is that a resident secures a lease to occupy a permanent building or part of a building and may include a house, condominium, apartment, room in a house, or mobile home. No vacant lot shall be considered a residence. To further refine the definition of a resident for the sole purpose of traffic noise abatement preference survey, the lease must be intended for long term residence and is not intended for vacation, holiday or seasonal occupancy.

Shielding—Noise reduction attributable to any structures or terrain features which are located between a noise source and receptor. The presence or absence of landscaping or vegetation does not affect shielding.

Sound—Mechanical energy produced by pressure fluctuations in a medium (air, water, etc.) that travels in waves and can be detected by the human ear.

Statement of Likelihood - A statement provided in the environmental decision document based on the feasibility and reasonableness analysis completed at the time the environmental document is being approved.

Substantial Noise Increase—For a Type I project, the predicted noise levels increase by 10 dBA or more over the existing noise levels as a result of a highway project.

Study Zone—The area encompassed within a 500 foot halo around the extents of a project which must be considered in the noise analysis. The 500 foot halo is measured from the edge of the roadway pavement, not the highway centerline. If there is a reasonable expectation that noise impacts would extend beyond 500 feet from the edge of the travel way, the study zone will be expanded to include those receptors.

Through Lane – A through lane is any general purpose or managed lane that provides capacity to the roadway.

Traffic Noise Model (TNM) - Current FHWA approved traffic noise prediction software for use on CDOT projects. Former noise modeling program, STAMINA 2.0 has been superseded and is no longer applicable for project analyses.

Traffic Noise Impacts—Impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria or when the predicted traffic noise levels substantially exceed the existing noise levels.

Turn Lane – For the purposes of noise analysis, a turn lane is considered to be the designated lanes required for storage and for completion of a full turning movement. This includes striped deceleration and acceleration lanes that merge into existing through lane traffic. On freeway facilities, extending existing ramp acceleration or deceleration lane(s) to meet current engineering design standard lengths is considered a turn lane(s), including the extension of an existing ramp lane(s) to connect two closely spaced existing interchanges, not to exceed 2500 feet in accumulated length, to accommodate weaving. Under these definitions, the addition of a turn lane would constitute a Type III project.

Type I Projects—A proposed Federal action or Federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through traffic lanes. See full criteria identified in Section 2.3.1.

Type II Projects—A proposed Federal action or Federal-aid highway project for noise abatement on an existing highway. No active Type II program currently exists in Colorado.

Type III Projects - A Federal action or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects are not required to undergo noise analysis.

Undeveloped Lands—Lands on which no current human activity areas already exist or are not currently permitted for future development.

Worst Traffic Noise Condition—Traffic conditions that yield the highest absolute noise levels by consisting of the highest volume of traffic traveling at the highest possible speed. In general, this is the roadway design hour traffic volume at the posted speed limit.

APPENDIX B
NOISE TECHNICAL REPORT REQUIREMENTS

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The purpose of the noise technical report is to provide complete documentation of a highway traffic noise analysis. The noise analysis shall include the following steps for each alternative under detailed study, to include the no-action alternative:

- Identification of existing activities (receptors), developed lands, and undeveloped lands for which development is permitted,
- Determination of existing noise levels,
- Prediction of future noise levels,
- Identification of traffic noise impacts, and, if necessary,
- Documentation of the evaluation of noise abatement measures.
- Development of mapped noise contours to identify future noise impact levels for local land use planning agencies.

Within the body of the report, the above steps taken shall be documented in a manner which allows clear comprehension to the reader of what analysis was done and its underlying reasoning.

The noise report shall include the following (this does not necessarily have to be in the following order and can be included as appendices where appropriate):

- **Introduction and Study Area**. Describe in detail the project location, project purpose, and project alternatives that are being proposed and the study zone that is being considered.
- **Noise Basics and Applicable Guidelines.** Describe general sound and noise terminology and the guidelines and regulations that are being adhered to in the development of the noise analysis.
- **Measurement Procedures.** Describe where and when noise measurements were taken and report the results. List in a table each measurement location and the corresponding results. Not every receptor needs to be measured individually, but enough locations are required in representative points throughout the project. Collect traffic data during the measurements to be used in the validation step.
- **Measurement/Model Comparison (Validation).** Compare the measurement results with the results obtained using the computer model. Report this data in tabular form as well. In general, agreement within 3 dBA will be acceptable. If the difference for any locations is more than 3 dBA, an explanation must be provided as to the reasons for the difference. This may require that the field measurements be repeated.
- **Model Input Data**. Describe the data that is to be included in the modeling of the existing and future conditions. Include and quantify all receptors which are within the study zone of the project. Include and describe which roadways, terrain features, buildings, and ground conditions are present. Describe in detail which traffic data are to be used for the modeling, to include the speeds. Generally, this will be the design hour volume for the roadway. If the design traffic year volumes are higher, use the volumes as

shown in **Exhibit 4**. If they are less, then use those values (do not model to actual capacity of the highway unless the traffic is projected to meet or exceed that capacity). Be sure to obtain as accurate a split as possible on medium truck and heavy truck volumes.

- **Modeling.** For all receptors, model the noise levels for the existing, all future alternatives being considered, and the future no-action alternative. List all data in tabular form for easy comparison. All receptors shall be identified with an address, business name, or location illustrated on a reasonably legible map in addition to whatever modeling convention is used (i.e. R1-1200 Oak Street) and to which activity category they were classified. If any modeled receptors represent more than one actual property, the representative information also needs to be included (R1, 1200 Oak Street, NAC Activity Category B, 5 residences).
- **Mitigation Analysis and Evaluation.** If noise impacts are identified, mitigation must be evaluated under the feasibility and reasonableness guidelines. Evaluate abatement first to attempt to achieve a 7 dBA minimum reduction for at least one receptor (CDOT noise reduction design goal). At least two barrier placements and heights should be analyzed unless it is very obvious that only one location/height will be possible. The goal of this effort is to attempt to optimize the barrier given the feasibility and reasonableness factors.
- **Mitigation Recommendation and Statement of Likelihood**. Explain in detail the final recommendations concerning noise mitigation. This information will also be used in the environmental document, if applicable.
- **Construction Noise.** A brief discussion of the implications of construction noise and typical mitigation measures that can be used is also required.
- **Maps**. To aid in visualization of the project and provide definition of receptor locations, maps should be included as appendices to the noise study report that locate the project, modeled receptors, measurement locations, and barrier locations.
- **CDOT Form 1209**. A copy of a signed CDOT Noise Abatement Determination Worksheet for each evaluated abatement site should be filled out, signed and attached as an appendix as an either hardcopy or an electronic file. Complete one form for each barrier segment or project area analyzed.
- **Benefited Receptor Preference Survey**. A sample blank copy and a scanned copy of all returned Benefited Receptor Preference Surveys must be compiled. Surveys should be independently conducted and tallied for each mitigation area passing feasibility and reasonableness Noise Reduction Design Goal and Cost-Benefit Index criteria. Copies of this compilation should be attached in a technical report appendix as either hardcopy or an electronic file. **Noise Modeling Data**. A copy of the input and output data can either be included in the appendix, or preferably, submitted with the report on electronic media.

APPENDIX C
TRAFFIC NOISE MODEL USER'S GUIDE FOR CDOT PROJECTS

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APPENDIX D
NOISE ABATEMENT WORKSHEET
and
SAMPLE BENEFITED RECEPTOR PREFERENCE SURVEY

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COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ___________________ Date of Analysis: ___________________

Project Name & Location: ____

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ❒ YES ❒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ❒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ❒ YES ❒ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ❒ YES ❒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❒ YES ❒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ❒ YES ❒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ❒ YES ❒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ❒ YES ❒ NO
2. Are noise mitigation measures reasonable?
   ❒ YES ❒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ❒ YES ❒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Completed by: ____ Date: ___________________

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BENEFITED RECEPTOR PREFERENCE SURVEY

This survey should be accompanied by an explanatory cover letter and either a stamped, self-addressed envelope or an email link for voting.

CDOT

Colorado Department of Transportation

NOISE WALL SURVEY

VOTE!
Express your opinion in the CDOT Noise Wall Preference Survey

Are You a Benefited Business, Homeowner or Tenant?

I own or lease at a location identified to receive at least 5 decibels of noise reduction from a noise barrier proposed along Hwy as a part of the Project Name.

Name____

Address______________________________________

Apt#__________ City____________________________

Are you the business or home owner or tenant?____________

A __ foot tall and __ foot long noise barrier is being recommended along Hwy between Street and Street. This barrier is designed to reduce traffic noise caused by roadway improvements made to Highway with the construction of the Project Name.

YES, I want a noise wall. ☐

NO, I do not want a noise wall. ☐

One owner and one tenant per dwelling unit that would benefit from 5 decibels of noise reduction from the proposed noise barrier are eligible to vote on whether a noise wall as described above should be built at this location. This survey of your preference will decide whether a noise barrier is built or not built based on a simple majority of votes that CDOT receives by Date, 2013.

Assigned Receptor ID# ______

COLORADO
Department of Transportation

BENEFITED RECEPTOR PREFERENCE SURVEY DOCUMENTATION FORMAT

This spreadsheet format is suggested to capture full receptor location, notification and voting information for each recommended final design noise barrier.

Benefited Receptor or ID #s	Pueblo Co. Assessor Parcel #	Resident First Name	Resident Last Name	Benefited Property Address	City	State	Zip Code	Received	Vote			Owner First Name	Owner Last Name	Owner Address	City	State	Zip Code	Received	Vote		
									Yes	No	Abstain								Yes	No	Abstain
101	431305004	Mary Ann and Pedro	a	315 S Bradford Ave	Town	CO	80222					*	*	315 S Bradford Ave	Town	CO	80222				
102	431238003	Angie	b	225 S Bradford Ave	Town	CO	80222					*	*	225 S Bradford Ave	Town	CO	80222				
103	431238010	Dwight	c	221 S Bradford Ave	Town	CO	80222	*	1			Angie	ff	225 S Bradford Ave	Town	CO	80222	*	1		
104	431238011	Steven	d	219 S Bradford Ave	Town	CO	80222	*	2			*	gg	219 S Bradford Ave	Town	CO	80222				
105	431238006	Patrick	e	217 S Bradford Ave	Town	CO	80222	*	2			*	*	217 S Bradford Ave	Town	CO	80222				
106	431235004	Current Resident	f	301 E River St	Town	CO	80222	*			1	Sam	hh	604 N Verbana Dr	Town B	CO	80222	*	2		
107	431235004	Current Resident	g	301 E River St	Town	CO	80222					Sam	ii	604 N Verbana Dr	Town B	CO	80222				
201	431317031	Rafelita	h	319 Beech St	Town	CO	80222	*	1					319 Beech St	Town	CO	80222				
202	431317001	Current Resident	i	302 S Bradford Ave	Town	CO	80222					Miguel	jj	2834 Lake Ave	Town	CO	80222				
203	431239008	Charles and Angela	j	224 S Bradford Ave	Town	CO	80222					Caroline	kk	4036 Hillside Dr	Town	CO	80222				
204	431239007	Phillip and Billy	k	222 S Bradford Ave	Town	CO	80222	*		2		*	*	222 S Bradford Ave	Town	CO	80222				
205	431239006	Current Resident	l	220 S Bradford Ave	Town	CO	80222					Jessica Lynn	ll	219 S Bradford Ave	Town	CO	80222				
206	431239005	Tony	m	218 S Bradford Ave	Town	CO	80222	*	2			*	*	218 S Bradford Ave	Town	CO	80222				
207	431239004	Benito	n	312 E River St	Town	CO	80222					*	*	312 E River St	Town	CO	80222				
208	431239003	Crito	o	314 E River St	Town	CO	80222	*		2		*	*	314 E River St	Town	CO	80222				
209	431235006	Current Resident	p	305 E River St	Town	CO	80222	*			1	Virginia	mm	16 E Caldwell St - Un	City A	AZ	80222	*	1		
210	431235005	Angela	q	303 E River St	Town	CO	80222	*	1			Michael and Diane	nn	2705 Columbine Av	Town	CO	80222	*		1	
305	431317002	Current Resident	r	217 E Ash St	Town	CO	80222					Retirement LLC		PO Box 43	City B	CO	99999				
308	431239009	Current Resident	s	216 E Ash St	Town	CO	80222					Earl	oo	218 S Chester Ave	Town	CO	80222				
309	431239011	Current Resident	t	218 E Ash St	Town	CO	80222					Earl	oo	218 S Chester Ave	Town	CO	80222				
310	431239012	Teresa	u	216 S Chester Ave	Town	CO	80222					*	*	216 S Chester Ave	Town	CO	80222				
311	431239001	Ana	v	317 E River St	Town	CO	80222	*		2		*	*	317 E River St	Town	CO	80222				
312	431239002	Current Resident	w	316 E River St	Town	CO	80222					Eleanor	pp	903 Currie Ave	Town	CO	80222	*	1		
313	431235008	Current Resident	x	311 E River St	Town	CO	80222					Reed and Melinda	qq	3637 Goodnight Ave	Town	CO	80222				
314	431235009	Robert and Melissa	y	313 E River St	Town	CO	80222					*	*	313 E River St	Town	CO	80222				
315	431235010	Donna	z	329 E River St	Town	CO	80222					*	*	329 E River St	Town	CO	80222				
		Ben and Jim	a	234 E River St	Town	CO	80222	*		2		*	*	*	*	*	*				
101	431230001	Current Resident		302 E 2nd St	Pueblo	CO	80222	*			1	Kevin	aa	3 Dover Ln	Town	CO	80222	*	3		
102	431230001	Current Resident		302 E 2nd St Apt A	Pueblo	CO	80222	*			1										
103	431230001	Current Resident		302 E 2nd St Apt B	Pueblo	CO	80222	*			1										
104	431225010	Current Resident		202 N Bradford Ave	Pueblo	CO	80222	*			1	Holdings LLC		7245 S Havana St Ste	City C	CO	80222	*	1		
105	431225009	Current Resident		204 N Bradford Ave Ap	Pueblo	CO	80222					Matthew	bb	3000 Saint Charles R	Town	CO	80222				
105	431225009	Current Resident		204 N Bradford Ave Ap	Pueblo	CO	80222														
105	431225009	Kirk	b	4 N Bradford Ave Ap	Pueblo	CO	80222	*	1												
105	431225009	Patsy	c	4 N Bradford Ave Ap	Pueblo	CO	80222	*	1												
106	431225008	Current Resident		206 N Bradford Ave	Pueblo	CO	80222	*			1	Crapatola LLC		PO Box 704	City B	CO	99999				
106	431225007	Current Resident		208 N Bradford Ave	Pueblo	CO	80222										80222				
106	431225006	Current Resident		216 N Bradford Ave	Pueblo	CO	80222					Julie	cc	335 Corral Ranch R	Town	CO	80222	*	1		
107	431225005	Current Resident		220 N Bradford Ave	Pueblo	CO	80222					Le Roy and Elizabeth	dd	PO Box 11572	Town	CO	80222				
108	431230018	Kevin	d	313 E 1st St	Pueblo	CO	80222										80222				
109	431230013	Lucille	e	315 E 1st St	Pueblo	CO	80222					Nelson and Alice	ee	2 White Dove Ct	Town	CO	80222				
201	431230002	Current Resident		306 E 2nd St	Pueblo	CO	80222	*			2	*	*	313 E 1st St	Town	CO	80222				
202	431230003	Jay Dee	f	312 E 2nd St	Pueblo	CO	80222	*	1			Properties LLC		PO Box 1424	Town	CO	80222	*	1		
203	431225011	Current Resident		311 E 2nd St	Pueblo	CO	80222	*			1	Crapolla LLC		PO Box 11160	Town	CO	80222	*			1
204	431230004	Patricia	g	314 E 2nd St	Pueblo	CO	80222					*	*	312 E 2nd St	Town	CO	80222				
205	431230005	Current Resident		316 E 2nd St	Pueblo	CO	80222					*	*	311 E 2nd St	Town	CO	80222				
301	431230006	Richard	h	320 E 2nd St	Pueblo	CO	80222					*	*	314 E 2nd St	Town	CO	80222				
302												Gary and Jenny	rr	39 S Golfview Dr	City A	CO	80222				
303												*	*	320 E 2nd St	Town	CO	80222				
									12	8	10								11	1	1

*** = Owner address and property address are same.**

(An owner-resident vote counts as 2 votes)

Total Votes			
Yes		23	53%
No		9	21%
Abstain		11	26%
As of 10-16-2013		43	total votes
		102	possible votes
		42%	votes received

APPENDIX E
TECHNICAL SUPPORT DOCUMENTATION

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CDOT White Paper: Review of General Barrier Cost/Benefit Data for CDOT Noise Guidelines

The purpose of this memorandum is to document TNM Version 2.5 modeling and associated analyses that were performed in support of CDOT staff as the agency updated the traffic noise analysis guidance document to comply with changes made in 2010 by FHWA to 23CFR772. Specifically, this memo addresses evaluations of barrier cost/benefit as it relates to barrier "reasonableness" assessments under the new regulations.

OVERVIEW

The evaluation of noise barriers for highway projects as specified by 23CFR772 consists of two primary considerations—feasibility and reasonableness. One of several criteria under reasonableness is an examination of the cost/benefit ratio of the noise abatement from a proposed barrier (i.e., wall). The new CDOT guidance must set the threshold for this criterion to allow comparisons and decisions during environmental analysis of future CDOT projects.

CDOT's previous guidance (2002) specified that costs of $4,000/receptor/decibel or higher were unreasonable. This assumed a barrier cost of $30/square foot and counted all receptors receiving at least 3 dBA of noise reduction. The numeric values for the new guidance needed to be updated for 2011 and beyond construction costs while also recognizing the regulatory change that benefiting receptors must now receive at least 5 dBA of noise reduction. The consensus among the CDOT staff participating in the guidance update was that the 2002 cost/benefit threshold had worked well and that a comparable threshold under the new guidelines was appropriate.

To facilitate setting the new cost/benefit threshold, several real-world situations were examined through TNM modeling to evaluate several cost and benefit situations. The examination focused on residential receptors (Land Use Category B) because this is by far the most common situation involving noise barrier evaluations that CDOT has faced. Varying densities of receptors (i.e., neighborhoods) with similarly-performing barriers were combined with updated construction costs to build comparative data (Table 1) to support the selection by CDOT of a new cost/benefit threshold.

TNM MODELING REVIEW

Three example situations were selected from recent past professional experience for examination. The situations are illustrated in Figures 1 through 3. The situations were selected to represent a range of common receptor densities—denser receptor situations would be expected to give better cost/benefit results while lower receptor density would give worse results.

TNM software was used and the modeling processes followed those currently in use for CDOT projects. The actual terrain elevations for the sites were used to ensure realism. The modeling was intended to establish the most compact noise barrier that would provide at least 7 dBA of noise reduction (a simple size optimization of each barrier was included) for the front row receptors so that a matrix of benefits and costs for these neighborhoods could be developed and compared (Table 1).

Separate research for the guidance update, that is not detailed here, reviewed recent CDOT noise barrier construction costs to establish a new barrier cost basis. A new value of $45/square foot was chosen—up from the previous $30/square foot. (Note: earth berms were not examined in this exercise.)

RESULTS

Using the new barrier cost basis along with the "optimized" barrier sizes, the performance of each example barrier was calculated and the results are summarized in Table 1.

Table 1. Example Situation Noise Barrier Cost/Benefit Results

Situation	Benefitting Receptors	Total Noise Reduction (in dBA)	Estimated Cost of Barrier	Cost/Benefit Ratio
Example 1	20	142	$464,000	$3,270
Example 2	57	508	$1,820,000	$3.580
Example 3	21	153	$2,920,000	$19,100

The examples fell into two basic groups: those under $5,000/receptor/dBA and those above. For comparison, the outcomes appeared to be similar to those that would have been expected under the 2002 guidelines, which was viewed favorably by the CDOT panel.

Based on these results, the participating CDOT and FHWA staff felt that an appropriate $/dBA threshold value would be between the $4,000 allowed under the 2002 guidance and the $19,100 exhibited by the poorest-performing example situation (which should not be recommended). A straight escalation of the 2002 threshold value that matched the increased construction cost basis (150%) would give a new threshold value of $6,000. However, this value would not take into account that comparatively fewer receptors would be viewed as benefitting because the minimum noise reduction would increase from 3 dBA to 5 dBA under the new regulations—which affects the final cost/benefit value for a wall. Therefore, it was felt that a (relatively modest) 13% added cost allowance ($800) was appropriate in the new threshold value to offset the loss of some receptors that "benefitted" under the old guidance.

This results in a final recommended cost/benefit threshold value of $6,800/receptor/dBA for the new reasonableness criterion—potential barriers less than or equal to this cost/benefit value are considered to be "reasonable."

SUMMARY

TNM modeling was performed for several example situations to "test drive" ideas regarding a new cost/benefit criterion for potential noise barriers required under the new traffic noise regulations. The results of the modeling fed into the selection by the CDOT panel of a new cost/benefit threshold value that partially determines the "reasonableness" of a potential noise barrier in a CDOT traffic noise abatement evaluation. The new threshold value selected for the CDOT criterion was $6,800/receptor/dBA.

Figure 1. TNM Model Example 1

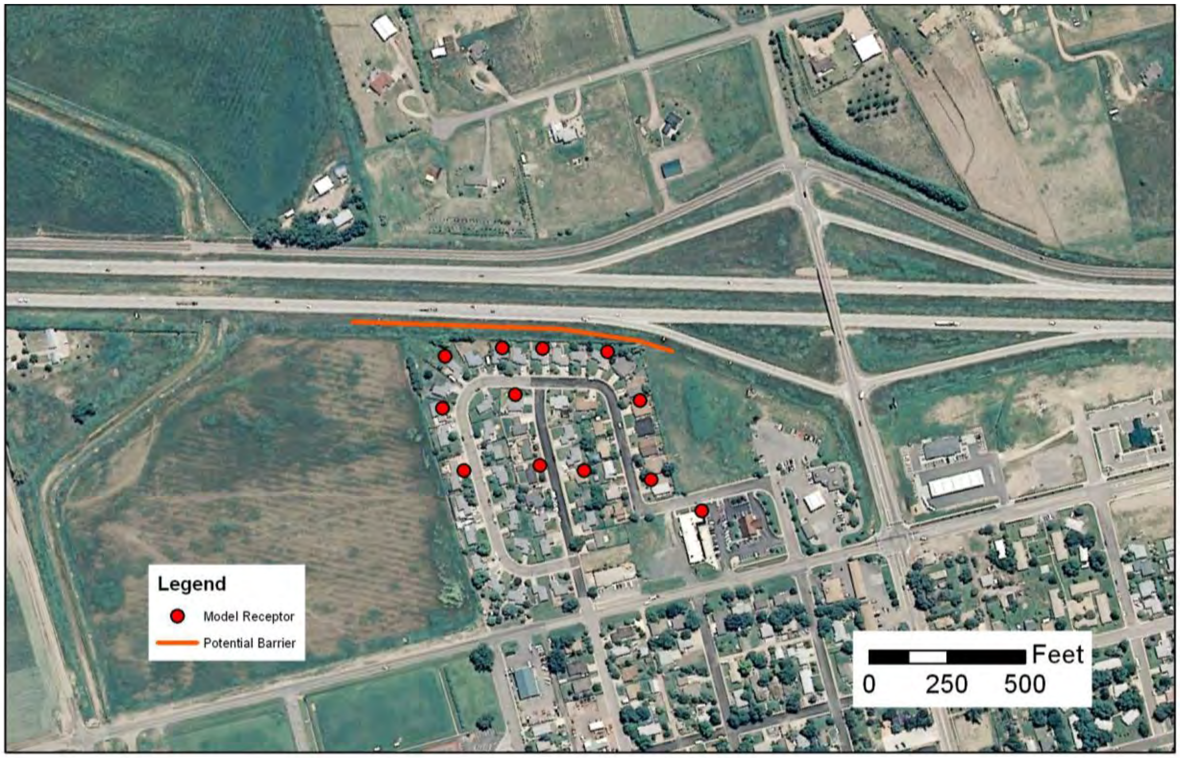
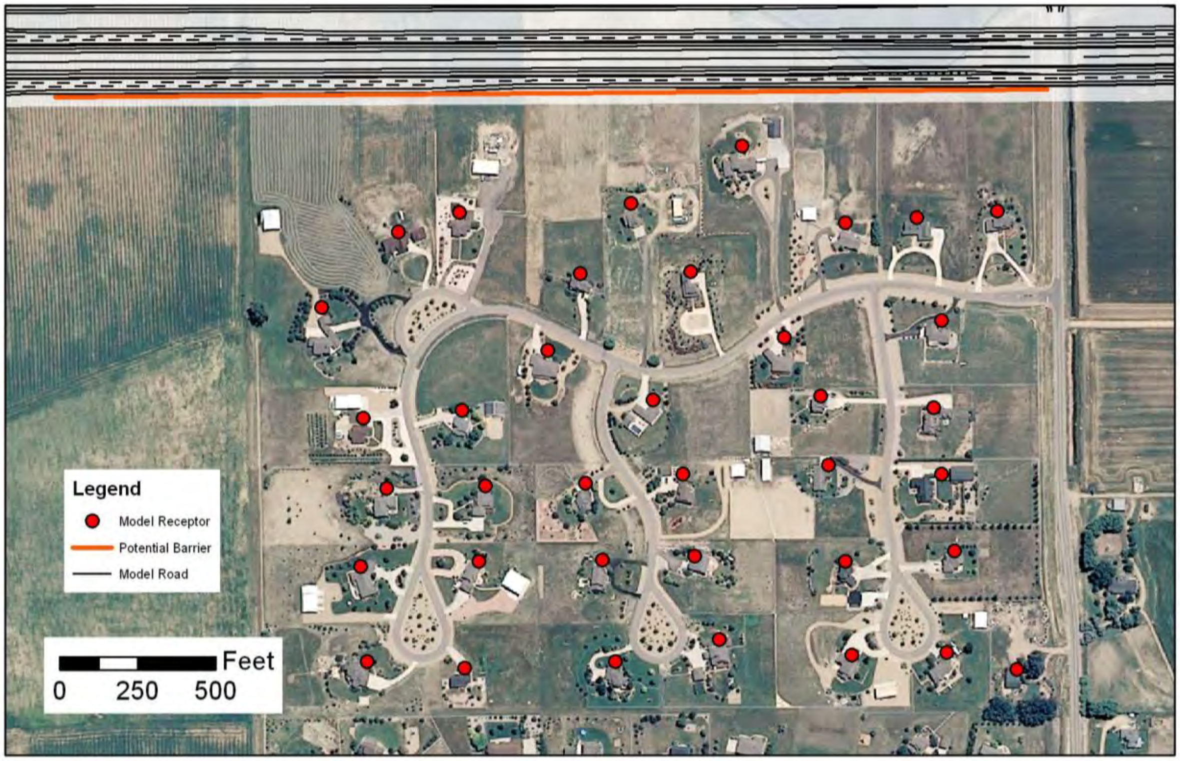


Figure 2. TNM Model Example 2

Figure 3. TNM Model Example 3



CDOT White Paper: General Methodology for Determining Proper Traffic Volumes for use in Noise Analyses

One of the requirements for predicting noise levels in highway traffic noise studies is to capture what is usually referred to as the "worst noise hour," or the point in time where the traffic noise from a given system is at its highest (in the new 23CFR772.9 (d) the term used to describe this is officially "the worst traffic noise impact"). This will be when the highest volume of traffic is traveling at the highest possible speed, or typically just before or after the corresponding "rush" hour, when traffic on some facilities begins to slow with increasing volumes.

When attempting to predict noise under future conditions for highway projects, traffic volumes are either provided by a separate traffic study or derived from existing information. These volumes, however, are usually given as "peak-hour" volumes, which only represent the highest traffic throughput and represent in many cases a congested situation. As such, it is not appropriate to use peak hour volumes in the noise analysis unless it can be shown that those volumes are below the threshold in which noise levels begin to decrease. Additionally, it is not valid to take congestion-level peak hour volumes and model them at the peak speed limit.

For simplicity, many State Highway Agencies have defined the worst noise hour as the point in time where traffic Levels of Service (LOS), as described in the Highway Capacity Manual (HCM), are at a rating of between "C" and "D". While this has been a functional approach, it does have limitations as the parameters that are used may not be something that can be universally used over all facilities. Based on this question, the Colorado DOT performed a general evaluation of highway traffic and corresponding noise levels.

The first task undertaken was to determine at what speeds different volumes (which will be based on vehicles per lane per hour) of traffic will be able to travel. The 2000 version of the HCM was used to investigate this question. Initially, freeway facilities were investigated, as it was the simplest methodology provided (Chapter 23 of the HCM) but also because most of the major noise impacts are associated with these facilities. Chapter 23 of the HCM shows the criteria for freeway facilities and is not included in its entirety here, but the basics of the methodology involve identifying a free-flow speed (FFS) for a facility and the traffic characteristics for that facility. The main calculation that is performed determines the actual vehicle speed based on the volume of traffic per lane per hour. Also determined is the LOS of a facility, which is based on traffic density (calculated by dividing the traffic per lane by the speed).

Based on the equations shown in the HCM, there are inflection points with traffic volumes where traffic will begin to slow. These range from 1150 vehicles/lane/hr. for a FFS=75 mph facility to 1750 vehicles/lane/hr. for a facility with a FFS=55 mph. It is interesting to note that based on the LOS definitions in the HCM, the LOS levels for these inflection points (as shown on Figure 23-3 in the HCM) range from B to D. As such, this would indicate that a blanket LOS C or D approach may not result in the highest noise levels for all facilities.

Exhibit 1 illustrates the speeds by volume for different FFS facilities.

Exhibit 1.

VOLUME (vehicles/ln/hr)	Traffic Speed (mph)				
	FFS=75	FFS=70	FFS=65	FFS=60	FFS=55
1500	74.21	69.80	64.99	60.00	55.00
1600	73.48	69.43	64.88	60.00	55.00
1700	72.44	68.80	64.54	59.94	55.00
1800	71.04	67.85	63.90	59.66	54.99
1900	69.26	66.55	62.89	59.02	54.78
2000	67.05	64.85	61.45	57.93	54.18

These numbers illustrate that adding volume to a facility affects the speeds with higher FFS values to a greater extent than facilities with a lower FFS. Thus, it is possible to continue to increase volumes on some facilities more and still increase noise levels up to a certain point.

Exhibit 2 illustrates the approximate traffic volumes and corresponding speeds for the high end of the LOS C condition (defined as a facility density of 26 vehicles/hour/lane).

Exhibit 2.

FFS (mph)	Volume (vehicles/ln/hr)	Actual Speed (mph)
75	1832	70.52
70	1771	68.16
65	1680	64.63
60	1600*	60.00*
55	1750*	55.00*

*Represents LOS D conditions, traffic will begin to slow with higher volumes

This table, when reviewed along with the volume/speed table, illustrates that a blanket consideration of LOS traffic volumes may not result in a true representation of the actual worst-noise hour conditions.

To determine the vehicle traffic/speed combination that would result in the worst-noise hour condition, the FHWA Traffic Noise Model (TNM) was used. For this analysis, a very basic model was constructed, which simulates the physical conditions of a rural interstate (2-lanes per direction with a median; receptors placed 50 feet from the nearest centerline). Traffic was input as all passenger vehicles, as the interest is not the actual noise levels but the combination of traffic/speed values that would result in the highest levels. By using TNM for this analysis the worst noise hour can be determined directly rather than anecdotally.

To perform the TNM analysis, the major assumption that was made was to treat the FFS of a particular segment as being equivalent to the posted speed limit. There are some drawbacks to performing the analysis in this manner, as for some facilities the FFS can be higher than the posted speed, especially if the engineered facility design speed is greater. This can result in potentially underestimating noise levels. However, for the purposes of this analysis it was felt that as volumes increase to the point of congestion, the overall speeds of the vehicles will tend to congregate around the posted speed limit. Traffic/speed combinations were input into TNM based on the HCM calculations.

Many model iterations were performed in TNM to determine the worst-noise hour levels; those values are shown in Exhibit 3.

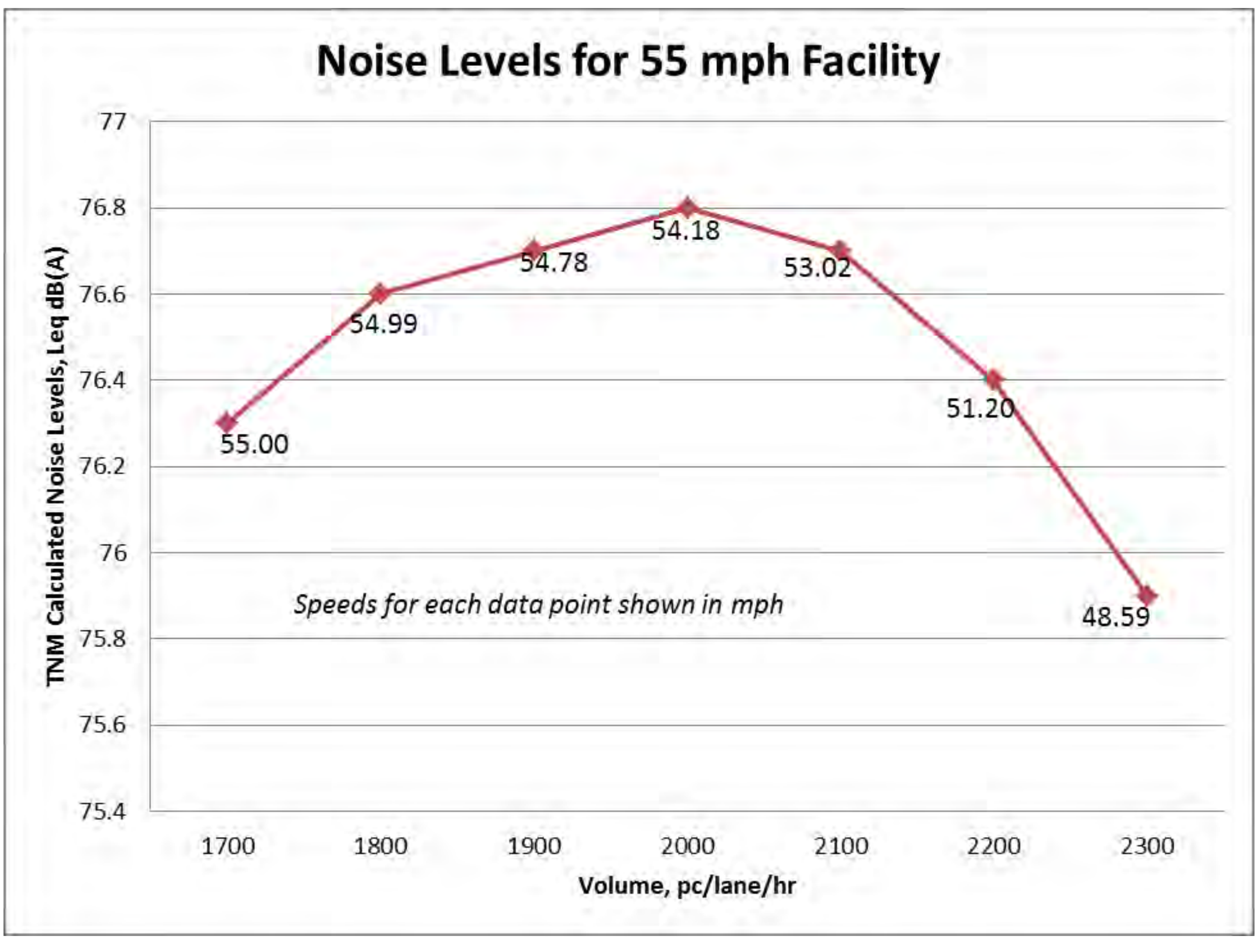
Exhibit 3.

FFS (mph)	Volume (vehicles/ln/hr)	Actual Speed (mph)	TNM Leq Value (dBA)*	LOS
75	1600	73.48	80.6	C
70	1700	68.8	79.8	C
65	1800	63.9	79.0	D
60	1900	59.02	78.0	D
55	2000	54.18	77.0	E

* These values were obtained using the FFS, not the actual speed

For ease of use, CDOT recommends that, for freeway facilities, these volumes be used to represent the worst-noise hour for different facilities based on the posted speed limit. Additionally, although the worst-noise hour was calculated based on the actual speeds, for simplicity CDOT recommends using the posted speed and not the actual speed as calculated. This will increase the noise level that will be predicted by TNM, but this over-prediction ranges from only 0.2 dBA for FFS=55 to 0.3 dBA for FFS=75, which is not felt to be significant.

Exhibit 4. Volume/Speed vs. Noise Level Chart, Example illustrates FFS=55 mph



This detailed analysis was shown for freeway facilities. Additional analysis was also performed for multi-lane facilities (non-freeway) and 2-lane facilities. The methodology for multi-lane facilities is almost identical than that for freeways, and the base results were very similar. However, the impact of other factors with these facilities, for example at-grade intersections, resulted in lower recommended maximum volumes for the worst-noise hour. Two lane facilities utilize an entirely different approach for determining speed and LOS based on an overall capacity of 1600 vehicles/ln/hr. This methodology was combined with the freeway methodology to arrive at the recommended maximum volumes for those facilities.

Admittedly, this approach does not result in a major change in TNM calculated noise levels over the basic LOS approach and may appear to over-simplify some of these variables. Having performed this analysis, however, has provided the data that supports the overall approach. Having this data allows for an expansion on the LOS concept which identifies discrete values that can be easily used for the analysis so that the worse noise hour levels will be reasonably identified. This also allows noise analysts to concentrate on building their models without having to be experts in traffic analysis.

Appendix B

CDOT Noise Abatement Determination Worksheets

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA, Chatfield Bluffs

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall inside CDOT ROW has a CBI of $12,553. This is over the $6,800 threshold for reasonableness

Completed by: [illegible signature] Date: 6/19/15

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ____________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Meadowbrook western

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $21,248, over the reasonableness criteria.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Meadowbrook Central

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $12,624

Completed by: [signature] Date: June 19, 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Meadowbrook Eastern

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Filling in gaps in existing walls within CDOT ROW has a CBI of $30,960

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Chatfield Ave

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall within CDOT ROW has a CBI of $6,579

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Columbine Hills

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

20' Wall in CDOT ROW does not achieve 7 dB(A) design goal and has a CBI of $192,857.

Completed by: ________________ Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised ISA Littleton Commons

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☐ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $3,057.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Villas at Verona

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $2,210.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Bluffs

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ❐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ❐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ❐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❐ YES ❐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ❐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ❐ YES ❐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ❐ YES ❐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ❐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ❐ NO
3. Is insulation of buildings both feasible and reasonable?
   ❐ YES ❐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ❐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $6,317.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Township

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☐ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☐ YES ☒ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☐ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 1,700 feet long x 20 feet tall wall does not provide even 5 dB(A) insertion loss. Noise from County Line Road minimizes the benefits from a wall for C470

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Highlands Ranch Dad Clark western

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:
While a wall in CDOT's ROW does provide design goal insertion losses, the CBI is $9,265, which is above the $6,800 reasonableness criterion.

Completed by: [signature] Date: June 19 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Highlands Ranch Dad Clark Eastern

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

While a wall in CDOT's ROW does provide design goal insertion losses, the CBI is $9,674, which is above the $6,800 reasonableness criteria.

Completed by: [signature] Date: June 19, 2015

Noise Analysis and Abatement Guidelines

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ____________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Highlands Ranch Vennerford

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

a 3,330 feet long x 20 feet tall wall in CDOT ROW does not provide the design goal of 7 dB(A) insertion loss and the CBI is $25,101. This CBI is over the $6,800 reasonableness criteria.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA ACC

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW achieves design goals for insertion loss and has a CBI of $4,236.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Shadow Canyon

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW achieves insertion loss design goals and has a CBI of $5,684.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Gleneagle Village

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $15,321 which is over CDOT's reasonableness criteria of $6,800.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Palomino

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $15,000 which is over CDOT's reasonableness criteria of $6,800.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Crest

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW achieves insertion loss design goals and has a CBI of $3,821.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Deer Creek Golf

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

The CBI for a wall within CDOT ROW that provides the 7.0 dBA design goal is $145,568. This is over CDOT criteria

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Deer Creek Pool

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $93,214

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Trail Stop near Wadsworth

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

Depending on the final location of the wall that is recommend for Chatfield Ave this area may be addressed. Review in final design.

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

On its own this location has a CBI of $9,000 which is unreasonable. However, Chatfield Ave has been recommended for a wall and this area could come in behind that wall.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Rec 10 Park Trail

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet CBI criteria for reasonableness.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Rec 11 Trail North

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet CBI criteria for reasonableness

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C420 Revised EA Johnny's Pond

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ❒ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❒ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ❒ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❒ YES ❒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ❒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ❒ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ❒ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ❒ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ❒ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 20 feet tall wall x 1,550 feet long does not meet CDOT design goal.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA University Area Ball Field

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $157,564.
This is over the $6,800 threshold for reasonableness.

Completed by: ______________________ Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: CU70 Revised EA Loveland

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☐ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☐ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet design goal for insertion loss with a 20 feet tall wall.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Frisbee

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $136,800

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ______________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Gleneagles Golf

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has CBI of $43,902 which is over CDOT's criteria for reasonableness.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Skyview Soccer

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has CBI of $89,196 which is over CDOT's criteria for reasonableness

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Willow Creek South

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☐ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☐ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 1,620 feet long x 20 feet tall wall does not provide design goal insertion loss.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Red Robin

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet design goal for insertion loss

Completed by: [signature] Date: June 19 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: ________________

Project Name & Location: C470 Revised TEA On the Border, LODO, & Brothers

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet design goal for insertion loss.

Completed by: [signature] Date: June 19 2015

Traffic Noise Technical Report

For the C-470 Corridor Revised Environmental Assessment

July 2015

Submitted To:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted By:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

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TABLES (Cont.)

1.0 INTRODUCTION

The Colorado Department of Transportation (CDOT) and the Federal Highway (FHWA) have identified a need for capacity and mobility improvements to the C-470 corridor from Kipling Parkway to Interstate 25 (I-25). CDOT right-of-way within this portion of the C-470 corridor, which will be referenced as the "project area," is located in the South Denver Metropolitan area and crosses through portions of Douglas, Arapahoe, and Jefferson Counties as shown in **Figure 1**. This Traffic Noise Technical Memorandum describes the results of a noise study conducted along this corridor.

Figure 1. C-470 Corridor and its Surrounding Vicinity

1.1 Purpose and Need

The purpose of this project is to address traffic congestion from Kipling Parkway to I-25, reduce traveler delay, and improve reliability for corridor users.

1.2 Alternatives

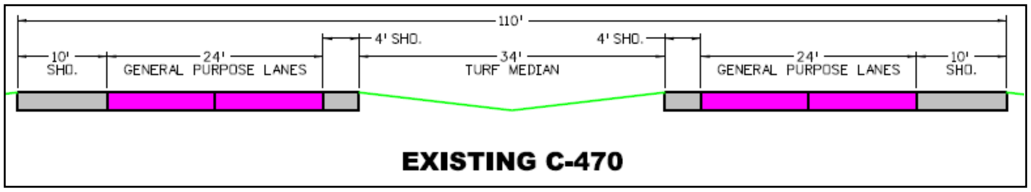
Two alternatives are presented and evaluated in the 2013 Environment Assessment (EA) for the project. These alternatives are the No-Action Alternative and the Proposed Action.

<u>C-470 No-Action Alternative</u>

The No-Action Alternative includes no new construction or action to improve the existing C-470 roadway between Kipling Parkway (milepost 12.449) and Interstate 25 (milepost 26.195) other than performing basic maintenance and/or safety improvements to maintain roadway operation.

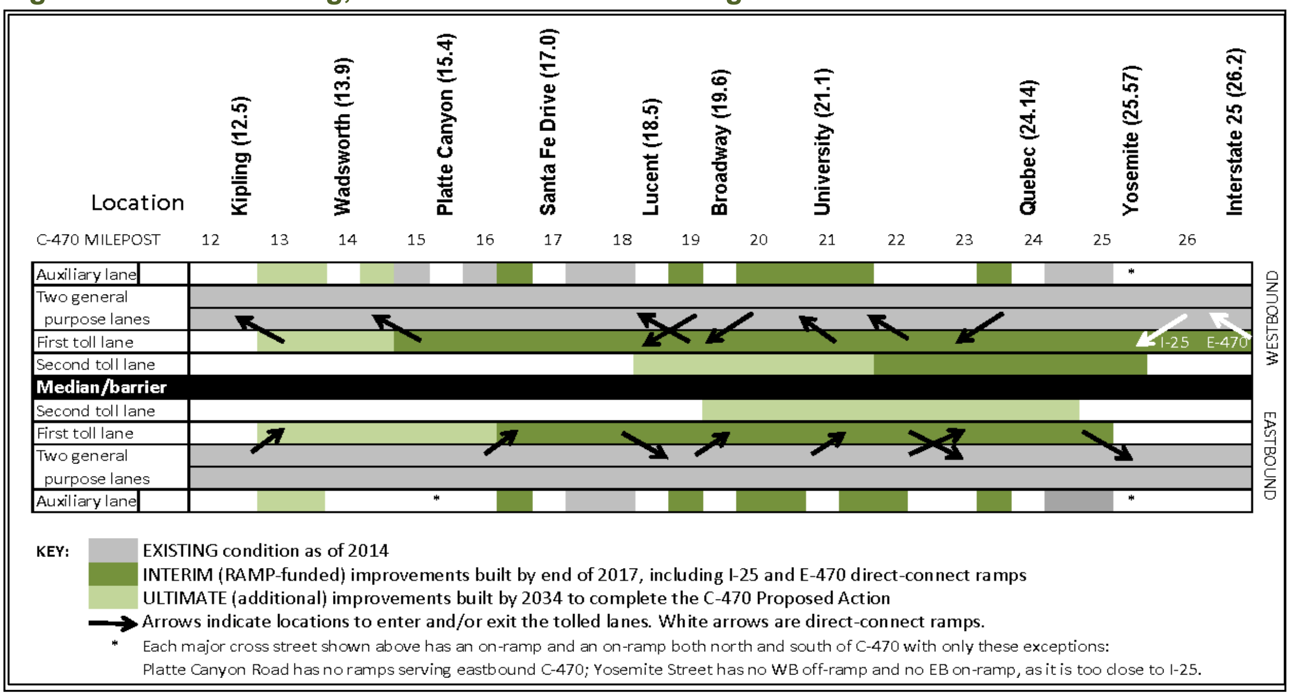
Within the project area limits, the existing C-470 roadway consists of two general purpose lanes in each direction between Kipling Parkway and I-25. An auxiliary lane in each direction exists between the Quebec Street interchange and the I-25 interchange, serving as continuous acceleration and deceleration lanes. The existing roadway consists of 12-foot travel lanes, including auxiliary lanes, with inside and outside shoulders, plus a 34-foot unpaved median, as shown in **Figure 2**. Paved shoulder widths vary between four and ten feet. CDOT has installed ramp metering at all entrance ramps to C-470 within the project area, with the exception of Kipling Parkway. Ramp metering may be installed at that location in the future when warranted.

Figure 2. Existing C-470 Typical Cross Section



C-470 Proposed Action
The C-470 Proposed Action would add managed express lanes and new auxiliary lanes to improve traffic flow, and would reconstruct more than half of the existing pavement to address structural deficiencies. It is expected to be built in two phases. A $230 million construction project to be built by the end of 2017 would provide interim improvements with currently available funds. Additional improvements resulting in the ultimate configuration would complete the Proposed Action by the year 2034. For details, see **Figure 3** below.

Figure 3. C-470 Existing, Interim and Ultimate Configuration

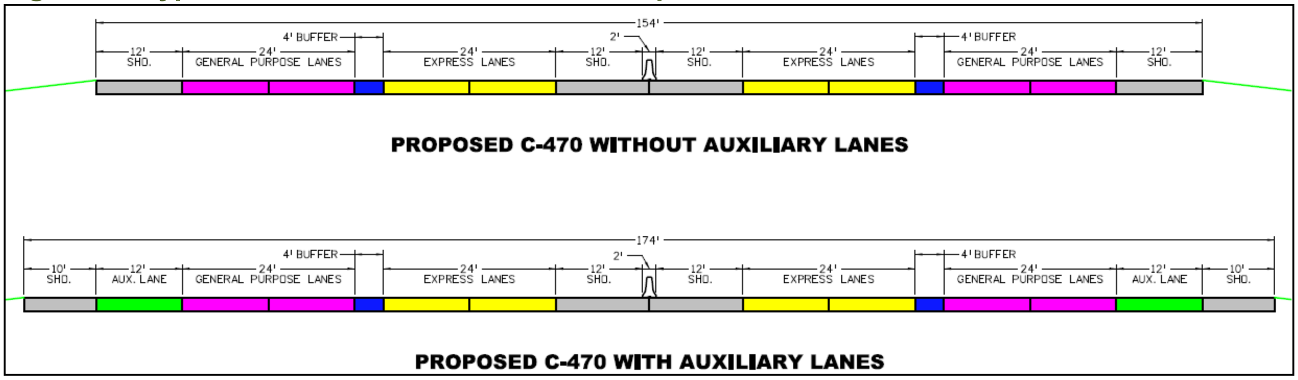


In the more heavily travelled, eastern half of the project, the Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross-section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes.

In the less heavily travelled, western half of the project, the Proposed Action would add only one tolled Managed Express Lane in each direction, but would be designed to accommodate an additional lane in the future. Westbound, the second toll lane would end at Lucent Boulevard, and the westbound single toll lane would end about one mile east of Kipling Parkway. Eastbound, the first toll lane would begin east of Kipling. The second eastbound toll lane would begin in the vicinity of Broadway.

The new proposed typical sections are shown in **Figure 4**, with typical widths of 154 feet and 174 feet.

Figure 4. Typical Cross Sections for C-470 Proposed Action



The Proposed Action includes no new interchanges and no major interchange modifications, except for the addition of two "direct-connect" ramps at the I-25/C-470 interchange.

1.3 Changes from the 2006 C-470 Environmental Assessment

The noise analysis completed in July 2005 for the 2006 C-470 EA was prepared using FHWA's prior noise model (STAMINA), 2002 Federal and state noise abatement guidelines, year 2025 traffic projections, and a slightly different proposed action. No decision document was issued to approve the project. Therefore, the 2005 noise mitigation recommendations are no longer valid and the 2014 noise analysis for the Revised EA supersedes the 2005 analysis.

2.0 APPLICABLE NOISE STANDARDS

The C-470 Proposed Action would use state and federal funds and thus is subject to regulations that govern highway traffic noise for Federal-aid and Federal action projects contained in Part 772 of Title 23 of the Code of Federal Regulations (23CFR772). These regulations describe the methods that must be followed in the evaluation and mitigation of highway traffic noise in Federal-aid and Federal action highway projects. The regulations require each state highway agency to prepare and adopt written guidelines specific to that state which must demonstrate compliance with 23CFR772.

CDOT's Noise Analysis and Abatement Guidelines dated January 15, 2015, see Appendix A, describe CDOT policy and program to implement 23CFR772. These guidelines establish noise abatement criteria, design and cost requirements for noise mitigation. Traffic noise impacts occur when noise levels, for different categories of land uses and activities, meet or exceed the CDOT Noise Abatement Criteria (NAC) shown in **Table 1.** The noise impact threshold for residential (Category B) and recreational outdoor use areas (Category C) receptors is 66 dB(A). The guidelines also state that noise mitigation must be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 dB(A) or more.

Table 1. CDOT Noise Abatement Criteria

Activity Category	Activity Leq(h)*	Evaluation Location	Activity Description
A	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to its intended purpose.
B[1]	66	Exterior	Residential
C[1]	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[1]	71	NA	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	NA	NA	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	NA	NA	Undeveloped lands that are not permitted for development.

[1] Includes undeveloped lands permitted for this activity category.
* Hourly A- weighted sound level in dB(A), reflecting a 1-dB(A) approach value below 23CFR772 values.

CDOT guidelines also outline a method for determining the "feasibility and reasonableness" of proposed mitigation measures. Feasibility issues include:

- Can a 5 dB(A) noise reduction be achieved by constructing a noise barrier or berm?
- Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
- Can a noise barrier or berm less than 20 feet tall be constructed?

Reasonableness issues include:

- Has the design goal of 7 dB(A) noise reduction for mitigation measure been met for at least one impacted receptor?
- Is the Cost Benefit Index below $6,800 per receptor per dB(A) reduced?
- Are more than 50% of benefitted resident/owners in favor of the recommended noise mitigation measure?

This noise analysis complies with regulatory requirements defined in 23CFR772 and CDOT Noise Analysis and Abatement Guidelines approved January 15, 2015 by FHWA.

3.0 NOISE PREDICTION METHODOLOGY

Noise levels were predicted using the TNM 2.5 highway noise level prediction software program developed by the Federal Highway Administration, which is approved for use on CDOT and Federal-aid projects. TNM calculates the hourly noise level at a receptor location based on the following factors:

- the noise emission level of automobiles, medium trucks, heavy trucks, buses, and motorcycles
- the volume and speed of each of these vehicle types on each key roadway
- the relative location of all roadways, receptors, and terrain features
- the type of land cover between each receptor and each roadway

Sub-section 3.1 describes the TNM input data used to predict existing and 2035 design-year conditions. Sub-section 3.2 describes the validation of the model.

The following paragraphs from the Colorado Noise Analysis and Abatement Guidelines explain the technical terminology for the units of measurement that the model uses:

> *Since sound travels in waves, there are also varying frequencies associated with each sound event. The human ear does not respond equally to all frequencies, however, and filtering of these frequencies must be done in order to obtain accurate measurements and descriptions of highway traffic noise, as this noise is comprised of many frequencies. The filtering (weighting of frequencies) of the "A" scale on sound-level meters most closely approximates the average frequency response of the human ear, and is the scale that is used for traffic noise analyses. Decibel units described in this manner are referred to as A-weighted decibels, or dB(A).*
>
> *As sound intensity tends to fluctuate with time, a method is required to describe a noise source, such as a highway, in a steady state condition. The descriptor most commonly used in environmental noise analysis is the equivalent steady state sound level, or Leq. This value is representative of the same amount of acoustic energy that is contained in a time-varying sound measurement over a specified period. For highway traffic noise analyses in Colorado that time period is one hour, and the value then reflects the hourly equivalent sound level, or Leq(h).*

3.1 TNM Model Input and Assumptions

<u>Vehicle Emission Levels</u>
Vehicle emission levels refer to the noise level of vehicles measured at a reference distance and a reference speed. TNM provides separate emission levels for automobiles, medium trucks (trucks with two axles, six tires, and a gross vehicle weight greater than 4500 kg and less than 12,000 kg), and heavy trucks (trucks with three or more axles and a gross vehicle weight greater than 12,000 kg).

<u>Traffic</u>
The loudest hour for noise occurs when the highest volume of traffic is traveling at the highest free flow speed for the particular roadway. This is often <u>not</u> the peak hour, when heavy traffic volumes result in lower speeds. For the C-470 Proposed Action this would be a theoretical point in time when the express, general purpose, and auxiliary lanes are all carrying the highest possible traffic volumes while maintaining free flow speeds. The problem with this scenario is

that demand for express lanes (tolled) does not peak until the general purpose and auxiliary lanes are overly congested. These congested flow rates on the general purpose and auxiliary lanes, while carrying more vehicles, have significantly lower travel speeds and thus do not represent the loudest or worst hours for noise. The same can be said for the other scenario when the general purpose and auxiliary lanes are running at free flow speed with high traffic volumes and express lanes are underutilized.

To replicate the loudest possible noise condition for existing, no-build and the Proposed Action, all lanes of C-470, including cross streets, were modeled with a theoretical maximum traffic volume per lane at the posted speed. This is the worst-case noise scenario for modeling purposes. These traffic volumes, presented in the January 15, 2015 Noise Abatement Guidelines, were developed by CDOT using the Highway Capacity Manual (2000) and TNM.

Truck percentages for the general purpose and auxiliary lanes were developed from June 2014 traffic counts taken at various locations on the corridor. As with many express lane projects, trucks are not expected to use the express lanes. Truckers generally avoid congested peak hours and tolled facilities. For the C-470 noise analysis, one percent trucks were included in the express lanes as a worst-case assumption. The resulting modeled traffic volumes are shown in **Table 2.**

Table 2. Assumed Loudest Hour Traffic

Posted Speed	Volume/Lane/Hour					
	Total	Automobiles	Midsize Trucks	Heavy Trucks	Buses	Motorcycles
General Purpose and Auxiliary Lanes						
65	1800	1,741	36	18	2	2
	100%	97%	2%	1%	0.1%	0.1%
Express Lanes						
65	1800	1,782	12	6	0	0
	100%	99%	0.7%	0.3%	0%	0%

It should be noted that the existing and no-build models result in identical noise level results because of the use of the same maximized worst-case noise and lane geometry.

Terrain

The terrain surrounding C-470 is rolling foothills with both natural and man-made features such as ridges, berms, ponds, and existing noise walls. These features can directly affect the propagation of traffic noise to the surrounding area and receptors. The locations and elevations of the major features along C-470 were determined using the CAD topographic files and included in the TNM model. An example of the modeled terrain features are shown as green lines in the TNM screen shot in **Figure 5**.

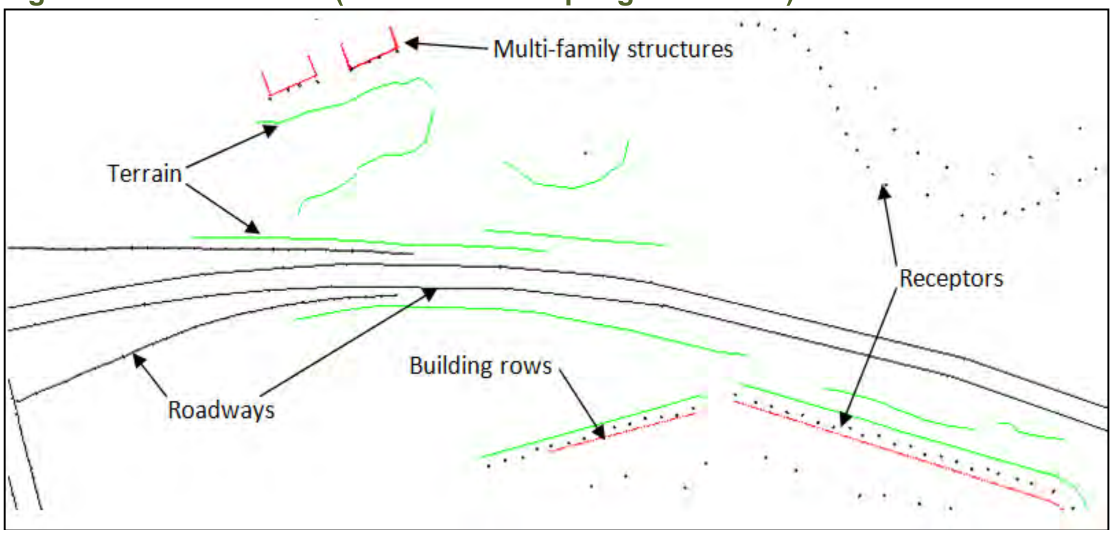
Ground Cover

Throughout the study area, ground cover adjacent to C-470 consists primarily of field grass with sporadic trees.

Buildings

Developed areas along the C-470 corridor have a mix of single and multi-family homes, with commercial properties located primarily around the interchange areas. Closely spaced or large buildings structures impede the transmission of sound from the roadway to the receptors. In TNM, building rows are used to replicate the effect of closely spaced structures and three-sided barriers are used to replicate the effects of large multi-family structures. The locations and elevations of these features was determined using the CAD topographic files and included in the TNM model and are shown in **Figure 5**.

Figure 5. TNM Features (C-470 east of Kipling Boulevard)



Receptors

Modeled receptors, as shown in the TNM screen shot in **Figure 5** and the example location in **Figure 6**, are located in the outdoor use areas of individual residential, commercial, and recreational properties within 500 feet of C-470. All first row homes were modeled as individual receptors. Second and third row homes, depending on modeled noise levels, were either modeled as individual receptors or grouped. Individual 2nd, 3rd, and 4th level residential units with outdoor use areas, such as balconies, were modeled as individual receptors. The locations and elevations of these features was determined using the CAD topographic files and included in the TNM model. Individual receptors locations are identified for each analysis area in Section 4.

Figure 6. Receptor Location Example (Wingate Neighborhood)

Roadways

The existing and proposed roadway alignments, including profiles and pavement width, for C-470 and cross streets, were determined using the CAD roadway design files and topographical survey data and included in the TNM model and are shown in **Figure 5**. Where two lanes are moving traffic in the same direction, e.g. westbound general purpose, the two lanes were combined in a single TNM roadway in the center of the two lanes with the combined traffic. All single travel lanes (e.g., most ramps and auxiliary lanes) were modeled as a single TNM roadway in the center of the lane.

3.2 Validation of Noise Model

The above-described modeling procedures were validated by measuring noise levels at fifteen locations along the corridor and comparing the measured readings with the TNM model predictions for these same locations with the same traffic. These sites are shown in **Figure 7**. Noise levels were measured on July 2^{nd} and 3^{rd}, 2013 which were warm, dry, wind free (less than 10 mph) days, using Quest 2900 integrating/logging level meters. Each meter was field-calibrated before and re-checked after the measurements. At the same time that noise levels were measured, the associated traffic counts, vehicle type data, and average speeds were collected. Noise measurements were collected during off-peak hours to ensure free flow traffic. Two readings were conducted at each site. Modifications to the TNM model were made if required to ensure the model was sufficiently replicating the site conditions and the manner in which sound propagates through the environment.

The measured and predicted noise levels are compared in **Table 3.** The noise model is expected to predict noise levels with an accuracy of ± 3 dB(A), which suggests the model of existing conditions is accurately predicting the noise environment.

Figure 7. Field Measurement Sites

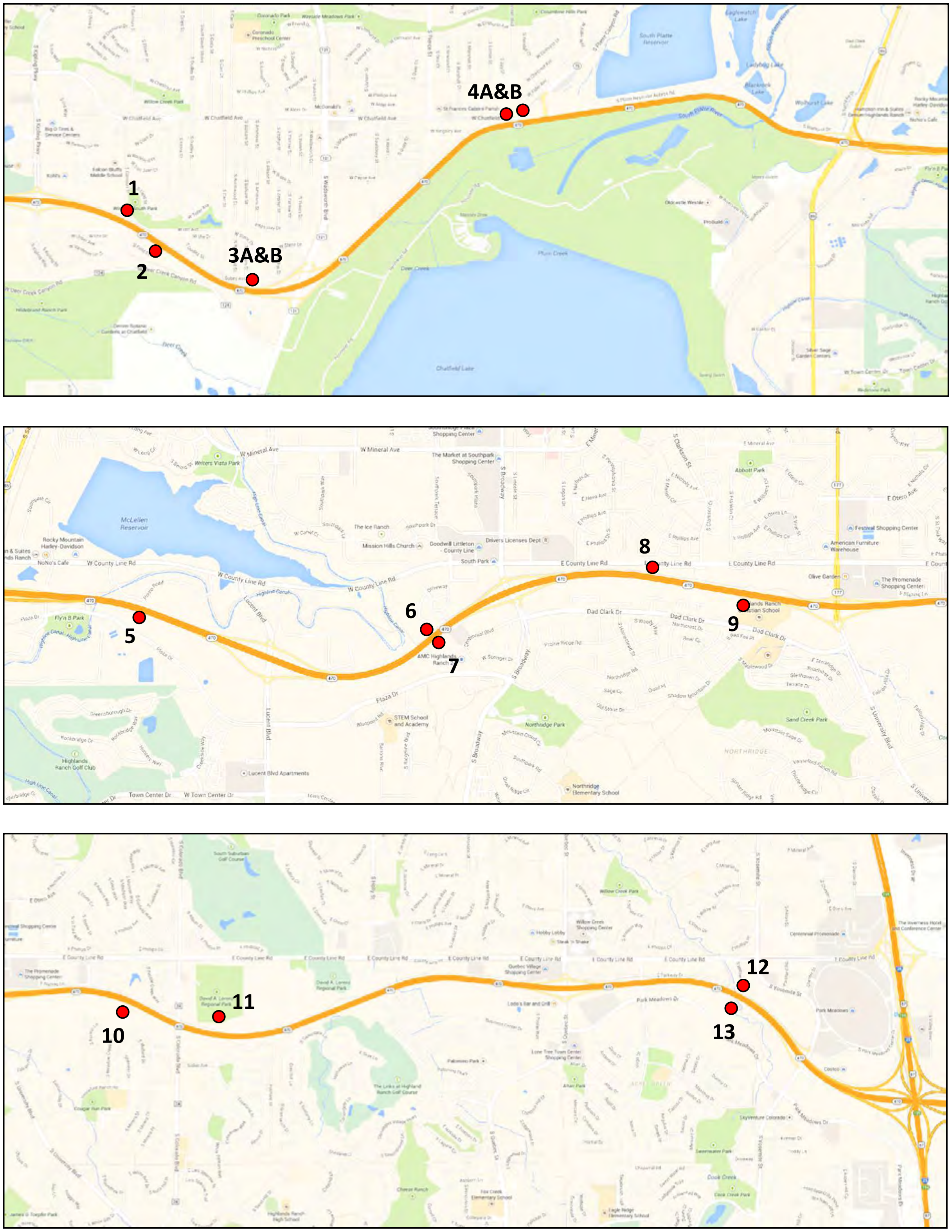


Table 3 - Noise Model Validation

Site #	Location	Field (dB(A) Leq)	Direction of Travel	Traffic (Hourly Equivalent)					Model (dB(A) Leq)	Variance (dB(A) Leq)	Notes/ Issues in Field
				Auto	MT	HT	Mo	Bus			
1 - 1	Deer Creek Park/Pool (east of Kipling)	**74.8**	WB	1,782	54	42	18	6	**73.7**	**1.1**	
			EB	1,212	24	48	6	0			
1 – 2*		**77.9**	WB	1,668	48	60	30	6	**74.0**	**3.9**	Pool traffic & truck
			EB	1,674	12	48	6	0			
2 - 1	Chatfield Bluffs Neighborhood (east of Kipling)	**71.2**	WB	1,782	54	42	18	6	**70.8**	**0.4**	
			EB	1,212	24	48	6	0			
2 - 2		**71.8**	WB	1,668	48	60	30	6	**71.4**	**0.4**	
			EB	1,674	12	48	6	0			
3A - 1	Meadowbrook Home side (N) of berm (west of Wadsworth)	**53.7**	WB	1,278	42	24	0	0	**55.6**	**-1.9**	
			EB	1,506	30	66	6	0			
3A - 2		**55.6**	WB	1,596	48	66	18	0	**56.1**	**-0.5**	
			EB	1,650	6	66	0	0			
3B - 1	Meadowbrook C-470 side (S) of berm (west of Wadsworth)	**73.2**	WB	1,278	42	24	0	0	**71.6**	**1.6**	
			EB	1,506	30	66	6	0			
3B – 2*		**68.2**	WB	1,596	48	66	18	0	**72.3**	**-4.1**	Meter error
			EB	1,650	6	66	0	0			
4A-1	Columbine Hills/Chatfield Ave behind the existing barrier	**59.7**	WB	2,484	72	54	6	0	**61.2**	**-1.5**	
			EB	2,112	36	84	42	24			
			Front	450	6	0	0	0			
4A-2		**59.7**	WB	2,310	66	54	42	0	**61.5**	**-1.8**	
			EB	1,848	6	60	24	0			
			Front	438	0	0	0	0			
4B-1	Columbine Hills/Chatfield Ave	**65.5**	WB	2,484	72	54	6	0	**67.3**	**-1.8**	
			EB	2,112	36	84	42	24			
			Front	450	6	0	0	0			
4B-2		**66.6**	WB	2,310	66	54	42	0	**66.7**	**-0.1**	
			EB	1,848	6	60	24	0			
			Front	438	0	0	0	0			
5-1	Highlands Ranch Sign (Broadway to University)	**69.1**	WB	3,642	90	42	6	6	**67.8**	**1.3**	
			EB	3,444	60	36	18	12			
5-2		**67.4**	WB	3,744	102	18	24	0	**67.8**	**-0.4**	
			EB	3,354	18	54	18	12			
6-1	Bluffs Apts (west of Broadway)	**73.8**	WB	3,108	60	48	18	0	**72.4**	**1.4**	
			EB	2,622	30	36	12	6			
6-2		**74.3**	WB	3,366	66	78	30	18	**73.0**	**1.3**	
			EB	3,354	18	54	18	12			

* Readings 1-2 and 3B-2 varied by greater than 3 dB(A) with the model results and were thus not used in the calibration process.

Table 3 - Noise Model Validation (Cont.)

Site #	Location	Field (dB(A) Leq)	Direction of Travel	Vehicle (Hourly Equivalent)					Model (dB(A) Leq)	Variance (dB(A) Leq)	Notes/ Issues in Field
				Auto	MT	HT	Mo	Bus			
7-1	AMC Theater (west of Broadway)	**72.8**	WB	3,108	60	48	18	0	**74.6**	**-1.8**	
			EB	2,622	30	36	12	6			
7-2		**72.2**	WB	3,366	66	78	30	18	**74.5**	**-2.3**	
			EB	2,616	48	60	36	12			
8-1	U-Stor-it (east of Broadway)	**72**	WB	2,934	36	48	18	0	**74.4**	**-2.4**	
			EB	2,424	102	42	12	6			
8-2		**73.6**	WB	3,168	30	60	24	12	**74.8**	**-1.2**	
			EB	2,796	108	36	18	0			
9-1	Denver Christian HS (west of University)	**72.6**	WB	2,934	36	48	18	0	**74.1**	**-1.5**	
			EB	2,424	102	42	12	6			
9-2		**72.6**	WB	3,168	30	60	24	12	**74.6**	**-2.0**	
			EB	2,796	108	36	18	0			
10-1	Highlands Ranch Sign (University to Colorado)	**58.6**	WB	2,489	65	32	32	0	**60.7**	**-2.1**	
			EB	2,886	30	60	48	18			
10-2		**59.1**	WB	3,126	66	60	12	6	**60.7**	**-1.6**	
			EB	2,760	30	78	12	12			
11-1	David Lorenz Park (east of Colorado)	**63.2**	WB	2,489	65	32	32	0	**64.8**	**-1.6**	
			EB	2,886	30	60	48	18			
11-2		**64.1**	WB	3,126	66	60	12	6	**64.7**	**-0.6**	
			EB	2,760	30	78	12	12			
12-1	Commercial area (N of C-470, west of Park Meadows)	**75**	WB	2,940	108	54	12	6	**74.1**	**0.9**	
			EB	3,576	60	30	24	6			
12-2		**75.1**	WB	3,144	90	48	12	0	**74.2**	**0.9**	
			EB	3,384	90	66	18	6			
13-1	Willow Creek Trail (S of C-470, west of Park Meadows)	**65.1**	WB	2,940	108	54	12	6	**67.2**	**-2.1**	
			EB	3,576	60	30	24	6			
13-1		**65.6**	WB	3,144	90	48	12	0	**67.4**	**-1.8**	
			EB	3,384	90	66	18	6			

4.0 NOISE IMPACT ASSESSMENT AND MITIGATION ANALYSIS

The validated noise models were the basis for the development of the noise prediction models for the 2013 existing, 2035 No Action, and 2035 Proposed Action traffic scenarios. These models were then used to predict noise levels for all receptor locations.

4.1 Noise Impact Assessment

Traffic noise impacts occur when noise levels, for different categories of land uses and activities, meet or exceed the CDOT Noise Abatement Criteria (NAC) shown in **Table 1.** The noise impact threshold for residential (Category B) and recreational outdoor use areas (Category C) receptors is 66 dB(A). The guidelines also state that noise mitigation must be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 dB(A) or more.

4.2 Mitigation Analysis

Any and all receptors which were determined to be impacted by noise must be evaluated for traffic noise mitigation. This requires that the overall social, economic, and environmental effects of the mitigation be evaluated against the benefits. When determining mitigation measures, primary consideration is to be given to exterior areas surrounding residential areas or areas of frequent human use for other uses such as parks and commercial districts where a reduced noise level would be of benefit. All feasible and reasonable mitigation measures are required to be included in the highway project.

The following are common mitigation measures that may be incorporated in highway projects to reduce traffic noise impacts.

- Traffic management measures, such as lane-use restrictions, designated truck routes, and speed limit reductions. While lesser speeds do decrease noise levels, it generally will take a reduction in speed of approximately 20 miles per hour to achieve a readily perceptible (5 dB(A)) reduction of noise at its source
- Alteration of horizontal and vertical alignments to reduce noise impacts. Acquisition of undeveloped land for buffer zone creation. This is not an option as the area is a highly developed corridor with residential uses adjacent to the roadway.
- Noise insulation, but for NAC Activity Category D structures only.
- Construction of noise barriers or earthen berms within highway right-of-way is the most common mitigation measure employed by CDOT and will be evaluated for this project.

CDOT guidelines outline a method for determining the “feasibility and reasonableness” of constructing an acoustically effective noise barrier at a particular site. Feasibility considerations include:

- Can a 5 dB(A) noise reduction be achieved by constructing a noise barrier or berm?
- Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
- Can a noise barrier or berm less than 20 feet tall be constructed?

Reasonableness issues include:

- Is the design goal of 7 dB(A) noise reduction for mitigation measure met for at least one impacted receptor?
- Is the Cost Benefit Index below $6,800 per receptor per dB(A)?

- Are more than 50% of benefitted resident/owners in favor of the recommended noise mitigation measure?

The cost benefit index is not intended to function as an accurate cost itemization for the design and construction of a noise barrier, but rather to provide a consistent level of consideration that will be used for CDOT noise mitigation decision-making. For purposes of the mitigation evaluation, the unit cost for a generic wall, as prescribed by CDOT, is $45 per exposed square foot, which approximates the typical costs in construction of a standard concrete/masonry barrier that does not require special site considerations. This cost is based on an average of 2005 to 2009 noise wall square footage costs collected from CDOT cost tabulations. This cost does not include engineering design, right-of-way acquisition, and utility mitigations.

Communities, recreational resources, and noise sensitive commercial properties within 500 feet of C-470 were analyzed separately for noise impact and mitigation. The areas are as follows; with residential areas in order from west to east:

4.3 Kipling Parkway to Wadsworth Boulevard
  - Redstone Ranch
  - Chatfield Bluffs
  - Wingate
  - Meadowbrook

4.4 Wadsworth Boulevard to Santa Fe Drive
  - Chatfield Avenue
  - Columbine Hills
  - Wolhurst

4.5 Santa Fe Drive to Broadway
  - Littleton Commons
  - Villas at Verona
  - Bluffs at Highlands Ranch

4.6 Broadway to University Boulevard
  - Township at Highlands Ranch
  - Highlands Ranch Dad Clark

4.7 University Boulevard to Colorado Boulevard
  - Highlands Ranch Venneford Ranch
  - Autumn Chase, Copper Canyon and Canyon Ranch

4.8 Colorado Boulevard to Quebec Street
  - Shadow Canyon
  - Gleneagles Village
  - Palomino Park

4.9 I-25 Crest

4.10 Recreational Resources

4.11 Noise Sensitive Commercial Properties

The analysis description for each area includes:

- Map of receptor locations,
- Screen shot of the TNM model,
- Predicted existing, no build, and 2035 Proposed Action noise levels,
- Change in noise levels between the existing and the Proposed Action,
- Determination of whether predicted noise levels equal or exceed CDOT's abatement criteria, as presented in Section 2.0 Applicable Noise Standards,
- Noise mitigation analysis with feasible and reasonable evaluation (as presented in Section 2.0, Applicable Noise Standards), and
- Mitigation recommendation.

4.3 Kipling Parkway to Wadsworth Boulevard

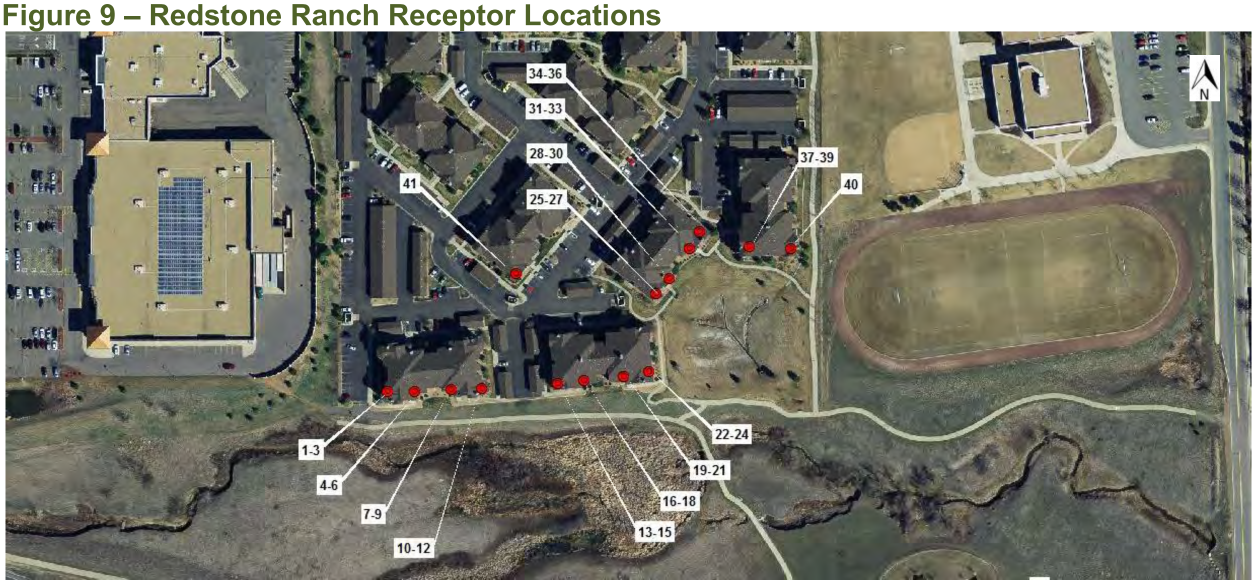
The Kipling Parkway to Wadsworth Boulevard area includes the communities of Redstone Ranch, Chatfield Bluffs, Wingate and Meadowbrook, as shown in **Figure 8**.

Figure 8 – Kipling Parkway to Wadsworth Boulevard

Redstone Ranch

Redstone Ranch is a multi-storied residential complex north of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 9. N**oise levels were predicted at each of 41 receptor locations for both existing and Proposed Action conditions and are shown in **Table 4.**

Figure 9 – Redstone Ranch Receptor Locations



Note: Impacted receptors are shaded green

Table 4 – Redstone Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	58.0	58.4	0.4	No	No
2	Residential	B	60.9	61.3	0.4	No	No
3	Residential	B	62.9	63.0	0.1	No	No
4	Residential	B	57.9	58.3	0.4	No	No
5	Residential	B	60.6	61.0	0.4	No	No
6	Residential	B	62.2	62.5	0.3	No	No
7	Residential	B	58.0	58.5	0.5	No	No
8	Residential	B	60.5	61.1	0.6	No	No
9	Residential	B	62.2	62.5	0.3	No	No
10	Residential	B	57.9	58.5	0.6	No	No
11	Residential	B	60.3	61.0	0.7	No	No
12	Residential	B	61.6	62.4	0.8	No	No
13	Residential	B	57.7	58.0	0.3	No	No
14	Residential	B	60.2	61.0	0.8	No	No
15	Residential	B	61.2	62.3	1.1	No	No
16	Residential	B	57.6	57.9	0.3	No	No
17	Residential	B	60.1	61.1	1.0	No	No
18	Residential	B	61.0	62.4	1.4	No	No
19	Residential	B	57.3	57.8	0.5	No	No
20	Residential	B	60.1	60.9	0.8	No	No
21	Residential	B	61.0	62.3	1.3	No	No
22	Residential	B	56.0	57.1	1.1	No	No
23	Residential	B	59.6	60.5	0.9	No	No
24	Residential	B	60.8	62.1	1.3	No	No
25	Residential	B	51.4	53.4	2.0	No	No
26	Residential	B	56.0	57.2	1.2	No	No
27	Residential	B	58.4	59.7	1.3	No	No
28	Residential	B	51.5	53.2	1.7	No	No
29	Residential	B	55.7	57.0	1.3	No	No
30	Residential	B	58.3	59.5	1.2	No	No
31	Residential	B	51.5	53.2	1.7	No	No
32	Residential	B	55.4	56.8	1.4	No	No
33	Residential	B	58.3	59.3	1.0	No	No
34	Residential	B	51.6	53.1	1.5	No	No
35	Residential	B	55.3	56.6	1.3	No	No
36	Residential	B	58.2	59.0	0.8	No	No
37	Residential	B	51.8	53.5	1.7	No	No
38	Residential	B	55.4	57.0	1.6	No	No
39	Residential	B	58.4	59.3	0.9	No	No
40	Residential	B	51.9	53.9	2.0	No	No
41	Residential	B	52.5	53.0	0.5	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. This table contains no impacted receptors

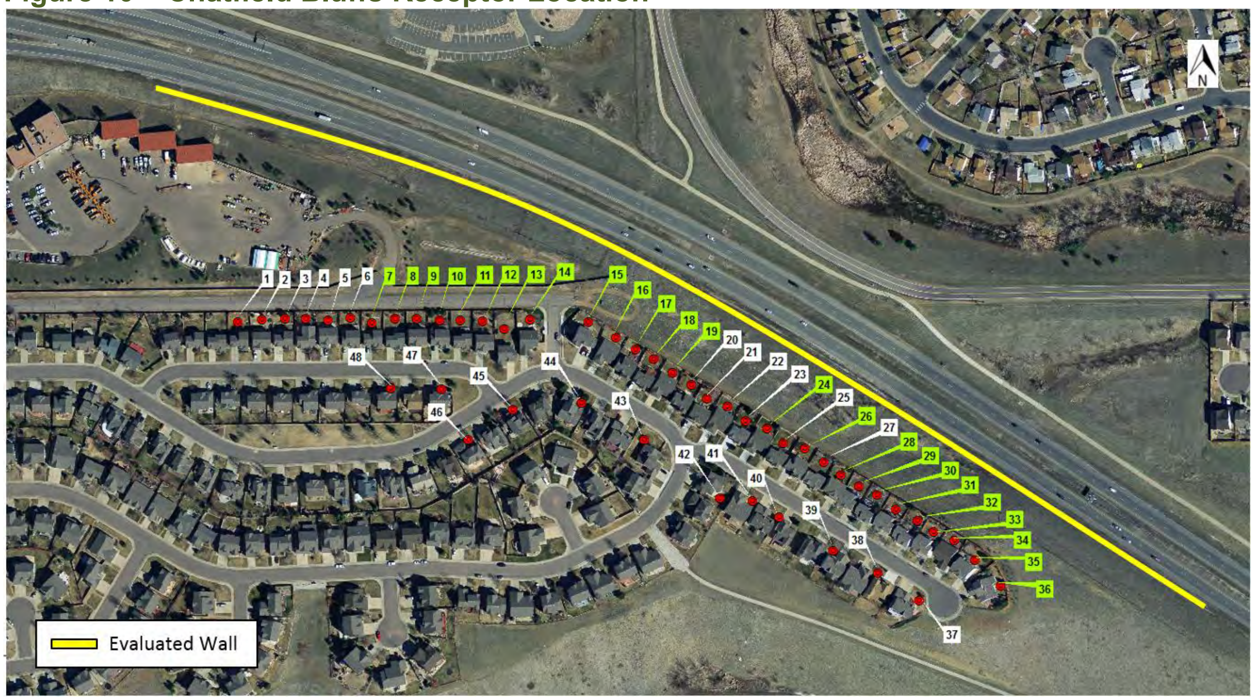
Redstone Ranch Noise Impact Assessment

Table 4 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. No receptors equal or exceed CDOT impact criteria for residential properties. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation.

Chatfield Bluffs

Chatfield Bluffs is a single-family residential development south of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 10. Figure 11** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 5.**

Figure 10 – Chatfield Bluffs Receptor Location



Note: Impacted receptors are shaded green

Figure 11 – Chatfield Bluffs TNM Proposed Action Model View

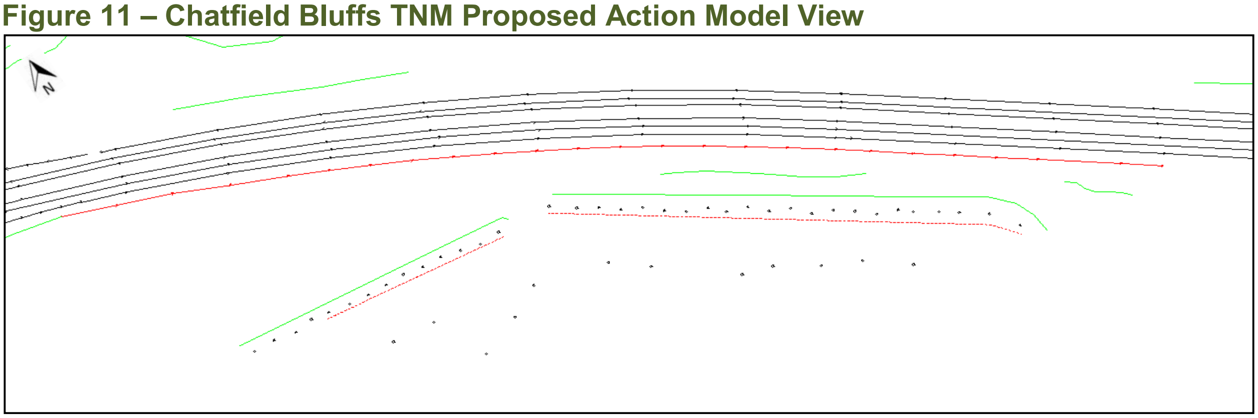


Table 5 – Chatfield Bluffs Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	60.9	63.8	2.9	No	No
2	Residential	B	60.9	64.2	3.3	No	No
3	Residential	B	61.2	64.1	2.9	No	No
4	Residential	B	61.5	65.1	3.6	No	No
5	Residential	B	61.4	65.1	3.7	No	No
6	Residential	B	61.5	65.2	3.7	No	No
7	Residential	B	61.7	65.5	3.8	Yes	No
8	Residential	B	61.8	65.9	4.1	Yes	No
9	Residential	B	62.1	66.9	4.8	Yes	No
10	Residential	B	62.2	67.0	4.8	Yes	No
11	Residential	B	62.3	67.6	5.3	Yes	No
12	Residential	B	62.6	68.0	5.4	Yes	No
13	Residential	B	62.7	68.4	5.7	Yes	No
14	Residential	B	64.3	70.1	5.8	Yes	No
15	Residential	B	69.2	73.3	4.1	Yes	No
16	Residential	B	68.2	72.6	4.4	Yes	No
17	Residential	B	67.8	72.2	4.4	Yes	No
18	Residential	B	64.8	69.5	4.7	Yes	No
19	Residential	B	64.7	68.8	4.1	Yes	No
20	Residential	B	62.1	65.2	3.1	No	No
21	Residential	B	61.9	64.2	2.3	No	No
22	Residential	B	63.0	65.1	2.1	No	No
23	Residential	B	61.7	64.1	2.4	No	No
24	Residential	B	64.3	66.4	2.1	Yes	No
25	Residential	B	62.6	64.9	2.3	No	No
26	Residential	B	64.7	67.2	2.5	Yes	No
27	Residential	B	62.7	65.4	2.7	No	No
28	Residential	B	67.9	71.2	3.3	Yes	No
29	Residential	B	68.8	71.9	3.1	Yes	No
30	Residential	B	67.8	71.2	3.4	Yes	No
31	Residential	B	69.5	72.4	2.9	Yes	No
32	Residential	B	68.7	71.9	3.2	Yes	No
33	Residential	B	68.3	71.4	3.1	Yes	No
34	Residential	B	66.6	69.9	3.3	Yes	No
35	Residential	B	65.0	69.1	4.1	Yes	No
36	Residential	B	64.2	68.1	3.9	Yes	No
37	Residential	B	54.6	57.9	3.3	No	No
38	Residential	B	52.5	55.2	2.7	No	No
39	Residential	B	51.9	54.7	2.8	No	No
40	Residential	B	51.2	54.5	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 5 – Chatfield Bluffs Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
41	Residential	B	52.3	55.7	3.4	No	No
42	Residential	B	54.9	58.8	3.9	No	No
43	Residential	B	56.7	61.2	4.5	No	No
44	Residential	B	57.1	62.3	5.2	No	No
45	Residential	B	56.6	60.4	3.8	No	No
46	Residential	B	55.1	58.8	3.7	No	No
47	Residential	B	55.7	58.9	3.2	No	No
48	Residential	B	55.4	58.2	2.8	No	No
41	Residential	B	52.3	55.7	3.4	No	No
42	Residential	B	54.9	58.8	3.9	No	No
43	Residential	B	56.7	61.2	4.5	No	No
44	Residential	B	57.1	62.3	5.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Chatfield Bluffs Noise Impact Assessment

Table 5 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 10** and **Table 5.** Twenty-four receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 73.3 dB(A) at receptor 15. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Chatfield Bluffs Noise Mitigation Assessment

A 2,650 foot long noise wall was modeled in C-470 right-of-way with heights up to 20 feet. The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 2,500 feet long averaging and 18.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 10 dB(A) exceeding the 7 dB(A) design goal reduction. However, several locations, such as receptors 24 and 25, were unable to receive the minimal 5 dB(A) reduction with a 20 foot tall barrier. The insertion losses are presented in Table 5. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$2,081,250	(Cost of wall = 2,500 feet long x 18.5 feet tall x $45/sf = $2,081,250)
÷ 165.8	(Total dB(A) reduction for the 24 receptors with equal to or greater than 5 dB(A) reduction)
$12,553	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 6 – Chatfield Bluffs Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
7	Residential	B	65.5	60.4	5.1
8	Residential	B	65.9	60.2	5.7
9	Residential	B	66.9	60.5	6.4
10	Residential	B	67.0	60.3	6.7
11	Residential	B	67.6	60.4	7.2
12	Residential	B	68.0	60.4	7.6
13	Residential	B	68.4	60.5	7.9
14	Residential	B	70.1	61.1	9.0
15	Residential	B	73.3	63.2	10.1
16	Residential	B	72.6	62.4	10.2
17	Residential	B	72.2	62.4	9.8
18	Residential	B	69.5	62.0	7.5
19	Residential	B	68.8	62.6	6.2
24	Residential	B	66.4	63.2	3.2
26	Residential	B	67.2	62.7	4.5
28	Residential	B	71.2	62.6	8.6
29	Residential	B	71.9	62.6	9.3
30	Residential	B	71.2	62.5	8.7
31	Residential	B	72.4	63.6	8.8
32	Residential	B	71.9	63.7	8.2
33	Residential	B	71.4	64.2	7.2
34	Residential	B	69.9	64.4	5.5
35	Residential	B	69.1	64.1	5.0
36	Residential	B	68.1	63.0	5.1
				Total dB(A) Reduction (5dB(A) or greater)	**165.8**

In summary, the Chatfield Bluffs area has twenty-four impacted receptors that could benefit from noise mitigation. However, the CBI is above CDOT's cost threshold and mitigation is not recommended.

Wingate

Wingate is a single-family residential development north of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Receptors were developed for each front and select second row outdoor use area as shown in **Figure 12.** Existing and future noise levels are presented in **Table 7.**

Wingate Noise Impact Assessment

Using the above described prediction methodology, noise levels were predicted at each front row and selected second row outdoor use areas as shown in **Figure 12** for both existing and Proposed Action conditions. **Table 7** shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. The highest predicted future noise level is 65.1 dB(A) at receptor 11. No receptors equal or exceed CDOT impact criteria for residential properties. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation.

Figure 12 – Wingate Receptor Locations

Note: Impacted receptors are shaded green

Table 7 – Wingate Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	54.2	57.3	3.1	No	No
2	Residential	B	54.9	58.0	3.1	No	No
3	Residential	B	55.6	58.9	3.3	No	No
4	Residential	B	56.4	59.7	3.3	No	No
5	Residential	B	57.5	60.3	2.8	No	No
6	Residential	B	58.4	61.6	3.2	No	No
7	Residential	B	59.1	63.0	3.9	No	No
8	Residential	B	59.9	63.7	3.8	No	No
9	Residential	B	60.4	64.0	3.6	No	No
10	Residential	B	61.2	64.8	3.6	No	No
11	Residential	B	61.2	65.1	3.9	No	No
12	Residential	B	60.8	64.0	3.2	No	No
13	Residential	B	60.5	63.9	3.4	No	No
14	Residential	B	59.5	63.0	3.5	No	No
15	Residential	B	59.0	62.2	3.2	No	No
16	Residential	B	57.8	61.4	3.6	No	No
17	Residential	B	56.6	60.4	3.8	No	No
18	Residential	B	55.5	59.5	4.0	No	No
19	Residential	B	54.9	58.8	3.9	No	No
20	Residential	B	54.5	58.4	3.9	No	No
21	Residential	B	54.2	58.2	4.0	No	No
22	Residential	B	53.8	57.8	4.0	No	No
23	Residential	B	53.7	57.8	4.1	No	No
24	Residential	B	53.8	58.0	4.2	No	No
25	Residential	B	52.4	57.4	5.0	No	No
26	Residential	B	52.3	57.2	4.9	No	No
27	Residential	B	52.8	57.4	4.6	No	No
28	Residential	B	53.7	57.7	4.0	No	No
29	Residential	B	55.3	59.4	4.1	No	No
30	Residential	B	57.4	61.1	3.7	No	No
31	Residential	B	58.1	61.8	3.7	No	No
32	Residential	B	58.8	62.4	3.6	No	No
33	Residential	B	58.7	62.0	3.3	No	No
34	Residential	B	57.3	60.3	3.0	No	No
35	Residential	B	55.4	58.3	2.9	No	No
36	Residential	B	60.9	57.0	-3.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. This table contains no impacted receptors

Meadowbrook

Meadowbrook is a single-family residential development north of C-470 between Wadsworth Boulevard and Kipling Parkway as shown in **Figure 8**. Two large berms and existing noise walls along C-470 provide significant traffic noise attenuation today and into the future. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and selected second row outdoor use areas as shown in **Figure 13. Figure 14** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 8.**

Figure 13 – Meadowbrook Receptor Locations

Note: Impacted receptors are shaded green

Figure 14 – Meadowbrook TNM Proposed Action Model View

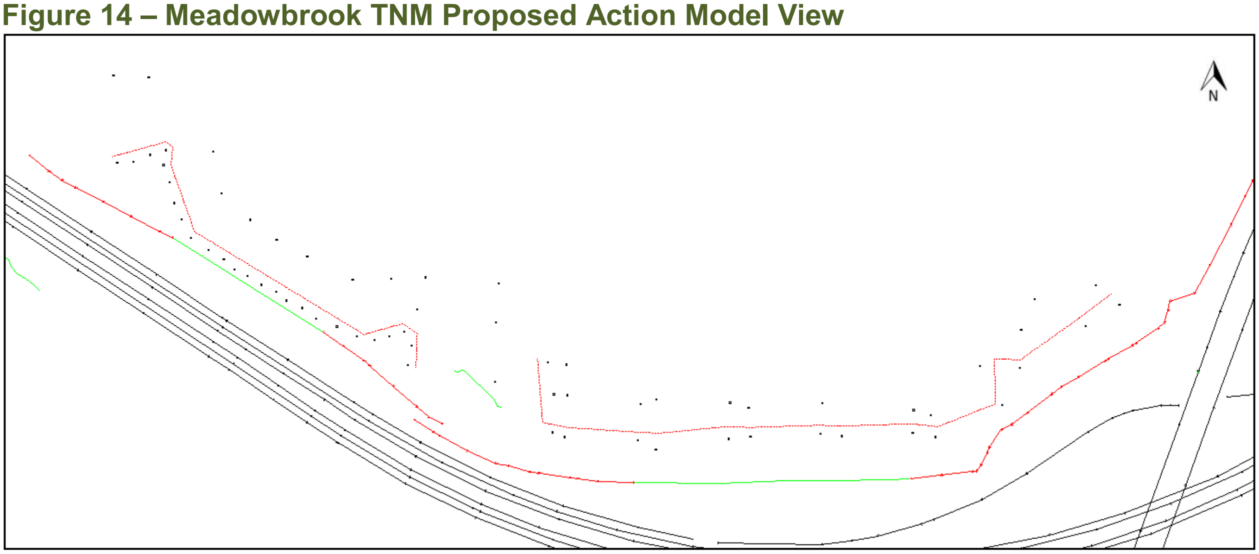


Table 8 – Meadowbrook Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	57.2	59.2	2.0	No	No
2	Residential	B	64.5	67.0	2.5	Yes	No
3	Residential	B	61.0	62.9	1.9	No	No
4	Residential	B	58.6	60.7	2.1	No	No
5	Residential	B	56.6	59.0	2.4	No	No
6	Residential	B	56.1	58.5	2.4	No	No
7	Residential	B	56.3	59.1	2.8	No	No
8	Residential	B	56.4	59.4	3.0	No	No
9	Residential	B	57.7	61.5	3.8	No	No
10	Residential	B	58.7	63.4	4.7	No	No
11	Residential	B	64.6	69.7	5.1	Yes	No
12	Residential	B	66.5	70.9	4.4	Yes	No
13	Residential	B	65.1	69.8	4.7	Yes	No
14	Residential	B	68.0	71.6	3.6	Yes	No
15	Residential	B	61.1	65.9	4.8	Yes	No
16	Residential	B	58.4	63.6	5.2	No	No
17	Residential	B	61.2	65.9	4.7	Yes	No
18	Residential	B	62.4	66.7	4.3	Yes	No
19	Residential	B	62.6	67.3	4.7	Yes	No
20	Residential	B	59.8	63.2	3.4	No	No
21	Residential	B	60.2	63.4	3.2	No	No
22	Residential	B	59.0	62.2	3.2	No	No
23	Residential	B	58.5	61.7	3.2	No	No
24	Residential	B	57.6	61.1	3.5	No	No
25	Residential	B	57.8	61.2	3.4	No	No
26	Residential	B	60.0	63.5	3.5	No	No
27	Residential	B	59.7	63.1	3.4	No	No
28	Residential	B	56.6	60.3	3.7	No	No
29	Residential	B	56.7	60.1	3.4	No	No
30	Residential	B	57.4	61.2	3.8	No	No
31	Residential	B	59.7	63.1	3.4	No	No
32	Residential	B	60.6	63.5	2.9	No	No
33	Residential	B	59.9	64.3	4.4	No	No
34	Residential	B	60.3	64.7	4.4	No	No
35	Residential	B	59.0	63.6	4.6	No	No
36	Residential	B	60.4	65.3	4.9	No	No
37	Residential	B	63.2	68.0	4.8	Yes	No
38	Residential	B	66.0	70.2	4.2	Yes	No
39	Residential	B	59.8	64.1	4.3	No	No
40	Residential	B	57.9	62.2	4.3	No	No
41	Residential	B	55.8	59.1	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 8 – Meadowbrook Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
42	Residential	B	56.6	60.6	4.0	No	No
43	Residential	B	57.2	61.0	3.8	No	No
44	Residential	B	56.6	60.1	3.5	No	No
45	Residential	B	56.6	59.7	3.1	No	No
46	Residential	B	55.4	58.6	3.2	No	No
47	Residential	B	54.9	58.6	3.7	No	No
48	Residential	B	55.5	60.3	4.8	No	No
49	Residential	B	58.0	62.9	4.9	No	No
50	Residential	B	55.1	59.1	4.0	No	No
51	Residential	B	56.6	61.5	4.9	No	No
52	Residential	B	60.5	65.3	4.8	No	No
53	Residential	B	63.9	68.1	4.2	Yes	No
54	Residential	B	62.3	67.2	4.9	Yes	No
55	Residential	B	57.7	61.6	3.9	No	No
56	Residential	B	57.5	61.0	3.5	No	No
57	Residential	B	56.8	59.6	2.8	No	No
58	Residential	B	56.8	59.4	2.6	No	No
59	Residential	B	56.0	58.2	2.2	No	No
60	Residential	B	59.6	62.4	2.8	No	No
61	Residential	B	61.4	64.0	2.6	No	No
62	Residential	B	61.4	62.6	1.2	No	No
63	Residential	B	58.8	60.7	1.9	No	No
64	Residential	B	58.0	60.8	2.8	No	No
65	Residential	B	55.5	57.3	1.8	No	No
66	Residential	B	55.4	57.3	1.9	No	No
67	Residential	B	57.9	59.6	1.7	No	No
68	Residential	B	60.4	65.3	4.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Meadowbrook Noise Impact Assessment

Table 8 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 10** and **Table 5.** Thirteen receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.6 dB(A) at receptor 14. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Meadowbrook Noise Mitigation Assessment

The impacted receptors were grouped in three distinct areas: the western area beyond the existing rise in the topography; the central area between the western rise in topography and the eastern berm; and the eastern area of the community near Wadsworth Avenue as shown in **Figure 13.** Walls up to 20 feet tall were modeled in C-470 right-of-way for each area.

Western - For the western end of the community, only receptors M37 and M38 are impacted. The optimal wall providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 485 feet long and averaging 18.4 feet tall. This wall provided over 5 dB(A) in noise reduction and did achieve the design goal of 7 dB(A) of noise reduction for one receptor. The insertion losses are presented in **Table 9**. No other receptors received 5 dB(A) of noise reduction. CDOT has set a noise barrier cost of $45 per square foot for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$401,580	(Cost of wall = 485 feet long x 18.4 feet tall x $45/sf = $401,580)
÷ 18.9	(Total dB(A) reduction for the 3 receptors with equal to or greater than 5 dB(A) reduction)
$21,248	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Central – A combination of overlapping walls, to accommodate the trail, and extension of the existing noise barrier were modeled in C-470 right-of-way with heights up to 20 feet. The optimal wall configuration, providing the greatest noise reduction for impacted receptors per square foot of wall, was a combination of a 485 long wall with an average height of 13.5 feet and 340 foot long wall with an average height of 19.2, and a 410 foot long extension of the existing wall with and average extension of 8 feet. With this optimized wall is predicted to provided impacted properties with at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 8.2 dB(A), achieving the design goal of 7 dB(A). The insertion losses are presented in **Table 9**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$294,638	(Cost of 1st segment of combined wall = 485 feet long x 13.5 feet tall x $45/sf = $294,638)
$293,760	(Cost of 2nd segment of combined wall = 340 feet long x 19.2 feet tall x $45/sf = $293,760)
$147,600	(Cost of 3rd segment of combined wall = 410 feet long x 8 feet tall x $45/sf = $147,600)
$735,998	Total
÷ 58.3	(Total dB(A) reduction for all receptors with equal to or greater than 5 dB(A) reduction)
$12,624	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Eastern - For the eastern end of the community the only impacted receptor is M2. The optimal wall providing the greatest noise reduction was a combination of filling in the gap between two existing noise walls (68 foot long by 12 feet high) and an extension up of on existing wall (400 feet long by 10 feet high). This combination of walls provided 7.0 dB(A) in noise reduction, achieving the design goal of 7 dB(A) of noise reduction. The insertion loss is presented in **Table 9**. No other receptors received 5 dB(A) of noise reduction. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$ 36,720	(Cost of gap segment of combined wall = 68 feet long x 12 feet tall x $45/sf = $36,720)
$180,000	(Cost of extension segment of combined wall = 400 feet long x 10 feet tall x $45/sf = $180,000)
$216,720	Total
÷ 7.0	(Total dB(A) reduction for all receptors with equal to or greater than 5 dB(A) reduction)
$ 30,960	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 9 – Meadowbrook Impacted Receptors with Mitigation

Impacted Receptors				Modeled Noise Levels (dB(A))		
ID No.		Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Western	36	Residential	B	65.3	59.8	5.5
	37	Residential	B	68.0	61.6	6.4
	38	Residential	B	70.2	63.2	7.0
	Total dB(A) Reduction (5dB(A) or greater)					**18.9**
Central	11	Residential	B	69.7	63.3	6.4
	12	Residential	B	70.9	64.2	6.7
	13	Residential	B	69.8	63.5	6.3
	14	Residential	B	71.6	63.4	8.2
	15	Residential	B	65.9	60.8	5.1
	17	Residential	B	65.9	60.8	5.1
	18	Residential	B	66.7	61.6	5.1
	19	Residential	B	67.3	62.3	5.0
	53	Residential	B	68.1	62.8	5.3
	54	Residential	B	67.2	62.1	5.1
	Total dB(A) Reduction (5dB(A) or greater)					**58.3**
Eastern	2	Residential	B	67.0	60.0	7.0
	Total dB(A) Reduction (5dB(A) or greater)					**7.0**

In summary, the Meadowbrook area has 14 receptors that could benefit from noise mitigation. However, the CBI is above CDOT's cost threshold and mitigation is not recommended.

4.4 Wadsworth Boulevard to Santa Fe Drive

The Wadsworth Boulevard to Santa Fe area includes the communities of Chatfield Avenue, Columbine Hills and Wolhurst as shown in **Figure 15**.

Figure 15 – Wadsworth Boulevard to Santa Fe Drive

Chatfield Avenue

Chatfield Avenue is a single family residential development north of C-470 between Santa Fe Drive and Wadsworth Boulevard as shown in **Figure 15**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 16. Figure 17** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 10.**

Figure 16 – Chatfield Avenue Receptor Locations

Note: Impacted receptors are shaded green

Figure 17 – Chatfield Avenue TNM Proposed Action Model View

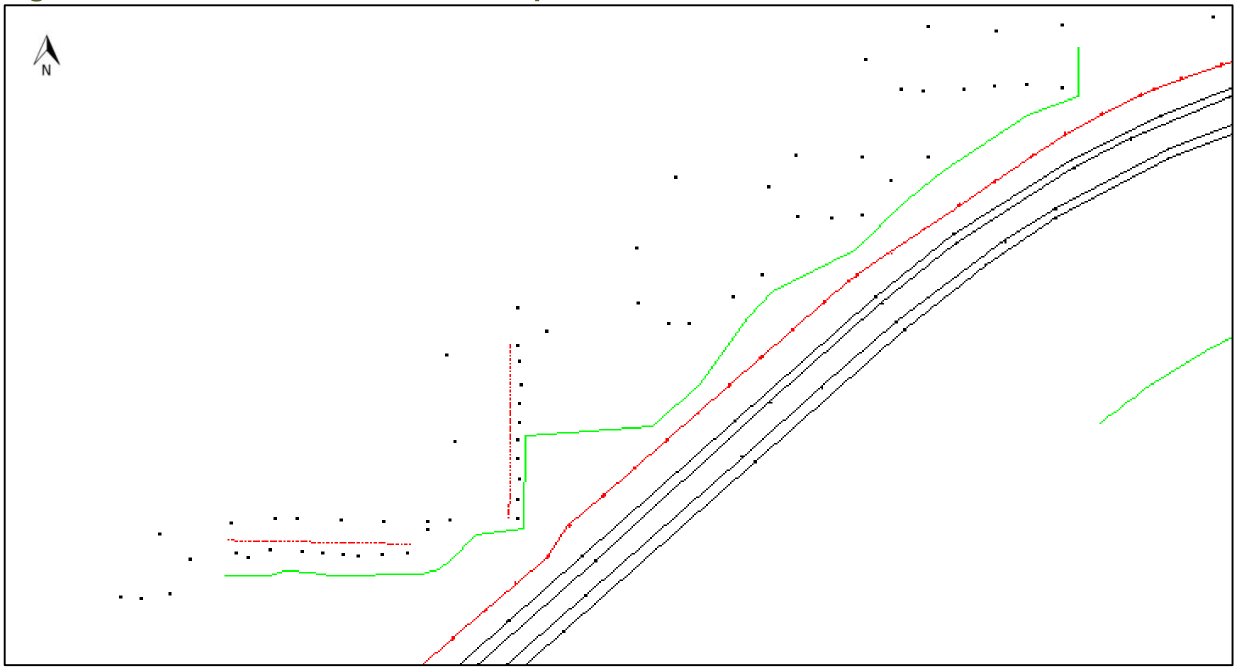


Table 10 – Chatfield Avenue Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	56.7	57.8	1.1	No	No
2	Residential	B	56.0	57.1	1.1	No	No
3	Residential	B	55.6	56.6	1.0	No	No
4	Residential	B	55.2	56.3	1.1	No	No
5	Residential	B	54.7	55.9	1.2	No	No
6	Residential	B	54.5	55.7	1.2	No	No
7	Residential	B	54.7	56.2	1.5	No	No
8	Residential	B	55.5	57.2	1.7	No	No
9	Residential	B	57.1	59.2	2.1	No	No
10	Residential	B	56.4	58.6	2.2	No	No
11	Residential	B	55.8	58.1	2.3	No	No
12	Residential	B	58.5	61.0	2.5	No	No
13	Residential	B	60.1	62.8	2.7	No	No
14	Residential	B	59.0	61.7	2.7	No	No
15	Residential	B	58.6	61.3	2.7	No	No
16	Residential	B	57.9	60.4	2.5	No	No
17	Residential	B	59.4	61.5	2.1	No	No
18	Residential	B	59.5	61.7	2.2	No	No
19	Residential	B	60.2	62.4	2.2	No	No
20	Residential	B	61.0	63.6	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 10 – Chatfield Avenue Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
21	Residential	B	61.8	64.7	2.9	No	No
22	Residential	B	62.5	65.8	3.3	Yes	No
23	Residential	B	63.2	66.6	3.4	Yes	No
24	Residential	B	63.5	67.0	3.5	Yes	No
25	Residential	B	64.8	68.7	3.9	Yes	No
26	Residential	B	66.9	70.4	3.5	Yes	No
27	Residential	B	68.5	71.7	3.2	Yes	No
28	Residential	B	64.6	68.3	3.7	Yes	No
29	Residential	B	63.5	67.8	4.3	Yes	No
30	Residential	B	64.4	68.2	3.8	Yes	No
31	Residential	B	62.8	66.9	4.1	Yes	No
32	Residential	B	61.7	65.6	3.9	Yes	No
33	Residential	B	61.3	64.9	3.6	No	No
34	Residential	B	60.7	63.9	3.2	No	No
35	Residential	B	60.4	63.0	2.6	No	No
36	Residential	B	60.0	61.8	1.8	No	No
37	Residential	B	59.5	61.0	1.5	No	No
38	Residential	B	59.3	60.6	1.3	No	No
39	Residential	B	58.3	59.4	1.1	No	No
40	Residential	B	58.9	59.5	0.6	No	No
41	Residential	B	58.3	58.9	0.6	No	No
42	Residential	B	57.6	58.6	1.0	No	No
43	Residential	B	56.5	58.3	1.8	No	No
44	Residential	B	62.0	63.5	1.5	No	No
45	Residential	B	62.7	64.5	1.8	No	No
46	Residential	B	63.1	64.9	1.8	No	No
47	Residential	B	63.9	65.9	2.0	No	No
48	Residential	B	64.4	67.0	2.6	Yes	No
49	Residential	B	63.7	67.7	4.0	Yes	No
50	Residential	B	61.9	64.8	2.9	No	No
51	Residential	B	59.4	62.2	2.8	No	No
52	Residential	B	57.6	59.8	2.2	No	No
53	Residential	B	57.0	59.1	2.1	No	No
54	Residential	B	53.4	55.6	2.2	No	No
55	Residential	B	54.1	56.4	2.3	No	No
56	Residential	B	53.0	55.0	2.0	No	No
57	Residential	B	54.1	55.9	1.8	No	No
58	Residential	B	55.7	56.5	0.8	No	No
59	Residential	B	60.8	61.0	0.2	No	No
60	Residential	B	60.1	60.5	0.4	No	No
61	Residential	B	61.3	61.7	0.4	No	No
62	Residential	B	63.7	64.1	0.4	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Chatfield Avenue Noise Impact Assessment

Table 10 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 15** and **Table 10.** Fourteen receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.7 dB(A) at receptor 27. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Chatfield Avenue Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 900 feet long and averaging 13.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with two achieving or exceeding the 7 dB(A) design goal. However, several locations, such as receptors 22 and 47, were unable to receive the minimal 5 dB(A) reduction with the optimal wall. The insertion losses are presented in Table 11. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$546,750	(Cost of wall = 900 feet long x 13.5 feet tall x $45/sf = $546,750)
÷ 83.1	(Total dB(A) reduction for the 14 receptors with equal to or greater than 5 dB(A) reduction)
$6,579	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 11 – Chatfield Avenue Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
22	Residential	B	65.8	61.3	4.5
23	Residential	B	66.6	61.5	5.1
24	Residential	B	67.0	61.3	5.7
25	Residential	B	68.7	62.1	6.6
26	Residential	B	70.4	63.4	7.0
27	Residential	B	71.7	63.3	8.4
28	Residential	B	68.3	61.6	6.7
29	Residential	B	67.8	61.0	6.8
30	Residential	B	68.2	62.0	6.2
31	Residential	B	66.9	61.1	5.8
32	Residential	B	65.6	60.4	5.2
47	Residential	B	65.9	61.9	4.0
48	Residential	B	67.0	62.0	5.0
49	Residential	B	67.7	61.6	6.1
			Total dB(A) Reduction (5dB(A) or greater)		**83.1**

In summary, the Chatfield Avenue area has 14 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is therefore recommended.

Columbine Hills

Columbine Hills is a single-family residential development north of C-470 between Santa Fe Drive and Wadsworth Boulevard as shown in **Figure 15**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 17. Figure 18** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 12.**

Figure 18 – Columbine Hills Receptor Locations

Note: Impacted receptors are shaded green

Figure 19 – Columbine Hills TNM Proposed Action Model View

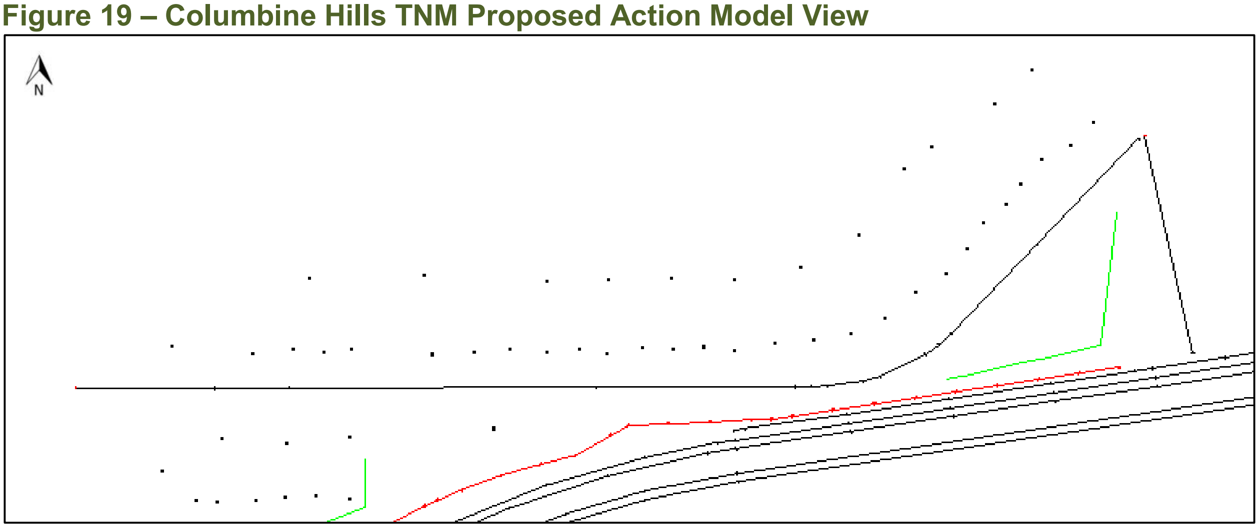


Table 12 – Columbine Hills Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	62.1	62.8	0.7	No	No
2	Residential	B	62.6	63.8	1.2	No	No
3	Residential	B	60.7	62.6	1.9	No	No
4	Residential	B	61.4	63.5	2.1	No	No
5	Residential	B	62.0	64.0	2.0	No	No
6	Residential	B	61.6	63.7	2.1	No	No
7	Residential	B	62.6	64.3	1.7	No	No
8	Residential	B	62.9	64.5	1.6	No	No
9	Residential	B	62.1	64.2	2.1	No	No
10	Residential	B	63.5	65.2	1.7	No	No
11	Residential	B	64.5	66.5	2.0	Yes	No
12	Residential	B	65.7	68.3	2.6	Yes	No
13	Residential	B	66.4	69.4	3.0	Yes	No
14	Residential	B	66.8	69.1	2.3	Yes	No
15	Residential	B	66.5	69.0	2.5	Yes	No
16	Residential	B	66.5	68.6	2.1	Yes	No
17	Residential	B	65.4	67.3	1.9	Yes	No
18	Residential	B	65.4	66.3	0.9	Yes	No
19	Residential	B	64.5	65.2	0.7	No	No
20	Residential	B	64.7	65.2	0.5	No	No
21	Residential	B	64.1	64.5	0.4	No	No
22	Residential	B	64.5	64.7	0.2	No	No
23	Residential	B	64.8	65.0	0.2	No	No
24	Residential	B	64.0	64.1	0.1	No	No
25	Residential	B	64.3	64.4	0.1	No	No
26	Residential	B	63.6	63.7	0.1	No	No
27	Residential	B	64.4	64.5	0.1	No	No
28	Residential	B	62.3	62.4	0.1	No	No
29	Residential	B	53.5	54.5	1.0	No	No
30	Residential	B	53.9	55.2	1.3	No	No
31	Residential	B	55.4	57.3	1.9	No	No
32	Residential	B	56.4	58.2	1.8	No	No
33	Residential	B	57.2	59.5	2.3	No	No
34	Residential	B	57.7	60.4	2.7	No	No
35	Residential	B	57.2	60.3	3.1	No	No
36	Residential	B	56.1	59.6	3.5	No	No
37	Residential	B	54.1	58.2	4.1	No	No
38	Residential	B	54.5	58.6	4.1	No	No
39	Residential	B	54.5	57.6	3.1	No	No
40	Residential	B	53.4	56.3	2.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Columbine Hills Noise Impact Assessment

Table 12 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 17** and **Table 12.** Ten receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 69.4 dB(A) at receptor 13. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Columbine Hills Noise Mitigation Assessment

The optimal wall, which is an extension of the existing wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,200 feet long and 20 feet tall. With the maximum height wall only one impacted property is predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) and none would achieve the design goal of 7dB(A). The lack of acoustic efficiency of the wall along C-470 is primarily due to the Chatfield Avenue traffic noise generated at a far closer proximity to the residences than C-470.The insertion losses are presented in **Table 13**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,080,000	(Cost of wall = 1,200 feet long x 20 feet tall x $45/sf = $1,080,000)
÷ 5.6	(Total dB(A) reduction for all receptors with equal to or greater than 5 dB(A) reduction)
$192,857	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in **Appendix B**.

Table 13 – Columbine Hills Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
11	Residential	B	66.5	63.3	3.2
12	Residential	B	68.3	63.5	4.8
13	Residential	B	69.4	63.8	5.6
14	Residential	B	69.1	65.1	4.0
15	Residential	B	69.2	64.8	4.4
16	Residential	B	68.7	65.3	3.4
17	Residential	B	67.7	65.0	2.7
18	Residential	B	66.6	65.6	1.0
19	Residential	B	65.6	64.9	0.7
20	Residential	B	65.5	65.2	0.3
			Total dB(A) Reduction (5 dB(A) or greater)		**5.6**

In summary, the Columbine Hills area has ten impacted receptors of which only one could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is over CDOT's cost threshold and mitigation is not recommended.

Wolhurst

Wolhurst is a single family residential development on the northwest quadrant of C-470 and Santa Fe Drive. The Wolhurst community has a pair of overlapping noise walls adjacent to C-470 totaling approximately 1,675 linear feet that were installed as part of the Santa Fe interchange improvements. These existing noise walls will be impacted by the Proposed Action due to the realignment of the westbound on-ramp and will be relocated and replaced in kind as part of this project. The existing and future noise walls were included in the model using the prediction methodology described in Section 3.0. Receptors were developed for each front row and select second row outdoor use area as shown in **Figure 20. Figure 21** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 14.**

Figure 20 – Wolhurst Receptor Locations

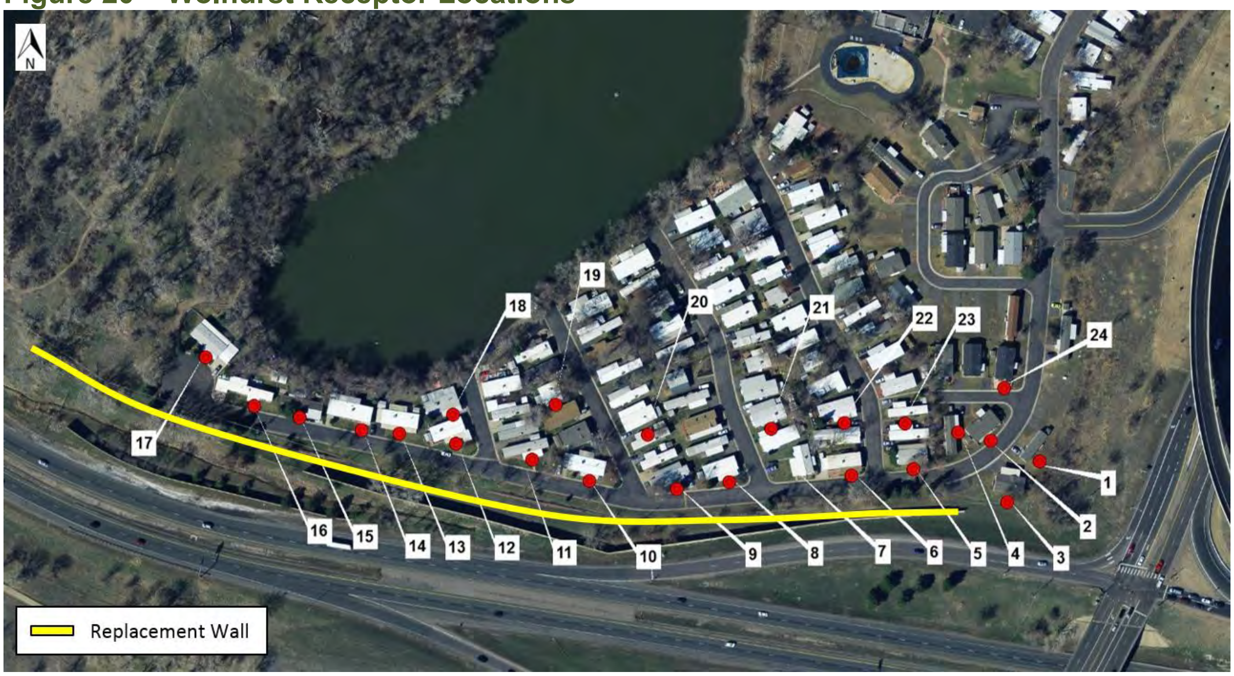
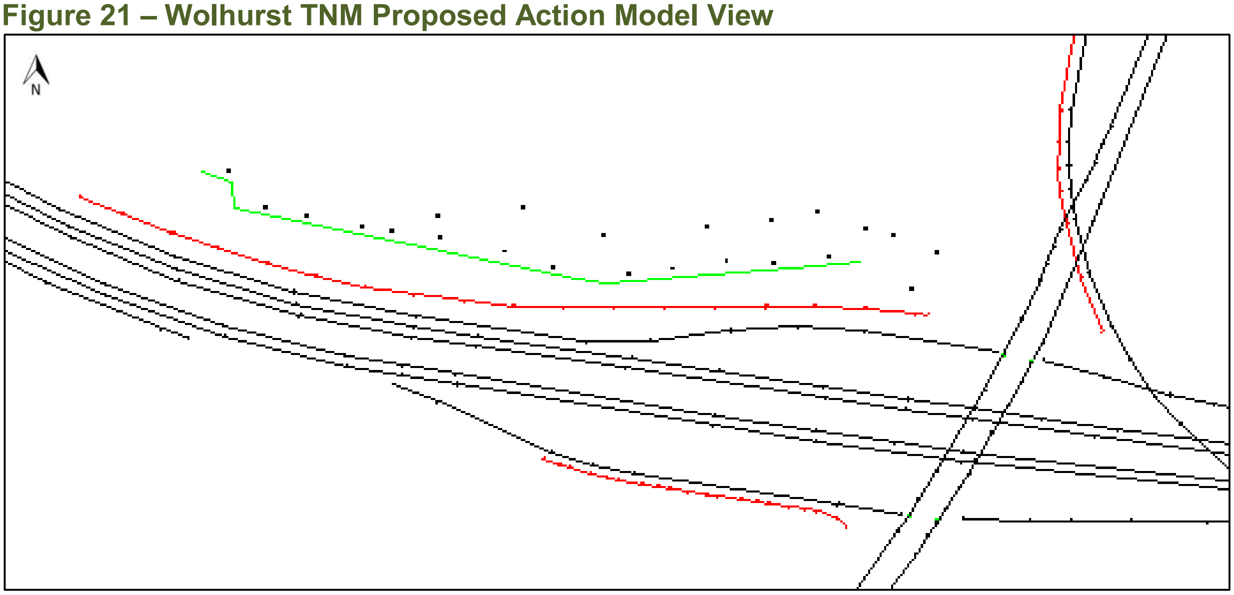


Figure 21 – Wolhurst TNM Proposed Action Model View



Wolhurst Noise Impact Assessment

Table 14 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. The Proposed Action includes the replacement of the existing wall with a single continuous wall measuring 1,500 feet long and averaging 15.5 foot high. With this wall no receptors are impacted by noise. Because this is the replacement of an existing noise wall a Benefit Cost Index was not required. **The existing wall will be replaced.**

Table 14 – Wolhurst Noise Model Results

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	63.2	63.7	0.5	No	No
2	Residential	B	62.0	62.5	0.5	No	No
3	Residential	B	64.3	64.6	0.3	No	No
4	Residential	B	61.6	62.2	0.6	No	No
5	Residential	B	61.3	62.4	1.1	No	No
6	Residential	B	61.3	61.8	0.5	No	No
7	Residential	B	61.8	62.3	0.5	No	No
8	Residential	B	62.5	63.0	0.5	No	No
9	Residential	B	62.9	63.4	0.5	No	No
10	Residential	B	62.9	63.9	1.0	No	No
11	Residential	B	62.6	64.0	1.4	No	No
12	Residential	B	61.9	64.1	2.2	No	No
13	Residential	B	61.4	64.3	2.9	No	No
14	Residential	B	61.1	64.4	3.3	No	No
15	Residential	B	61.7	64.8	3.1	No	No
16	Residential	B	62.5	65.4	2.9	No	No
17	Residential	B	61.7	65.4	3.7	No	No
18	Residential	B	61.6	63.8	2.2	No	No
19	Residential	B	61.8	63.2	1.4	No	No
20	Residential	B	62.4	63.1	0.7	No	No
21	Residential	B	61.5	62.1	0.6	No	No
22	Residential	B	61.1	61.7	0.6	No	No
23	Residential	B	61.0	61.6	0.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

4.5 Santa Fe Drive to Broadway

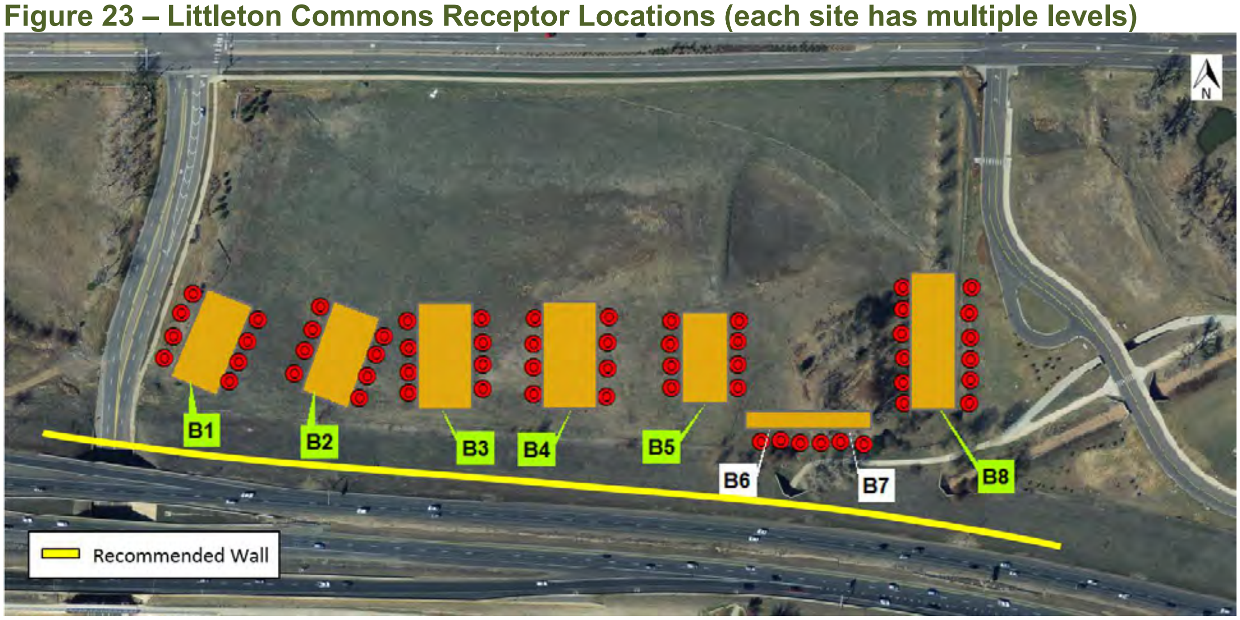
The Santa Fe Drive to Broadway area includes the communities of Littleton Commons, Villas at Verona and Bluffs at Highlands Ranch shown in **Figure 22**.

Figure 22 – Santa Fe Drive to Broadway

Littleton Commons

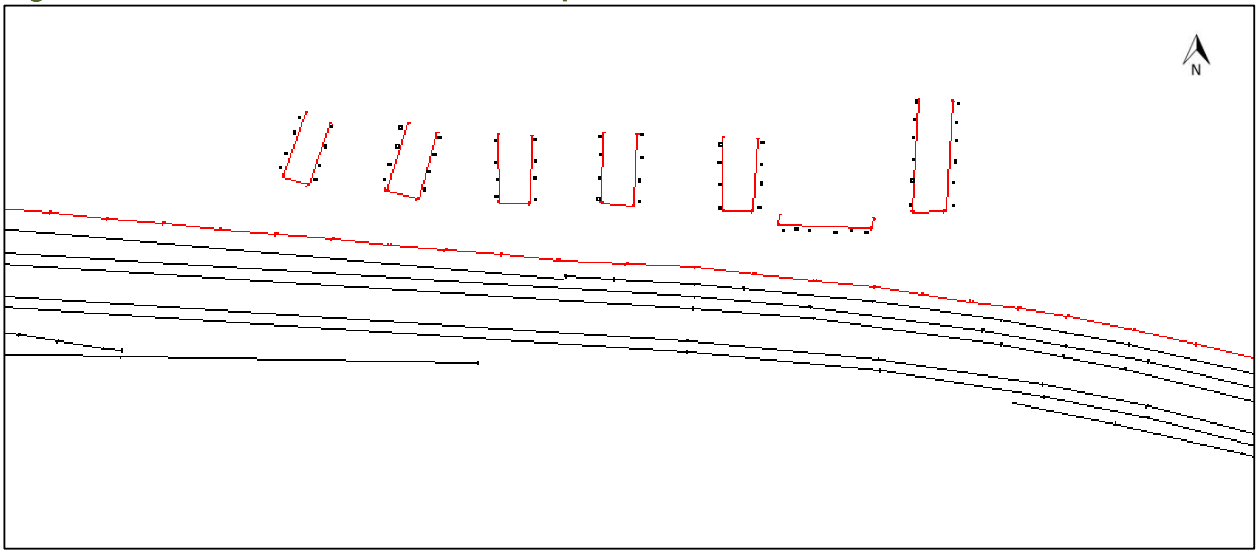
Littleton Commons is a multi-storied residential complex currently under construction, with approved plans from the City of Littleton, north of C-470 between Broadway and Santa Fe Drive as shown in **Figure 22**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 23.** It should be noted that **Figure 23** was developed from site plans provided by the Littleton Commons which is currently under construction. **Figure 24** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 162 receptor locations for both existing and Proposed Action conditions and are shown in **Table 14.**

Figure 23 – Littleton Commons Receptor Locations (each site has multiple levels)



Note: Impacted receptors are shaded green

Figure 24 – Littleton Commons TNM Proposed Action Model View



Littleton Commons Noise Impact Assessment

Table 15 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 23** and **Table 15.** Twenty-seven receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 73.1 dB(A) at receptor B1-4-3. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Littleton Commons Noise Mitigation Assessment

Much of the complex is well below the grade of the roadway, thus the optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 2,200 feet long and 7 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 9.5 dB(A), achieving the design goal of 7 dB(A). The insertion losses are presented in **Table 16**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$693,000	(Cost of wall = 2,200 feet long x 7 feet tall x $45/sf = $693,000)
÷ 226.7	(Total dB(A) reduction for the 36 receptors with equal to or greater than 5 dB(A) reduction)
$3,057	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 15 – Littleton Commons Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B1-1-1	Residential	B	56.7	58.9	2.2	No	No
2	Residential	B	63.1	65.9	2.8	Yes	No
3	Residential	B	66.9	68.6	1.7	Yes	No
B1-2-1	Residential	B	57.1	59.4	2.3	No	No
2	Residential	B	63.3	66.2	2.9	Yes	No
3	Residential	B	67.7	69.3	1.6	Yes	No
B1-3-1	Residential	B	57.9	60.1	2.2	No	No
2	Residential	B	64.4	67.3	2.9	Yes	No
3	Residential	B	69.5	71.0	1.5	Yes	No
B1-4-1	Residential	B	59.1	61.3	2.2	No	No
2	Residential	B	65.8	67.9	2.1	Yes	No
3	Residential	B	71.4	73.1	1.7	Yes	No
B1-5-1	Residential	B	56.6	59.1	2.5	No	No
2	Residential	B	61.9	64.8	2.9	No	No
3	Residential	B	71.5	72.6	1.1	Yes	No
B1-6-1	Residential	B	55.6	58.1	2.5	No	No
2	Residential	B	60.3	63.9	3.6	No	No
3	Residential	B	69.0	70.4	1.4	Yes	No
B1-7-1	Residential	B	55.6	57.6	2.0	No	No
2	Residential	B	60.4	62.7	2.3	No	No
3	Residential	B	66.6	68.8	2.2	Yes	No
B1-8-1	Residential	B	54.2	56.5	2.3	No	No
2	Residential	B	59.3	61.4	2.1	No	No
3	Residential	B	64.7	67.3	2.6	Yes	No
B2-1-1	Residential	B	52.4	54.5	2.1	No	No
2	Residential	B	55.8	58.8	3.0	No	No
3	Residential	B	60.4	62.7	2.3	No	No
B2-2-1	Residential	B	53.0	55.1	2.1	No	No
2	Residential	B	56.3	59.5	3.2	No	No
3	Residential	B	61.3	64.3	3.0	No	No
B2-3-1	Residential	B	53.5	55.9	2.4	No	No
2	Residential	B	57.7	59.9	2.2	No	No
3	Residential	B	64.1	66.2	2.1	Yes	No
B2-4-1	Residential	B	55.1	57.0	1.9	No	No
2	Residential	B	59.6	61.4	1.8	No	No
3	Residential	B	67.3	68.6	1.3	Yes	No
B2-5-1	Residential	B	55.8	58.5	2.7	No	No
2	Residential	B	61.0	64.5	3.5	No	No
3	Residential	B	71.3	73.3	2.0	Yes	No
B2-6-1	Residential	B	55.7	58.0	2.3	No	No
2	Residential	B	59.7	63.3	3.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 15 – Littleton Commons Noise Model Results without Mitigation (cont 1)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
3	Residential	B	68.2	70.9	2.7	Yes	No
B2-7-1	Residential	B	55.2	57.7	2.5	No	No
2	Residential	B	59.8	62.7	2.9	No	No
3	Residential	B	65.9	69.0	3.1	Yes	No
B2-8-1	Residential	B	54.6	56.6	2.0	No	No
2	Residential	B	59.1	61.1	2.0	No	No
3	Residential	B	64.3	66.9	2.6	Yes	No
B3-1-1	Residential	B	54.7	55.6	0.9	No	No
2	Residential	B	57.1	59.1	2.0	No	No
3	Residential	B	61.0	63.3	2.3	No	No
B3-2-1	Residential	B	54.9	56.4	1.5	No	No
2	Residential	B	58.0	59.6	1.6	No	No
3	Residential	B	63.7	65.0	1.3	No	No
B3-3-1	Residential	B	55.2	57.5	2.3	No	No
2	Residential	B	58.8	60.3	1.5	No	No
3	Residential	B	66.2	66.6	0.4	Yes	No
B3-4-1	Residential	B	55.9	57.4	1.5	No	No
2	Residential	B	59.2	61.3	2.1	No	No
3	Residential	B	66.3	68.1	1.8	Yes	No
B3-5-1	Residential	B	53.4	55.5	2.1	No	No
2	Residential	B	56.7	60.3	3.6	No	No
3	Residential	B	61.5	65.2	3.7	No	No
B3-6-1	Residential	B	51.3	54.7	3.4	No	No
2	Residential	B	55.2	59.2	4.0	No	No
3	Residential	B	58.3	64.1	5.8	No	No
B3-7-1	Residential	B	50.8	54.7	3.9	No	No
2	Residential	B	55.0	58.3	3.3	No	No
3	Residential	B	57.5	64.3	6.8	No	No
B3-8-1	Residential	B	50.9	53.7	2.8	No	No
2	Residential	B	53.9	57.3	3.4	No	No
3	Residential	B	56.6	62.7	6.1	No	No
B4-1-1	Residential	B	52.1	54.5	2.4	No	No
2	Residential	B	54.1	56.3	2.2	No	No
3	Residential	B	56.0	60.3	4.3	No	No
B4-2-1	Residential	B	52.4	55.8	3.4	No	No
2	Residential	B	54.8	57.6	2.8	No	No
3	Residential	B	56.8	60.8	4.0	No	No
B4-3-1	Residential	B	53.0	55.4	2.4	No	No
2	Residential	B	55.0	58.6	3.6	No	No
3	Residential	B	58.2	60.9	2.7	No	No
B4-4-1	Residential	B	53.4	56.0	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 15 – Littleton Commons Noise Model Results without Mitigation (cont 2)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
2	Residential	B	56.4	59.9	3.5	No	No
3	Residential	B	60.8	63.7	2.9	No	No
B4-5-1	Residential	B	51.0	55.6	4.6	No	No
2	Residential	B	54.2	60.5	6.3	No	No
3	Residential	B	58.6	63.4	4.8	No	No
B4-6-1	Residential	B	52.2	56.8	4.6	No	No
2	Residential	B	55.3	61.8	6.5	No	No
3	Residential	B	59.8	65.4	5.6	No	No
B4-7-1	Residential	B	51.9	56.9	5.0	No	No
2	Residential	B	56.4	62.9	6.5	No	No
3	Residential	B	61.3	67.3	6.0	No	No
B4-8-1	Residential	B	52.7	58.3	5.6	No	No
2	Residential	B	58.4	63.0	4.6	No	No
3	Residential	B	64.6	69.6	5.0	Yes	No
B5-1-1	Residential	B	51.9	55.9	4.0	No	No
2	Residential	B	53.8	58.7	4.9	No	No
3	Residential	B	56.7	63.5	6.8	No	No
B5-2-1	Residential	B	51.5	58.6	7.1	No	No
2	Residential	B	54.7	58.6	3.9	No	No
3	Residential	B	56.8	63.4	6.6	No	No
B5-3-1	Residential	B	51.8	56.3	4.5	No	No
2	Residential	B	55.3	59.6	4.3	No	No
3	Residential	B	57.8	64.4	6.6	No	No
B5-4-1	Residential	B	54.2	58.2	4.0	No	No
2	Residential	B	56.1	61.0	4.9	No	No
3	Residential	B	59.9	64.0	4.1	No	No
B5-5-1	Residential	B	52.6	58.7	6.1	No	No
2	Residential	B	58.1	62.5	4.4	No	No
3	Residential	B	63.9	69.7	5.8	No	No
B5-6-1	Residential	B	52.4	56.9	4.5	No	No
2	Residential	B	55.1	62.0	6.9	No	No
3	Residential	B	60.7	67.3	6.6	Yes	No
B5-7-1	Residential	B	52.2	57.1	4.9	No	No
2	Residential	B	55.9	62.3	6.4	No	No
3	Residential	B	59.9	66.9	7.0	Yes	No
B5-8-1	Residential	B	52.6	58.8	6.2	No	No
2	Residential	B	56.8	62.4	5.6	No	No
3	Residential	B	59.7	65.9	6.2	Yes	No
B6-1-1	Residential	B	55.1	59.6	4.5	No	No
B6-2-1	Residential	B	54.9	59.5	4.6	No	No
B6-3-1	Residential	B	54.7	59.2	4.5	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 15 – Littleton Commons Noise Model Results without Mitigation (cont 3)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B7-4-1	Residential	B	54.3	58.8	4.5	No	No
B7-5-1	Residential	B	54.1	58.7	4.6	No	No
B7-6-1	Residential	B	53.9	58.5	4.6	No	No
B8-1-1	Residential	B	53.0	58.6	5.6	No	No
2	Residential	B	56.3	60.8	4.5	No	No
3	Residential	B	58.2	63.0	4.8	No	No
B8-2-1	Residential	B	53.1	58.7	5.6	No	No
2	Residential	B	55.4	60.9	5.5	No	No
3	Residential	B	58.5	63.6	5.1	No	No
B8-3-1	Residential	B	52.5	58.2	5.7	No	No
2	Residential	B	55.4	61.1	5.7	No	No
3	Residential	B	58.9	64.0	5.1	No	No
B8-4-1	Residential	B	52.0	57.9	5.9	No	No
2	Residential	B	55.6	61.3	5.7	No	No
3	Residential	B	59.0	64.8	5.8	No	No
B8-5-1	Residential	B	52.1	56.8	4.7	No	No
2	Residential	B	55.6	60.7	5.1	No	No
3	Residential	B	59.1	65.2	6.1	No	No
B8-6-1	Residential	B	52.5	57.6	5.1	No	No
2	Residential	B	56.7	60.8	4.1	No	No
3	Residential	B	59.6	66.3	6.7	Yes	No
B8-7-1	Residential	B	53.8	58.2	4.4	No	No
2	Residential	B	57.6	61.6	4.0	No	No
3	Residential	B	59.7	67.0	7.3	No	No
B8-8-1	Residential	B	53.3	56.2	2.9	No	No
2	Residential	B	55.8	59.7	3.9	No	No
3	Residential	B	58.3	64.6	6.3	No	No
B8-9-1	Residential	B	53.2	55.7	2.5	No	No
2	Residential	B	55.4	59.9	4.5	No	No
3	Residential	B	58.4	64.2	5.8	No	No
B8-10-1	Residential	B	53.0	55.6	2.6	No	No
2	Residential	B	55.1	59.4	4.3	No	No
3	Residential	B	57.9	62.7	4.8	No	No
B8-11-1	Residential	B	52.9	55.9	3.0	No	No
2	Residential	B	54.8	59.1	4.3	No	No
3	Residential	B	57.5	61.8	4.3	No	No
B8-12-1	Residential	B	52.8	55.4	2.6	No	No
2	Residential	B	54.7	58.7	4.0	No	No
3	Residential	B	57.2	61.2	4.0	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green

Table 16 – Littleton Commons Impacted Receptors with Mitigation

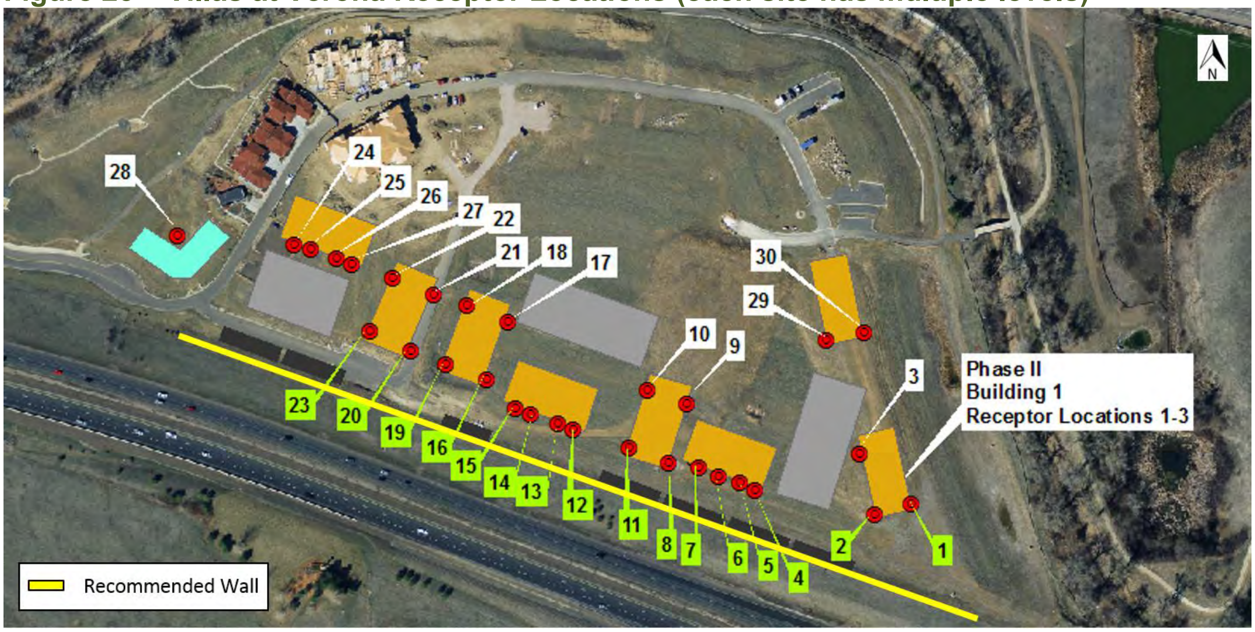
Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
B1-1-2	Residential	B	65.9	61.9	4.0
B1-1-3	Residential	B	68.6	63.6	5.0
B1-2-2	Residential	B	66.2	62.2	4.0
B1-2-3	Residential	B	69.3	63.9	5.4
B1-3-2	Residential	B	67.3	62.4	4.9
B1-3-3	Residential	B	71.0	64.4	6.6
B1-4-2	Residential	B	67.9	63.0	4.9
B1-4-3	Residential	B	73.1	65.6	7.5
B1-5-3	Residential	B	72.6	64.1	8.5
B1-6-3	Residential	B	70.4	62.6	7.8
B1-7-3	Residential	B	68.8	61.1	7.7
B1-8-3	Residential	B	67.3	59.8	7.5
B2-3-3	Residential	B	66.2	60.0	6.2
B2-4-3	Residential	B	68.6	61.7	6.9
B2-5-3	Residential	B	73.3	63.8	9.5
B2-6-3	Residential	B	70.9	62.4	8.5
B2-7-3	Residential	B	69.0	61.2	7.8
B2-8-3	Residential	B	66.9	59.9	7.0
B3-3-3	Residential	B	66.6	61.1	5.5
B3-4-3	Residential	B	68.1	62.2	5.9
B4-7-3	Residential	B	67.3	61.4	5.9
B4-8-3	Residential	B	69.6	63.1	6.5
B5-5-3	Residential	B	69.7	63.4	6.3
B5-6-3	Residential	B	67.3	61.5	5.8
B5-7-3	Residential	B	66.9	60.8	6.1
B5-8-3	Residential	B	65.9	59.9	6.0
B8-6-3	Residential	B	66.3	61.1	5.2
B8-7-3	Residential	B	67.0	62.0	5.0
Other Benefitted	Residential	B			67.1
			Total dB(A) Reduction (5 dB(A) or greater)		**226.7**

In summary, the Littleton Commons area has 36 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

Villas at Verona

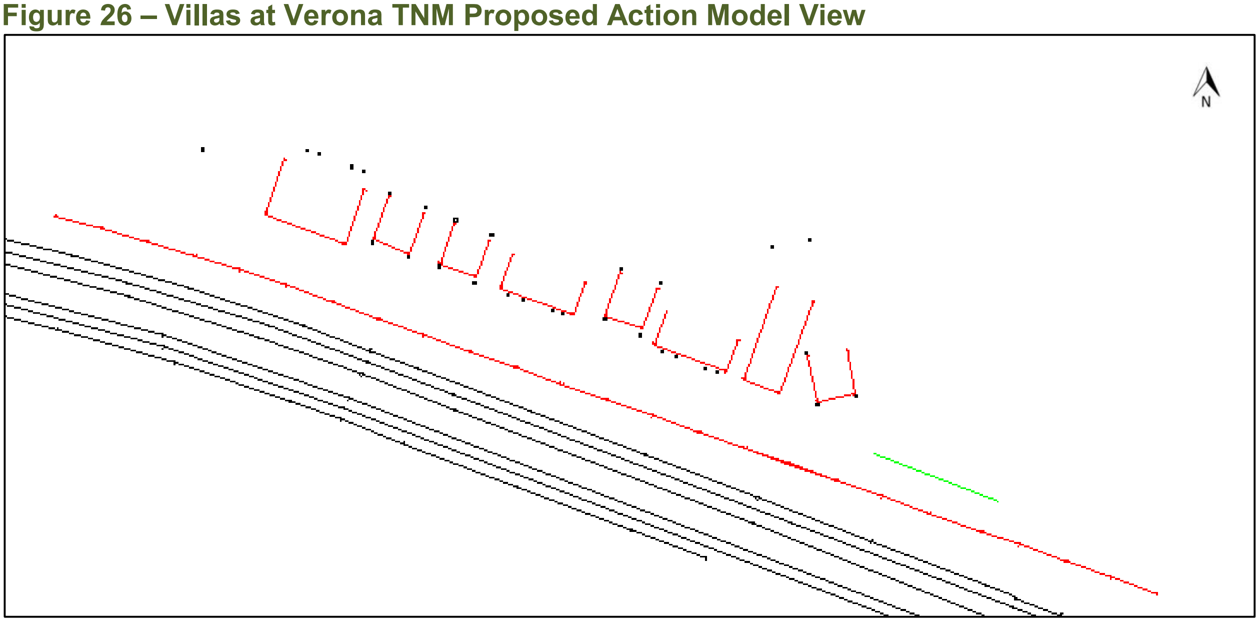
Villas at Verona is a multi-storied residential complex currently under construction north of C-470 between Broadway and Santa Fe Drive as shown in **Figure 22**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 25.** It should be noted that **Figure 25** was developed from site plans provided by the Villas at Verona which is currently under construction. **Figure 26** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 117 receptor locations for both existing and Proposed Action conditions and are shown in **Table 17.**

Figure 25 – Villas at Verona Receptor Locations (each site has multiple levels)



Note: Impacted receptors are shaded green

Figure 26 – Villas at Verona TNM Proposed Action Model View



Villas at Verona Noise Impact Assessment

Table 17 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 25** and **Table 17.** Fifty-nine receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 75.7 dB(A) at receptor 20-4. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Villas at Verona Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,720 feet long and 18.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 12.3 dB(A). Some third and fourth receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. The insertion losses are presented in **Table 18**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,431,900 (Cost of wall = 1,720 feet long x 18.5 feet tall x $45/sf = $1,431,900)
÷ 647.8 (Total dB(A) reduction for the 74 receptors with equal to or greater than 5 dB(A) reduction)
$2,210 (Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 17 – Villas at Verona Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	59.8	63.0	3.2	No	No
1-2	Residential	B	66.4	69.5	3.1	Yes	No
1-3	Residential	B	70.9	73.6	2.7	Yes	No
1-4	Residential	B	71.0	73.7	2.7	Yes	No
2	Residential	B	60.8	64.5	3.7	No	No
2-2	Residential	B	69.2	72.3	3.1	Yes	No
2-3	Residential	B	72.1	74.8	2.7	Yes	No
2-4	Residential	B	72.2	74.9	2.7	Yes	No
3	Residential	B	51.3	54.9	3.6	No	No
3-2	Residential	B	56.5	60.0	3.5	No	No
3-3	Residential	B	65.2	67.0	1.8	Yes	No
3-4	Residential	B	66.7	69.3	2.6	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 17 – Villas at Verona Noise Model Results without Mitigation (cont 1)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
4	Residential	B	60.0	64.0	4.0	No	No
4-2	Residential	B	69.6	72.8	3.2	Yes	No
4-3	Residential	B	72.2	75.0	2.8	Yes	No
4-4	Residential	B	72.3	75.2	2.9	Yes	No
5	Residential	B	60.1	64.1	4.0	No	No
5-2	Residential	B	69.7	72.8	3.1	Yes	No
5-3	Residential	B	72.2	75.1	2.9	Yes	No
5-4	Residential	B	72.3	75.2	2.9	Yes	No
6	Residential	B	60.8	64.7	3.9	No	No
6-2	Residential	B	70.1	73.4	3.3	Yes	No
6-3	Residential	B	72.2	75.1	2.9	Yes	No
6-4	Residential	B	72.3	75.3	3.0	Yes	No
7	Residential	B	60.6	64.5	3.9	No	No
7-2	Residential	B	70.1	73.4	3.3	Yes	No
7-3	Residential	B	72.2	75.2	3.0	Yes	No
7-4	Residential	B	72.3	75.3	3.0	Yes	No
8	Residential	B	60.9	65.7	4.8	Yes	No
8-2	Residential	B	69.8	73.2	3.4	Yes	No
8-3	Residential	B	71.8	74.8	3.0	Yes	No
8-4	Residential	B	71.9	74.9	3.0	Yes	No
9	Residential	B	50.7	53.9	3.2	No	No
9-2	Residential	B	56.1	60.0	3.9	No	No
9-3	Residential	B	60.5	63.4	2.9	No	No
9-4	Residential	B	61.3	64.2	2.9	No	No
10	Residential	B	53.3	59.2	5.9	No	No
10-2	Residential	B	60.1	64.0	3.9	No	No
10-3	Residential	B	62.9	66.1	3.2	Yes	No
10-4	Residential	B	63.3	66.5	3.2	Yes	No
11	Residential	B	62.8	67.9	5.1	Yes	No
11-2	Residential	B	70.3	73.7	3.4	Yes	No
11-3	Residential	B	71.8	74.9	3.1	Yes	No
11-4	Residential	B	71.9	75.0	3.1	Yes	No
12	Residential	B	62.4	66.2	3.8	Yes	No
12-2	Residential	B	70.9	74.3	3.4	Yes	No
12-3	Residential	B	72.2	75.4	3.2	Yes	No
12-4	Residential	B	72.3	75.5	3.2	Yes	No
13	Residential	B	62.7	66.4	3.7	Yes	No
13-2	Residential	B	71.0	74.4	3.4	Yes	No
13-3	Residential	B	72.2	75.5	3.3	Yes	No
13-4	Residential	B	72.4	75.6	3.2	Yes	No
V14	Residential	B	63.0	66.9	3.9	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 17 – Villas at Verona Noise Model Results without Mitigation (cont 2)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
14-2	Residential	B	71.1	74.4	3.3	Yes	No
14-3	Residential	B	72.2	75.5	3.3	Yes	No
14-4	Residential	B	72.3	75.6	3.3	Yes	No
15	Residential	B	63.8	66.7	2.9	Yes	No
15-2	Residential	B	71.2	74.6	3.4	Yes	No
15-3	Residential	B	72.3	75.6	3.3	Yes	No
15-4	Residential	B	72.4	75.7	3.3	Yes	No
16	Residential	B	63.1	65.8	2.7	Yes	No
16-2	Residential	B	71.0	74.2	3.2	Yes	No
16-3	Residential	B	72.2	75.6	3.4	Yes	No
16-4	Residential	B	72.4	75.8	3.4	Yes	No
17	Residential	B	55.0	58.2	3.2	No	No
17-2	Residential	B	61.5	65.4	3.9	Yes	No
17-3	Residential	B	63.9	67.4	3.5	Yes	No
17-4	Residential	B	64.2	67.8	3.6	Yes	No
18	Residential	B	55.6	57.9	2.3	No	No
18-2	Residential	B	61.7	63.9	2.2	No	No
18-3	Residential	B	64.1	67.1	3.0	Yes	No
18-4	Residential	B	64.4	67.6	3.2	Yes	No
19	Residential	B	64.1	66.4	2.3	Yes	No
19-2	Residential	B	71.0	74.1	3.1	Yes	No
19-3	Residential	B	72.1	75.5	3.4	Yes	No
19-4	Residential	B	72.3	75.7	3.4	Yes	No
20	Residential	B	64.1	66.5	2.4	Yes	No
20-2	Residential	B	71.0	73.8	2.8	Yes	No
20-3	Residential	B	72.3	75.6	3.3	Yes	No
20-4	Residential	B	72.4	75.8	3.4	Yes	No
21	Residential	B	55.7	57.7	2.0	No	No
21-2	Residential	B	61.9	64.6	2.7	No	No
21-3	Residential	B	64.5	67.9	3.4	Yes	No
21-4	Residential	B	64.8	68.4	3.6	Yes	No
22	Residential	B	53.6	56.6	3.0	No	No
22-2	Residential	B	59.1	60.5	1.4	No	No
22-3	Residential	B	61.2	63.6	2.4	No	No
22-4	Residential	B	66.5	69.6	3.1	Yes	No
23	Residential	B	63.6	66.2	2.6	Yes	No
23-2	Residential	B	70.6	72.7	2.1	Yes	No
23-3	Residential	B	72.0	75.3	3.3	Yes	No
23-4	Residential	B	72.3	75.6	3.3	Yes	No
24	Residential	B	52.4	55.2	2.8	No	No
24-2	Residential	B	55.2	57.8	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 17 – Villas at Verona Noise Model Results without Mitigation (cont 3)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
24-3	Residential	B	58.7	61.6	2.9	No	No
24-4	Residential	B	65.4	68.4	3.0	Yes	No
25	Residential	B	52.0	55.0	3.0	No	No
25-2	Residential	B	53.0	56.4	3.4	No	No
25-3	Residential	B	56.8	60.0	3.2	No	No
25-4	Residential	B	65.3	68.0	2.7	Yes	No
26	Residential	B	53.7	56.0	2.3	No	No
26-2	Residential	B	56.4	57.9	1.5	No	No
26-3	Residential	B	58.6	61.1	2.5	No	No
26-4	Residential	B	65.3	67.9	2.6	Yes	No
27	Residential	B	55.2	57.1	1.9	No	No
27-2	Residential	B	59.2	59.9	0.7	No	No
27-3	Residential	B	61.0	62.8	1.8	No	No
27-4	Residential	B	65.8	68.3	2.5	Yes	No
28	Residential	B	62.6	64.2	1.6	No	No
29	Residential	B	53.7	57.1	3.4	No	No
29-2	Residential	B	56.4	59.1	2.7	No	No
29-3	Residential	B	59.1	61.8	2.7	No	No
24-4	Residential	B	61.3	63.5	2.2	No	No
30	Residential	B	54.2	57.8	3.6	No	No
30-2	Residential	B	57.3	59.8	2.5	No	No
30-3	Residential	B	60.0	62.3	2.3	No	No
30-4	Residential	B	62.0	64.2	2.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 18 – Villas at Verona Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
1-2	Residential	B	69.5	64.5	5.0
1-3	Residential	B	73.6	66.1	7.5
1-4	Residential	B	73.7	67.4	6.3
2-2	Residential	B	72.3	64.0	8.3
2-3	Residential	B	74.8	65.8	9.0
2-4	Residential	B	74.9	68.3	6.6
3-3	Residential	B	67.0	54.7	12.3
3-4	Residential	B	69.3	59.6	9.7
4-2	Residential	B	72.8	62.1	10.7
4-3	Residential	B	75.0	64.0	11.0
4-4	Residential	B	75.2	67.5	7.7
5-2	Residential	B	72.8	62.0	10.8
5-3	Residential	B	75.1	64.0	11.1
5-4	Residential	B	75.2	67.7	7.5
6-2	Residential	B	73.4	62.0	11.4
6-3	Residential	B	75.1	64.2	10.9
6-4	Residential	B	75.3	68.1	7.2
7-2	Residential	B	73.4	61.9	11.5
7-3	Residential	B	75.2	64.2	11.0
7-4	Residential	B	75.3	68.1	7.2
8	Residential	B	65.7	59.5	6.2
8-2	Residential	B	73.2	61.1	12.1
8-3	Residential	B	74.8	63.5	11.3
8-4	Residential	B	74.9	67.8	7.1
10-3	Residential	B	66.1	54.9	11.2
10-4	Residential	B	66.5	58.0	8.5
11	Residential	B	67.9	60.4	7.5
11-2	Residential	B	73.7	62.3	11.4
11-3	Residential	B	74.9	65.0	9.9
11-4	Residential	B	75.0	69.1	5.9
12	Residential	B	66.2	60.3	5.9
12-2	Residential	B	74.3	62.2	12.1
12-3	Residential	B	75.4	65.0	10.4
12-4	Residential	B	75.5	69.3	6.2
13	Residential	B	66.4	60.3	6.1
13-2	Residential	B	74.4	62.3	12.1
13-3	Residential	B	75.5	65.2	10.3
13-4	Residential	B	75.6	69.6	6.0
V14	Residential	B	66.9	60.6	6.3
14-2	Residential	B	74.4	62.5	11.9
14-3	Residential	B	75.5	65.6	9.9
14-4	Residential	B	75.6	70.2	5.4

Table 18 – Villas at Verona Impacted Receptors with Mitigation (cont 1)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
15	Residential	B	66.7	60.7	6.0
15-2	Residential	B	74.6	62.7	11.9
15-3	Residential	B	75.6	65.9	9.7
15-4	Residential	B	75.7	70.7	5.0
16	Residential	B	65.8	60.7	5.1
16-2	Residential	B	74.2	62.7	11.5
16-3	Residential	B	75.6	65.7	9.9
16-4	Residential	B	75.8	70.5	5.3
17-2	Residential	B	65.4	53.7	11.7
17-3	Residential	B	67.4	56.1	11.3
17-4	Residential	B	67.8	59.0	8.8
18-3	Residential	B	67.1	57.2	9.9
18-4	Residential	B	67.6	60.6	7.0
19	Residential	B	66.4	61.3	5.1
19-2	Residential	B	74.1	63.7	10.4
19-3	Residential	B	75.5	67.1	8.4
19-4	Residential	B	75.7	72.0	3.7
20	Residential	B	66.5	61.6	4.9
20-2	Residential	B	73.8	64.2	9.6
20-3	Residential	B	75.6	67.9	7.7
20-4	Residential	B	75.8	72.9	2.9
21-3	Residential	B	67.9	57.4	10.5
21-4	Residential	B	68.4	60.6	7.8
22-4	Residential	B	69.6	68.1	1.5
23	Residential	B	66.2	61.4	4.8
23-2	Residential	B	72.7	63.8	8.9
23-3	Residential	B	75.3	68.0	7.3
23-4	Residential	B	75.6	73.4	2.2
24-4	Residential	B	68.4	65.8	2.6
25-4	Residential	B	68.0	65.9	2.1
26-4	Residential	B	67.9	67.0	0.9
27-4	Residential	B	68.3	67.6	0.7
				Total dB(A) Reduction (5 dB(A) or greater)	**647.8**

In summary, the Villas at Verona area has seventy-four receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

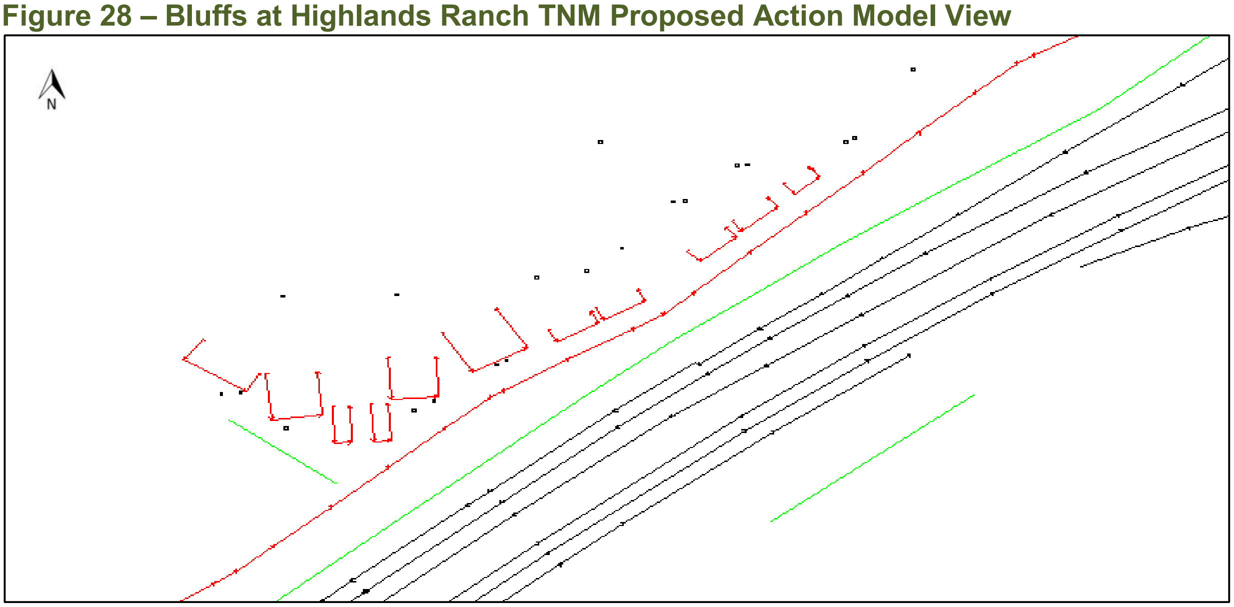
Bluffs at Highlands Ranch

Bluffs at Highlands Ranch is a multi-storied residential complex north of C-470 between Broadway and Santa Fe Drive as shown in **Figure 22**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 27. Figure 28** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 38 receptor locations for both existing and Proposed Action conditions and are shown in **Table 19.**

Figure 27 – Bluffs at Highlands Ranch Receptor Locations (each site has multiple levels)

Note: Impacted receptors are shaded green

Figure 28 – Bluffs at Highlands Ranch TNM Proposed Action Model View



Bluffs at Highlands Ranch Noise Impact Assessment

Table 19 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 27** and **Table 28.** Twenty-eight receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 76.9 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Bluffs at Highlands Ranch Noise Mitigation Assessment

The optimal wall, shown in **Figure 27**, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,200 feet long and 17.7 feet tall. Some third and fourth story receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. However, the design goal reduction of 7 dB(A) or more was met by at least one receptor. The insertion losses are presented in **Table 20**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$955,800	(Cost of wall = 1,200 feet long x 17.7 feet tall x $45/sf = $955.800)
÷ 151.3	(Total dB(A) reduction for 28 receptors with equal to or greater than 5 dB(A) reduction)
$6,317	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 19 – Bluffs at Highlands Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	64.9	68.4	3.5	Yes	No
2	Residential	B	71.1	74.4	3.3	Yes	No
3	Residential	B	65.3	68.6	3.3	Yes	No
4	Residential	B	71.3	74.4	3.1	Yes	No
5	Residential	B	63.0	65.6	2.6	Yes	No
6	Residential	B	69.3	72.4	3.1	Yes	No
7	Residential	B	62.6	65.3	2.7	No	No
8	Residential	B	68.8	71.9	3.1	Yes	No
9	Residential	B	61.6	65.0	3.4	No	No
10	Residential	B	69.9	72.9	3.0	Yes	No
11	Residential	B	61.8	64.9	3.1	No	No
12	Residential	B	69.6	72.6	3.0	Yes	No
13	Residential	B	63.6	67.6	4.0	Yes	No
14	Residential	B	70.3	73.1	2.8	Yes	No
15	Residential	B	63.0	65.7	2.7	Yes	No
16	Residential	B	68.8	71.6	2.8	Yes	No
17	Residential	B	70.9	75.6	4.7	Yes	No
18	Residential	B	73.5	76.9	3.4	Yes	No
19	Residential	B	70.9	75.5	4.6	Yes	No
20	Residential	B	73.5	76.9	3.4	Yes	No
21	Residential	B	70.8	75.5	4.7	Yes	No
22	Residential	B	73.4	76.9	3.5	Yes	No
23	Residential	B	70.5	75.3	4.8	Yes	No
24	Residential	B	73.3	76.8	3.5	Yes	No
25	Residential	B	60.8	67.9	7.1	Yes	No
26	Residential	B	68.8	72.9	4.1	Yes	No
27	Residential	B	70.9	74.3	3.4	Yes	No
28	Residential	B	57.1	64.9	7.8	No	No
29	Residential	B	63.8	68.7	4.9	Yes	No
30	Residential	B	67.4	70.9	3.5	Yes	No
31	Residential	B	57.4	65.2	7.8	No	No
32	Residential	B	64.0	69.1	5.1	Yes	No
33	Residential	B	67.9	71.4	3.5	Yes	No
34	Residential	B	55.1	58.9	3.8	No	No
35	Residential	B	59.0	63.4	4.4	No	No
36	Residential	B	62.4	66.5	4.1	Yes	No
37	Residential	B	57.5	59.6	2.1	No	No
38	Residential	B	61.9	64.7	2.8	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 20 – Bluffs at Highlands Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
10	Residential	B	72.9	67.6	5.3
12	Residential	B	72.6	67.2	5.4
13	Residential	B	67.6	60.6	7.0
14	Residential	B	73.1	66.5	6.6
15	Residential	B	65.7	60.0	5.7
16	Residential	B	71.6	66.3	5.3
17	Residential	B	75.6	63.7	11.9
18	Residential	B	76.9	71.5	5.4
19	Residential	B	75.5	63.7	11.8
20	Residential	B	76.9	71.4	5.5
21	Residential	B	75.5	63.4	12.1
22	Residential	B	76.9	71.5	5.4
23	Residential	B	75.3	63.1	12.2
24	Residential	B	76.8	71.0	5.8
25	Residential	B	67.9	62.2	5.7
26	Residential	B	72.9	64.7	8.2
27	Residential	B	74.3	68.2	6.1
29	Residential	B	68.7	63.6	5.1
30	Residential	B	70.9	65.9	5.0
32	Residential	B	69.1	64.0	5.1
33	Residential	B	71.4	66.2	5.2
36	Residential	B	66.5	61.0	5.5
				Total dB(A) Reduction (5 dB(A) or greater)	**151.3**

In summary, the Bluffs at Highlands Ranch has 28 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and therefore mitigation is recommended.

4.6 Broadway to University Boulevard

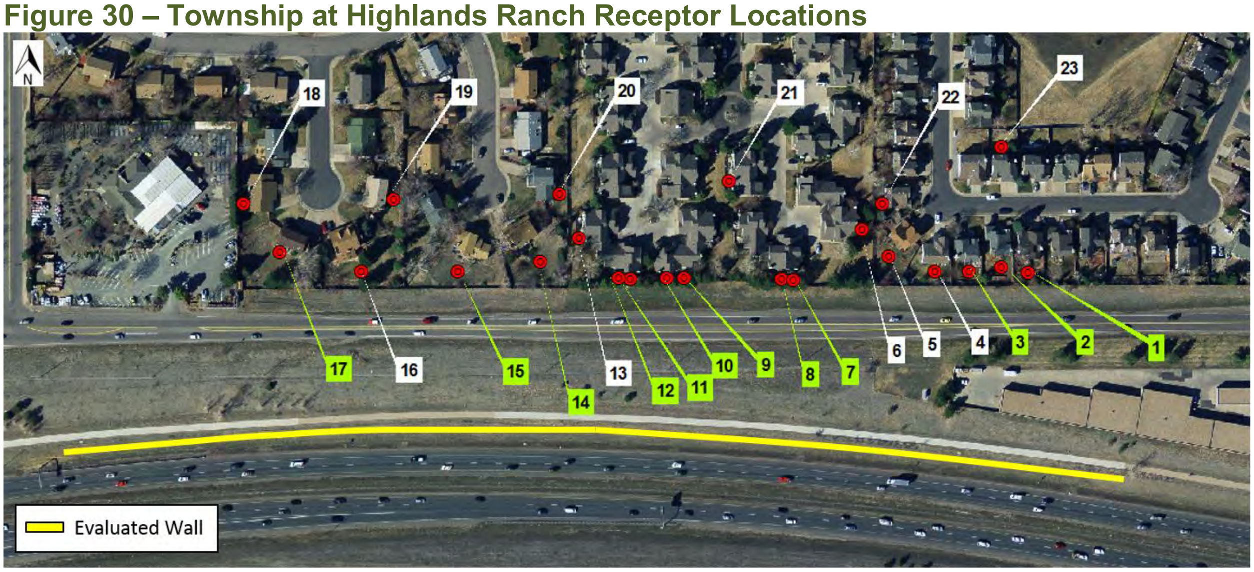
The Broadway to University Boulevard area includes the communities of Township at Highlands Ranch and Highlands Ranch Dad Clark as shown in **Figure 29**.

Figure 29 – Broadway to University Boulevard

Township at Highlands Ranch

Township at Highlands Ranch is a single-family residential development north of C-470 and County Line Road between University Boulevard and Broadway as shown in **Figure 29**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 30. Figure 31** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 21.**

Figure 30 – Township at Highlands Ranch Receptor Locations



Note: Impacted receptors are shaded green.

Figure 31 – Township at Highlands Ranch TNM Proposed Action Model View

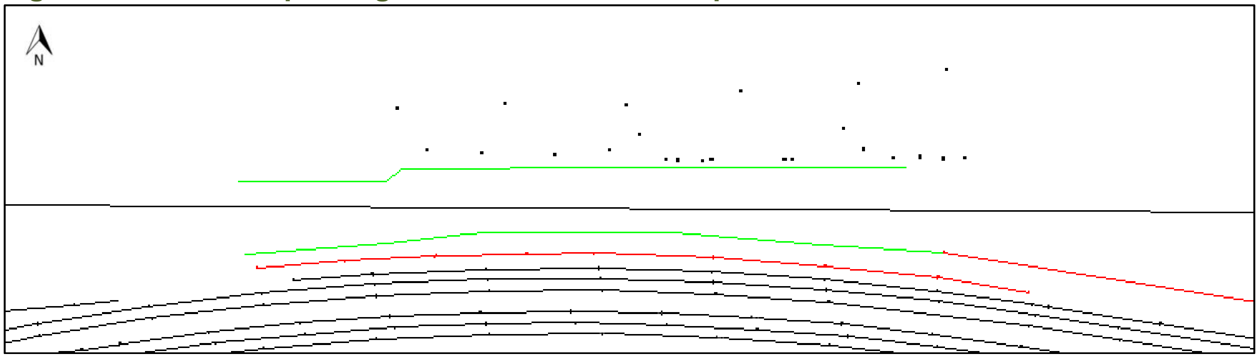


Table 21 – Township at Highlands Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	62.6	66.1	3.5	No	No
2	Residential	B	62.5	66.5	4.0	No	No
3	Residential	B	62.3	65.9	3.6	No	No
4	Residential	B	61.1	63.5	2.4	No	No
5	Residential	B	59.7	63.0	3.3	No	No
6	Residential	B	57.8	61.7	3.9	No	No
7	Residential	B	62.5	66.6	4.1	Yes	No
8	Residential	B	63.0	67.0	4.0	Yes	No
9	Residential	B	64.8	68.3	3.5	Yes	No
10	Residential	B	65.0	68.5	3.5	Yes	No
11	Residential	B	64.9	68.5	3.6	Yes	No
12	Residential	B	63.9	67.9	4.0	Yes	No
13	Residential	B	63.8	66.9	3.1	No	No
14	Residential	B	62.6	66.1	3.5	Yes	No
15	Residential	B	62.6	66.3	3.7	Yes	No
16	Residential	B	62.3	62.8	0.5	No	No
17	Residential	B	62.3	65.9	3.6	Yes	No
18	Residential	B	58.1	61.1	3.0	No	No
19	Residential	B	58.0	60.8	2.8	No	No
20	Residential	B	58.5	61.6	3.1	No	No
21	Residential	B	56.9	59.6	2.7	No	No
22	Residential	B	56.6	60.6	4.0	No	No
23	Residential	B	56.8	59.4	2.6	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Township at Highlands at Highlands Ranch Noise Impact Assessment

Table 21 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 30** and **Table 21.** Twelve receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 68.3 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Township at Highlands Ranch Noise Mitigation Assessment

A 1,700 feet long and 20 feet tall wall was evaluated along C-470 right-of-way. This wall was predicted to not provide the design goal of 7 dB(A) noise reduction or the minimum of 5 dB(A) of noise reduction (insertion loss) for any receptors. The lack of acoustic efficiency of the wall along C-470 is primarily due to the County Line Road traffic noise generated at a far closer proximity to the residences than C-470. Insertion losses are presented in **Table 22**. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

This wall would cost $1,530,000. Because this wall does not provide the design goal noise reduction of 7 dB(A) or even 5 dB(A) reduction to any receptors, there is no Benefit Cost Index for this wall within CDOT ROW. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 22 – Township at Highlands Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
1	Residential	B	66.1	65.2	0.9
2	Residential	B	66.5	65.3	1.2
3	Residential	B	65.9	64.5	1.4
7	Residential	B	66.6	63.0	3.6
8	Residential	B	67.0	63.2	3.8
9	Residential	B	68.3	65.0	3.3
10	Residential	B	68.5	65.5	3.0
11	Residential	B	68.5	65.9	2.6
12	Residential	B	67.9	65.8	2.1
13	Residential	B	66.9	62.7	4.2
14	Residential	B	66.1	65.0	1.1
15	Residential	B	66.3	65.7	0.6
17	Residential	B	65.9	65.5	0.4
				Total dB(A) Reduction (5dB(A) or greater)	**0**

In summary, the Township at Highlands Ranch area has 13 impacted receptors that would not benefit from noise mitigation. Mitigation is not recommended.

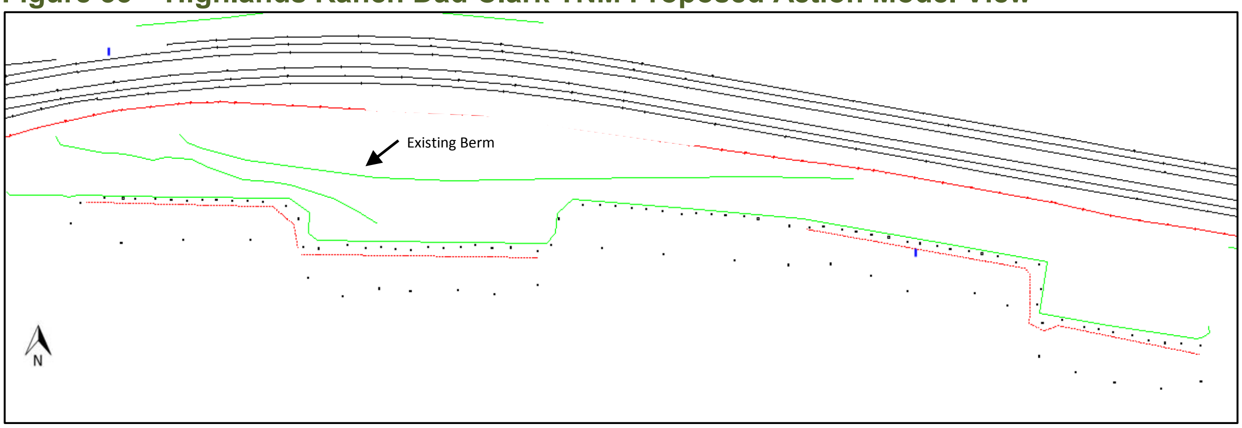
Highlands Ranch Dad Clark

Highlands Ranch Dad Clark area is a single-family residential development south of C-470 between University Boulevard and Broadway as shown in **Figure 29**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 32. Figure 33** shows a screen shot of the TNM model of the Proposed Action. While this is one neighborhood, the existing berm located in the middle of the neighborhood frontage splits these homes from a noise perspective, as shown in in **Figure 32. T**hus in an effort to focus on the specific needs of each area the evaluation was split into the western and eastern sections. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Tables 23 and 25.**

Figure 32 – Highlands Ranch Dad Clark Receptor Locations

Note: Impacted receptors are shaded green

Figure 33 – Highlands Ranch Dad Clark TNM Proposed Action Model View



WESTERN

Figure 34 – Western Highlands Ranch Dad Clark Receptor Locations

Note: Impacted receptors are shaded green

Table 23 – Western Highlands Ranch Dad Clark Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	53.7	59.4	5.7	No	No
2	Residential	B	55.1	59.9	4.8	No	No
3	Residential	B	56.1	63.8	7.7	No	No
4	Residential	B	55.7	61.9	6.2	No	No
5	Residential	B	55.4	61.5	6.1	No	No
6	Residential	B	55.5	61.6	6.1	No	No
7	Residential	B	55.6	61.0	5.4	No	No
8	Residential	B	56.6	61.7	5.1	No	No
9	Residential	B	58.0	62.5	4.5	No	No
10	Residential	B	58.0	63.3	5.3	No	No
11	Residential	B	57.9	63.1	5.2	No	No
12	Residential	B	58.0	62.6	4.6	No	No
13	Residential	B	57.8	62.4	4.6	No	No
14	Residential	B	57.3	61.5	4.2	No	No
15	Residential	B	56.1	60.1	4.0	No	No
16	Residential	B	55.7	59.5	3.8	No	No
17	Residential	B	55.6	59.2	3.6	No	No
18	Residential	B	55.6	59.2	3.6	No	No
19	Residential	B	55.9	59.3	3.4	No	No
20	Residential	B	56.0	59.3	3.3	No	No
21	Residential	B	56.4	60.0	3.6	No	No
22	Residential	B	56.7	60.5	3.8	No	No
23	Residential	B	57.1	61.1	4.0	No	No
24	Residential	B	57.2	61.4	4.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 23 – Western Highlands Ranch Dad Clark Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
25	Residential	B	57.4	61.5	4.1	No	No
26	Residential	B	57.9	62.4	4.5	No	No
27	Residential	B	59.4	63.8	4.4	No	No
28	Residential	B	61.2	65.2	4.0	No	No
29	Residential	B	58.5	60.5	2.0	No	No
30	Residential	B	59.7	64.3	4.6	No	No
31	Residential	B	60.9	65.8	4.9	Yes	No
32	Residential	B	62.0	67.0	5.0	Yes	No
33	Residential	B	63.0	67.7	4.7	Yes	No
34	Residential	B	63.8	68.3	4.5	Yes	No
35	Residential	B	64.4	68.7	4.3	Yes	No
36	Residential	B	64.9	69.3	4.4	Yes	No
37	Residential	B	65.4	69.7	4.3	Yes	No
38	Residential	B	66.0	70.1	4.1	Yes	No
39	Residential	B	66.4	70.5	4.1	Yes	No
40	Residential	B	65.7	70.1	4.4	Yes	No
41	Residential	B	65.9	70.2	4.3	Yes	No
42	Residential	B	66.4	70.6	4.2	Yes	No
43	Residential	B	67.9	71.5	3.6	Yes	No
44	Residential	B	66.8	70.6	3.8	Yes	No
45	Residential	B	67.1	70.8	3.7	Yes	No
46	Residential	B	66.7	70.0	3.3	Yes	No
47	Residential	B	63.7	67.3	3.6	Yes	No
48	Residential	B	59.9	63.6	3.7	No	No
49	Residential	B	59.0	62.9	3.9	No	No
50	Residential	B	57.2	61.0	3.8	No	No
51	Residential	B	56.4	60.4	4.0	No	No
52	Residential	B	55.0	58.8	3.8	No	No
53	Residential	B	54.6	58.1	3.5	No	No
54	Residential	B	54.0	58.0	4.0	No	No
55	Residential	B	56.1	60.3	4.2	No	No
56	Residential	B	55.1	59.4	4.3	No	No
57	Residential	B	53.9	59.5	5.6	No	No
58	Residential	B	53.4	57.8	4.4	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Western Highlands Ranch Dad Clark Noise Impact Assessment

Table 23 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 34** and **Table 23.** Seventeen receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.5 dB(A) at receptor 43. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Western Highlands Ranch Dad Clark Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,400 feet long and averaging 16.5 feet tall. With this optimized wall impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 8.6 dB(A), achieving the design goal of 7 dB(A) insertion loss. The insertion losses are presented in **Table 24**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,039,500	(Cost of wall = 1,400 feet long x 16.5 feet tall x $45/sf = $1,039,500)
÷ 112.2	(Total dB(A) reduction for the 18 receptors with equal to or greater than 5 dB(A) reduction)
$9,265	(Cost Benefit Index, cost per dB(A) per receptor)

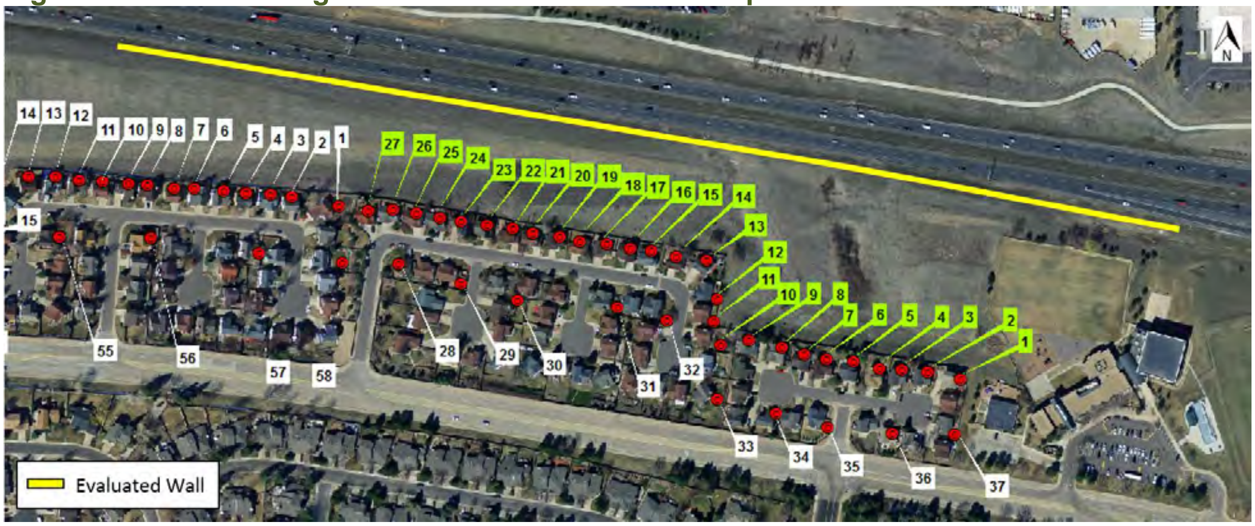
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 24 – Western Highlands Ranch Dad Clark Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
31	Residential	B	65.8	60.7	5.1
32	Residential	B	67.0	61.5	5.5
33	Residential	B	67.7	61.8	5.9
34	Residential	B	68.3	62.1	6.2
35	Residential	B	68.7	62.4	6.3
36	Residential	B	69.3	62.7	6.6
37	Residential	B	69.7	63.1	6.6
38	Residential	B	70.1	63.4	6.7
39	Residential	B	70.5	63.7	6.8
40	Residential	B	70.1	64.0	6.1
41	Residential	B	70.2	64.2	6.0
42	Residential	B	70.6	64.5	6.1
43	Residential	B	71.5	65.8	5.7
44	Residential	B	70.6	65.6	5.0
45	Residential	B	70.8	62.9	7.9
46	Residential	B	70.0	61.5	8.5
47	Residential	B	67.3	61.1	6.2
Other Benefitted	Residential	B			5.0
				Total dB(A) Reduction (5dB(A) or greater)	**112.2**

EASTERN

Figure 35 – Eastern Highlands Ranch Dad Clark Receptor Locations



Note: Impacted receptors are shaded green

Table 25 – Eastern Highlands Ranch Dad Clark Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	62.7	67.3	4.6	Yes	No
2	Residential	B	62.5	67.3	4.8	Yes	No
3	Residential	B	62.0	67.1	5.1	Yes	No
4	Residential	B	61.9	67.0	5.1	Yes	No
5	Residential	B	61.9	67.2	5.3	Yes	No
6	Residential	B	61.8	67.1	5.3	Yes	No
7	Residential	B	61.9	67.2	5.3	Yes	No
8	Residential	B	62.7	67.3	4.6	Yes	No
9	Residential	B	64.6	67.8	3.2	Yes	No
10	Residential	B	60.9	65.3	4.4	No	No
11	Residential	B	61.6	65.7	4.1	Yes	No
12	Residential	B	63.0	67.8	4.8	Yes	No
13	Residential	B	66.1	70.6	4.5	Yes	No
14	Residential	B	65.7	70.3	4.6	Yes	No
15	Residential	B	65.7	70.4	4.7	Yes	No
16	Residential	B	65.6	70.5	4.9	Yes	No
17	Residential	B	65.3	70.4	5.1	Yes	No
18	Residential	B	64.6	70.1	5.5	Yes	No
19	Residential	B	64.3	69.7	5.4	Yes	No
20	Residential	B	62.4	68.9	6.5	Yes	No
21	Residential	B	61.4	68.0	6.6	Yes	No
22	Residential	B	60.4	67.4	7.0	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 25 – Eastern Highlands Ranch Dad Clark Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
23	Residential	B	60.3	67.2	6.9	Yes	No
24	Residential	B	60.3	67.3	7.0	Yes	No
25	Residential	B	61.0	67.7	6.7	Yes	No
26	Residential	B	61.3	68.0	6.7	Yes	No
27	Residential	B	60.9	68.0	7.1	Yes	No
28	Residential	B	58.4	63.7	5.3	No	No
29	Residential	B	55.2	58.2	3.0	No	No
30	Residential	B	56.3	60.2	3.9	No	No
31	Residential	B	60.6	64.1	3.5	No	No
32	Residential	B	60.7	63.7	3.0	No	No
33	Residential	B	57.2	59.4	2.2	No	No
34	Residential	B	57.6	60.8	3.2	No	No
35	Residential	B	55.0	57.9	2.9	No	No
36	Residential	B	57.4	60.6	3.2	No	No
37	Residential	B	60.2	63.7	3.5	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Eastern Highlands Ranch Dad Clark Noise Impact Assessment

Table 25 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 35** and **Table 25.** Twenty-seven receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 71.4 dB(A) at receptor 16. An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Eastern Highlands Ranch Dad Clark Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, is 1,900 feet long and averaging 18.5 feet tall. With this optimized wall most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with some as high as 8.8 dB(A), achieving the design goal of 7 dB(A). The insertion losses are presented in **Table 26**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,581,750	(Cost of wall = 1,900 feet long x 18.5 feet tall x $45/sf = $1,581,750)
÷ 163.5	(Total dB(A) reduction for the 26 receptors with equal to or greater than 5 dB(A) reduction)
$9,674	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in **Appendix B**.

Table 26 – Eastern Highlands Ranch Dad Clark Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
1	Residential	B	67.3	64.1	3.2
2	Residential	B	67.3	63.5	3.8
3	Residential	B	67.1	62.9	4.2
4	Residential	B	67.0	62.5	4.5
5	Residential	B	67.2	62.2	5.0
6	Residential	B	67.1	61.9	5.2
7	Residential	B	67.2	61.9	5.3
8	Residential	B	67.3	61.9	5.4
10	Residential	B	67.8	61.9	5.9
11	Residential	B	65.7	59.7	6.0
12	Residential	B	67.8	60.4	7.4
13	Residential	B	70.6	61.8	8.8
14	Residential	B	70.3	61.8	8.5
15	Residential	B	70.4	61.9	8.5
16	Residential	B	70.5	62.1	8.4
17	Residential	B	70.4	62.1	8.3
18	Residential	B	70.1	61.9	8.2
19	Residential	B	69.7	61.9	7.8
20	Residential	B	68.9	61.4	7.5
21	Residential	B	68.0	61.0	7.0
22	Residential	B	67.4	60.8	6.6
23	Residential	B	67.2	61.1	6.1
24	Residential	B	67.3	61.6	5.7
25	Residential	B	67.7	62.0	5.7
26	Residential	B	68.0	62.5	5.5
27	Residential	B	68.0	63.0	5.0
				Total dB(A) Reduction (5dB(A) or greater)	**163.5**

In summary, the Highlands Ranch Dad Clark combined area (eastern and western) has 44 receptors that could benefit from noise mitigation. However, the CBI is over CDOT's cost threshold and mitigation is not recommended.

4.7 University Boulevard to Colorado Boulevard

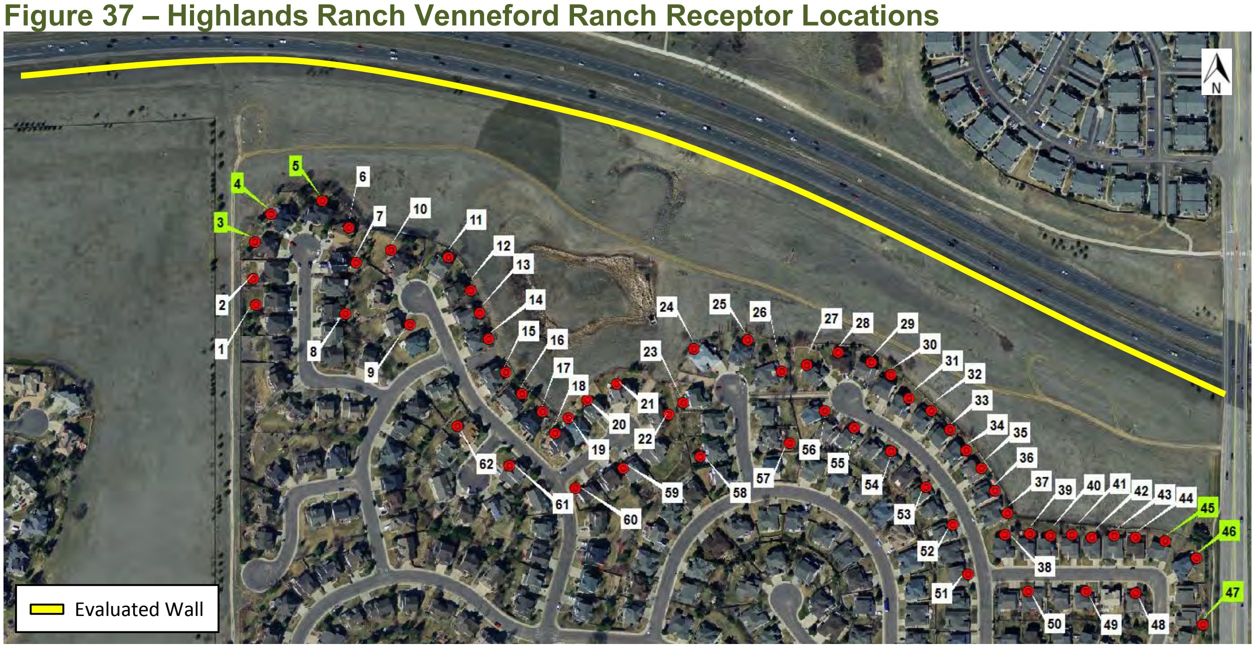
The Broadway to University Boulevard area includes the communities of Highlands Ranch Venneford Ranch, Autumn Chase, Copper Canyon, and Canyon Ranch as shown in **Figure 36**.

Figure 36 – University Boulevard to Colorado Boulevard

Highlands Ranch Venneford Ranch

Highlands Ranch Venneford Ranch is a single-family residential development south of C-470 between Colorado Boulevard and University Avenue as shown in **Figure 36**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 37**. **Figure 38** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 27.**

Figure 37 – Highlands Ranch Venneford Ranch Receptor Locations



Note: Impacted receptors are shaded green

Figure 38 – Highlands Ranch Venneford Ranch TNM Proposed Action Model View

Table 27 – Highlands Ranch Venneford Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	56.5	59.9	3.4	No	No
2	Residential	B	58.2	61.9	3.7	No	No
3	Residential	B	60.3	65.5	5.2	Yes	No
4	Residential	B	64.4	68.8	4.4	Yes	No
5	Residential	B	64.9	69.0	4.1	Yes	No
6	Residential	B	61.3	65.4	4.1	No	No
7	Residential	B	59.3	62.9	3.6	No	No
8	Residential	B	56.9	59.7	2.8	No	No
9	Residential	B	58.1	61.0	2.9	No	No
10	Residential	B	60.5	64.5	4.0	No	No
11	Residential	B	62.2	65.3	3.1	No	No
12	Residential	B	60.8	64.2	3.4	No	No
13	Residential	B	59.6	63.2	3.6	No	No
14	Residential	B	58.7	62.1	3.4	No	No
15	Residential	B	57.4	60.9	3.5	No	No
16	Residential	B	58.2	61.5	3.3	No	No
17	Residential	B	58.9	62.0	3.1	No	No
18	Residential	B	56.5	60.0	3.5	No	No
19	Residential	B	57.2	60.6	3.4	No	No
20	Residential	B	58.6	61.8	3.2	No	No
21	Residential	B	60.7	63.6	2.9	No	No
22	Residential	B	57.9	60.9	3.0	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 27 – Highlands Ranch Venneford Ranch Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
23	Residential	B	59.4	62.5	3.1	No	No
24	Residential	B	62.7	65.4	2.7	No	No
25	Residential	B	62.1	65.2	3.1	No	No
26	Residential	B	61.3	64.3	3.0	No	No
27	Residential	B	61.2	64.4	3.2	No	No
28	Residential	B	60.5	63.4	2.9	No	No
29	Residential	B	58.5	61.4	2.9	No	No
30	Residential	B	58.0	60.8	2.8	No	No
31	Residential	B	56.5	59.5	3.0	No	No
32	Residential	B	56.2	59.2	3.0	No	No
33	Residential	B	57.7	61.3	3.6	No	No
34	Residential	B	60.9	63.4	2.5	No	No
35	Residential	B	59.0	60.5	1.5	No	No
36	Residential	B	58.8	59.6	0.8	No	No
37	Residential	B	58.3	59.7	1.4	No	No
38	Residential	B	58.5	60.2	1.7	No	No
39	Residential	B	59.3	60.6	1.3	No	No
40	Residential	B	60.2	61.3	1.1	No	No
41	Residential	B	60.8	61.7	0.9	No	No
42	Residential	B	61.8	62.5	0.7	No	No
43	Residential	B	63.0	63.7	0.7	No	No
44	Residential	B	64.4	65.3	0.9	No	No
45	Residential	B	68.0	68.6	0.6	Yes	No
46	Residential	B	72.7	73.0	0.3	Yes	No
47	Residential	B	73.2	73.4	0.2	Yes	No
48	Residential	B	60.6	61.2	0.6	No	No
49	Residential	B	55.0	56.1	1.1	No	No
50	Residential	B	53.5	55.6	2.1	No	No
51	Residential	B	56.1	57.7	1.6	No	No
52	Residential	B	55.8	58.2	2.4	No	No
53	Residential	B	56.3	59.3	3.0	No	No
54	Residential	B	57.3	60.5	3.2	No	No
55	Residential	B	58.0	60.8	2.8	No	No
56	Residential	B	58.8	61.6	2.8	No	No
57	Residential	B	58.2	61.1	2.9	No	No
58	Residential	B	57.0	60.0	3.0	No	No
59	Residential	B	55.3	58.6	3.3	No	No
60	Residential	B	54.4	57.8	3.4	No	No
61	Residential	B	55.0	58.8	3.8	No	No
62	Residential	B	56.2	59.5	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Highlands Ranch Venneford Ranch Noise Impact Assessment

Table 27 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 37** and **Table 27.** Six receptors equal or exceed CDOT impact criteria for residential and thus per CDOT policy are considered impacted. The highest predicted future noise level is 73.4 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Highlands Ranch Venneford Ranch Noise Mitigation Assessment

A 3,330 feet long and 20 feet tall wall was evaluated along C-470 right-of-way from Colorado Boulevard west. This wall was predicted to be the optimal wall providing the most positive Cost Benefit Index calculation for the impacted receptors in addition to providing benefits to approximately 20 additional non-impacted residences which improved the Cost Benefit Index calculation. The insertion losses for the impacted receptors are presented in **Table 28**. However, the maximum wall did not provide the design goal of 7 dB(A) for any receptors and several impacted receptors did not receive the minimum 5 dB(A) insertion loss. Receptors 45, 46, and 47, located along Colorado Boulevard, received inaudible reductions of 0.5, 0.1 to 0.0 dB(A) respectively with a 20 foot high wall. The reason for the minimal insertion loss for these impacted receptors is because these homes along Colorado Boulevard are roughly 500 feet from C-470 and receive a majority of their traffic noise from the adjacent Colorado Boulevard. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$2,997,000	(Cost of wall = 3,330 feet long x 20.0 feet tall x $45/sf = $2,997,000)
÷ 119.4	(Total dB(A) reduction for the 22 receptors with equal to or greater than 5 dB(A) reduction)
$25,101	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier and the design goal of 7 dB(A) was not achieved with the 20 foot wall. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Venneford Rand receptors were evaluated for potential reflective noise from the wall recommended for the Autumn Chase, Copper Canyon and Canyon Ranch neighborhood. The recommended wall is roughly 500 feet plus north of Venneford Ranch across C-470. Predicted noise levels for Venneford Ranch receptors were unchanged with the Autumn Chase, Copper Canyon and Canyon Ranch recommended wall from when the wall was removed. The Autumn Chase, Copper Canyon and Canyon Ranch recommended wall will not change the noise environment for Venneford Ranch receptors.

Table 28 – Highlands Ranch Venneford Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
3	Residential	B	65.5	61.1	4.4
4	Residential	B	68.8	63.5	5.3
5	Residential	B	69.0	63.8	5.2
44	Residential	B	68.6	68.1	0.5
45	Residential	B	73.0	72.9	0.1
47	Residential	B	73.4	73.4	0.0
Additional Benefitted Receptors that were not Impacted					
9	Residential	B	61.0	56.0	5.0
11	Residential	B	65.3	60.1	5.2
12	Residential	B	64.2	58.4	5.8
13	Residential	B	63.2	57.6	5.6
14	Residential	B	62.1	56.7	5.4
15	Residential	B	60.9	55.8	5.1
16	Residential	B	61.5	56.4	5.1
17	Residential	B	62.0	56.5	5.5
18	Residential	B	60.0	54.9	5.1
19	Residential	B	60.6	55.4	5.2
20	Residential	B	61.8	56.4	5.4
21	Residential	B	63.6	57.2	6.4
22	Residential	B	60.9	55.9	5.0
23	Residential	B	62.5	57.2	5.3
24	Residential	B	65.4	58.9	6.5
25	Residential	B	65.2	59.5	5.7
59	Residential	B	58.6	53.3	5.3
60	Residential	B	57.8	52.4	5.4
61	Residential	B	58.8	53.4	5.4
62	Residential	B	59.5	54.0	5.5
				Total dB(A) Reduction (5dB(A) or greater)	119.4

In summary, the Highlands Ranch Venneford Ranch area has three impacted receptors and 20 additional receptors that could benefit from noise mitigation. However, with the maximum height wall the 7 dB(A) design goal was not met and the CBI is over CDOT's cost threshold. Mitigation is not recommended.

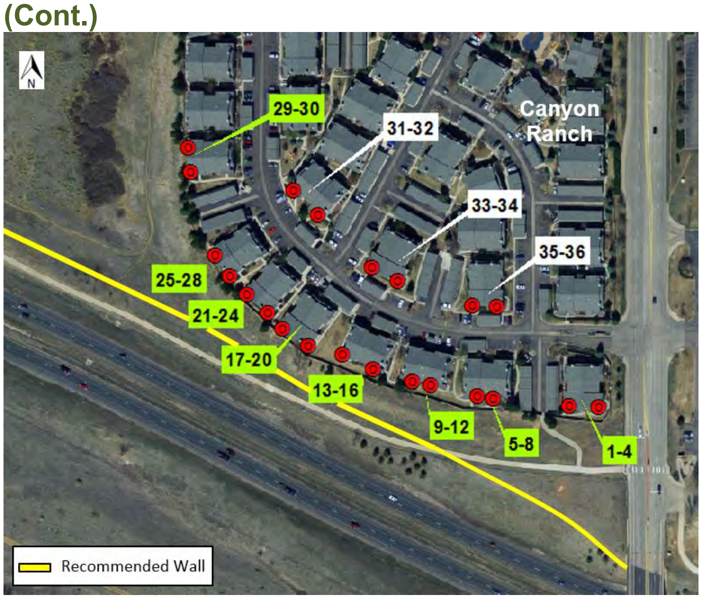
Autumn Chase, Copper Canyon, and Canyon Ranch (ACC)

Autumn Chase, Copper Canyon and Canyon Ranch are a series of multi-storied residential complexes north of C-470, extending from Colorado Boulevard approximately 3,800 feet west as shown in **Figure 36**. Based on the close proximity of these complexes the mitigation for these sites is interrelated and thus they were evaluated together. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 39. Figure 40** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 113 receptor locations for both existing and Proposed Action conditions and are shown in **Table 29.**

Figure 39 – Autumn Chase, Copper Canyon and Canyon Ranch Receptor Locations

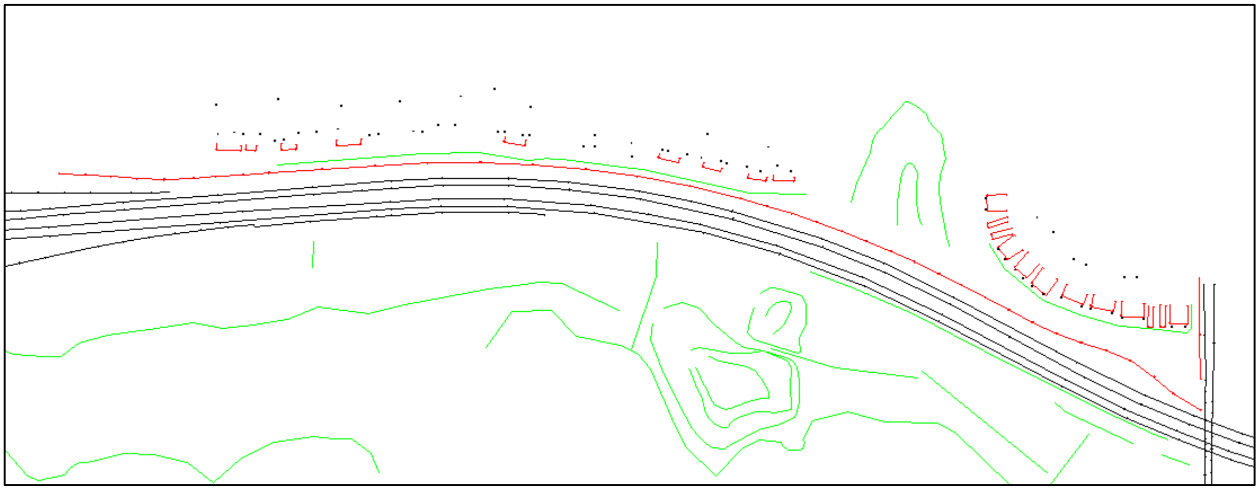
Note: Impacted receptors are shaded green

Figure 39 – Autumn Chase, Copper Canyon and Canyon Ranch Receptor Locations (Cont.)



Note: Impacted receptors are shaded green

Figure 40 – Autumn Chase, Copper Canyon and Canyon Ranch TNM Proposed Action Model View



Autumn Chase, Copper Canyon and Canyon Ranch Noise iAssessment
Table 29 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 39** and **Table 29.** One hundred receptors equal or exceed CDOT Impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 76.8 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Autumn Chase, Copper Canyon and Canyon Ranch Noise Mitigation Assessment
The optimal combination of walls providing the greatest noise reduction for impacted receptors per square foot of wall, was a 4,330 feet long and 15.75 feet tall wall north of C-470 and a 390 foot long 8 feet high wall west of Colorado Boulevard all within CDOT ROW. With these optimized walls most impacted properties are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 12.6 dB(A). The design goal reduction of 7 dB(A) or more was met by at least one receptor. The insertion losses are presented in **Table 30**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$3,068,888	(Cost of wall = 4,330 feet long x 15.75 feet tall x $45/sf = $3,068,888)
÷ 724.5	(Total dB(A) reduction for the 87 receptors with equal to or greater than 5 dB(A) reduction)
$4,236	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 29 – Autumn Chase, Copper Canyon and Canyon Ranch Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Canyon Ranch							
1	Residential	B	72.6	73.2	0.6	Yes	No
2	Residential	B	73.7	74.7	1.0	Yes	No
3	Residential	B	69.4	70.6	1.2	Yes	No
4	Residential	B	71.6	73.5	1.9	Yes	No
5	Residential	B	63.4	66.3	2.9	Yes	No
6	Residential	B	69.9	72.4	2.5	Yes	No
7	Residential	B	68.0	70.9	2.9	Yes	No
8	Residential	B	71.9	74.9	3.0	Yes	No
9	Residential	B	68.2	71.1	2.9	Yes	No
10	Residential	B	72.0	75.0	3.0	Yes	No
11	Residential	B	71.0	73.1	2.1	Yes	No
12	Residential	B	72.9	75.8	2.9	Yes	No
13	Residential	B	70.3	72.9	2.6	Yes	No
14	Residential	B	72.9	75.9	3.0	Yes	No
15	Residential	B	71.9	74.2	2.3	Yes	No
16	Residential	B	73.1	76.0	2.9	Yes	No
17	Residential	B	72.6	75.1	2.5	Yes	No
18	Residential	B	73.7	76.7	3.0	Yes	No
19	Residential	B	72.5	74.9	2.4	Yes	No
20	Residential	B	73.5	76.5	3.0	Yes	No
21	Residential	B	71.6	74.1	2.5	Yes	No
22	Residential	B	73.1	76.1	3.0	Yes	No
23	Residential	B	71.1	73.6	2.5	Yes	No
24	Residential	B	72.8	75.8	3.0	Yes	No
25	Residential	B	70.1	72.6	2.5	Yes	No
26	Residential	B	72.4	75.4	3.0	Yes	No
27	Residential	B	69.2	71.8	2.6	Yes	No
28	Residential	B	71.9	74.9	3.0	Yes	No
29	Residential	B	66.1	68.3	2.2	Yes	No
30	Residential	B	65.6	67.4	1.8	Yes	No
31	Residential	B	59.1	61.5	2.4	No	No
32	Residential	B	56.0	58.5	2.5	No	No
33	Residential	B	56.9	60.6	3.7	No	No
34	Residential	B	56.4	59.6	3.2	No	No
35	Residential	B	57.6	57.8	0.2	No	No
36	Residential	B	57.5	57.6	0.1	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 29 – Autumn Chase, Copper Canyon and Canyon Ranch Noise Model Results without Mitigation (cont 1)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Copper Canyon							
1	Residential	B	62.6	64.9	2.3	No	No
2	Residential	B	71.1	72.9	1.8	Yes	No
3	Residential	B	63.3	65.3	2.0	No	No
4	Residential	B	71.0	72.9	1.9	Yes	No
5	Residential	B	63.2	65.5	2.3	Yes	No
6	Residential	B	72.1	74.4	2.3	Yes	No
7	Residential	B	66.0	66.9	0.9	Yes	No
8	Residential	B	72.1	74.5	2.4	Yes	No
9	Residential	B	66.3	67.1	0.8	Yes	No
10	Residential	B	72.3	75.3	3.0	Yes	No
11	Residential	B	64.7	66.4	1.7	Yes	No
12	Residential	B	72.2	75.2	3.0	Yes	No
13	Residential	B	68.7	69.6	0.9	Yes	No
14	Residential	B	72.5	75.6	3.1	Yes	No
15	Residential	B	68.4	69.3	0.9	Yes	No
16	Residential	B	72.4	75.5	3.1	Yes	No
17	Residential	B	62.0	65.5	3.5	Yes	No
18	Residential	B	72.2	75.4	3.2	Yes	No
19	Residential	B	62.2	66.8	4.6	Yes	No
20	Residential	B	72.2	75.3	3.1	Yes	No
21	Residential	B	65.3	69.4	4.1	Yes	No
22	Residential	B	63.2	67.7	4.5	Yes	No
23	Residential	B	62.9	66.8	3.9	Yes	No
24	Residential	B	61.7	65.8	4.1	Yes	No
25	Residential	B	63.0	68.4	5.4	Yes	No
26	Residential	B	65.2	67.0	1.8	Yes	No
27	Residential	B	64.1	66.1	2.0	Yes	No
Autumn Chase							
1	Residential	B	60.9	64.8	3.9	No	No
2	Residential	B	72.1	74.1	2.0	No	No
3	Residential	B	60.3	63.9	3.6	No	No
4	Residential	B	72.1	74.2	2.1	No	No
5	Residential	B	63.0	67.8	4.8	No	No
6	Residential	B	71.9	74.7	2.8	No	No
7	Residential	B	63.3	69.2	5.9	No	No
8	Residential	B	71.9	74.6	2.7	No	No
9	Residential	B	67.2	69.2	2.0	No	No
10	Residential	B	71.8	75.0	3.2	No	No
11	Residential	B	67.4	69.7	2.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 29 – Autumn Chase, Copper Canyon and Canyon Ranch Noise Model Results without Mitigation (cont 2)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Autumn Chase (cont.)							
12	Residential	B	72.0	75.1	3.1	No	No
13	Residential	B	68.8	71.0	2.2	No	No
14	Residential	B	72.8	75.9	3.1	No	No
15	Residential	B	73.2	76.8	3.6	No	No
16	Residential	B	68.5	70.7	2.2	No	No
17	Residential	B	72.8	75.8	3.0	No	No
18	Residential	B	73.1	76.7	3.6	Yes	No
19	Residential	B	64.7	68.7	4.0	Yes	No
20	Residential	B	73.0	76.0	3.0	Yes	No
21	Residential	B	64.1	68.4	4.3	Yes	No
22	Residential	B	73.0	76.0	3.0	Yes	No
23	Residential	B	64.6	68.2	3.6	Yes	No
24	Residential	B	72.4	75.4	3.0	Yes	No
25	Residential	B	63.1	66.1	3.0	Yes	No
26	Residential	B	72.4	75.2	2.8	Yes	No
27	Residential	B	61.0	64.8	3.8	No	No
28	Residential	B	72.4	75.2	2.8	Yes	No
29	Residential	B	62.3	65.8	3.5	Yes	No
30	Residential	B	72.5	75.4	2.9	Yes	No
31	Residential	B	62.3	65.8	3.5	Yes	No
32	Residential	B	73.1	76.0	2.9	Yes	No
33	Residential	B	73.3	76.6	3.3	Yes	No
34	Residential	B	61.9	65.9	4.0	Yes	No
35	Residential	B	73.1	76.0	2.9	Yes	No
36	Residential	B	73.3	76.6	3.3	Yes	No
37	Residential	B	62.7	66.1	3.4	Yes	No
38	Residential	B	72.5	75.3	2.8	Yes	No
39	Residential	B	62.9	66.2	3.3	Yes	No
40	Residential	B	72.4	75.2	2.8	Yes	No
41	Residential	B	63.5	66.7	3.2	Yes	No
42	Residential	B	72.3	75.0	2.7	Yes	No
43	Residential	B	65.3	68.3	3.0	Yes	No
44	Residential	B	62.0	64.6	2.6	No	No
45	Residential	B	59.9	63.2	3.3	No	No
46	Residential	B	59.7	63.9	4.2	No	No
47	Residential	B	61.1	64.8	3.7	No	No
48	Residential	B	60.2	64.1	3.9	No	No
49	Residential	B	59.4	63.1	3.7	No	No
50	Residential	B	59.2	63.0	3.8	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 30 – Autumn Chase, Copper Canyon and Canyon Ranch Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Canyon Ranch					
1	Residential	B	73.2	64.6	8.6
2	Residential	B	74.7	69.6	5.1
3	Residential	B	70.6	64.7	5.9
4	Residential	B	73.5	68.1	5.4
5	Residential	B	66.3	60.2	6.1
6	Residential	B	72.4	65.0	7.4
7	Residential	B	70.9	64.5	6.4
8	Residential	B	74.9	68.1	6.8
9	Residential	B	71.1	64.3	6.8
10	Residential	B	75.0	68.1	6.9
11	Residential	B	73.1	66.0	7.1
12	Residential	B	75.8	70.0	5.8
13	Residential	B	72.9	65.1	7.8
14	Residential	B	75.9	69.1	6.8
15	Residential	B	74.2	65.3	8.9
16	Residential	B	76.0	70.3	5.7
17	Residential	B	75.1	65.5	9.6
18	Residential	B	76.7	69.5	7.2
19	Residential	B	74.9	65.9	9.0
20	Residential	B	76.5	70.1	6.4
21	Residential	B	74.1	65.4	8.7
22	Residential	B	76.1	68.7	7.4
23	Residential	B	73.6	65.6	8.0
24	Residential	B	75.8	68.8	7.0
25	Residential	B	72.6	65.6	7.0
26	Residential	B	75.4	68.1	7.3
27	Residential	B	71.8	65.8	6.0
28	Residential	B	74.9	67.9	7.0
29	Residential	B	68.3	62.7	5.6
30	Residential	B	67.4	61.7	5.7
Copper Canyon					
2	Residential	B	72.9	65.1	7.8
4	Residential	B	72.9	64.7	8.2
5	Residential	B	65.5	60.8	4.7
6	Residential	B	74.4	65.4	9.0
7	Residential	B	66.9	61.0	5.9
8	Residential	B	74.5	65.0	9.5
9	Residential	B	67.1	61.9	5.2
10	Residential	B	75.3	64.8	10.5

Table 30 – Autumn Chase, Copper Canyon and Canyon Ranch Impacted Receptors with Mitigation (cont 1)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Copper Canyon (cont.)					
11	Residential	B	66.4	62.0	4.4
12	Residential	B	75.2	64.8	10.4
13	Residential	B	69.6	62.4	7.2
14	Residential	B	75.6	64.8	10.8
15	Residential	B	69.3	61.9	7.4
16	Residential	B	75.5	64.3	11.2
17	Residential	B	65.5	60.6	4.9
18	Residential	B	75.4	63.5	11.9
19	Residential	B	66.8	60.9	5.9
20	Residential	B	75.3	63.3	12.0
21	Residential	B	69.4	61.6	7.8
22	Residential	B	67.7	61.3	6.4
23	Residential	B	66.8	61.2	5.6
24	Residential	B	65.8	60.8	5.0
25	Residential	B	68.4	60.7	7.7
26	Residential	B	67.0	62.0	5.0
27	Residential	B	66.1	62.2	3.9
Autumn Chase					
2	Residential	B	74.1	62.8	11.3
4	Residential	B	74.2	62.8	11.4
5	Residential	B	67.8	61.4	6.4
6	Residential	B	74.7	63.3	11.4
7	Residential	B	69.2	61.5	7.7
8	Residential	B	74.6	63.3	11.3
9	Residential	B	69.2	62.2	7.0
10	Residential	B	75.0	64.1	10.9
11	Residential	B	69.7	62.3	7.4
12	Residential	B	75.1	64.3	10.8
13	Residential	B	71.0	62.8	8.2
14	Residential	B	75.9	64.9	11.0
15	Residential	B	76.8	68.9	7.9
16	Residential	B	70.7	62.7	8.0
17	Residential	B	75.8	64.8	11.0
18	Residential	B	76.7	68.6	8.1
19	Residential	B	68.7	61.8	6.9
20	Residential	B	76.0	63.9	12.1
21	Residential	B	68.4	61.6	6.8
22	Residential	B	76.0	63.7	12.3
23	Residential	B	68.2	61.7	6.5
24	Residential	B	75.4	63.6	11.8

Table 30 – Autumn Chase, Copper Canyon and Canyon Ranch Impacted Receptors with Mitigation (cont 2)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Autumn Chase (cont.)					
25	Residential	B	66.1	61.3	4.8
26	Residential	B	75.2	63.2	12.0
28	Residential	B	75.2	62.7	12.5
29	Residential	B	65.8	61.1	4.7
30	Residential	B	75.4	63.2	12.2
31	Residential	B	65.8	59.9	5.9
32	Residential	B	76.0	63.4	12.6
33	Residential	B	76.6	66.0	10.6
34	Residential	B	65.9	59.5	6.4
35	Residential	B	76.0	63.5	12.5
36	Residential	B	76.6	66.1	10.5
37	Residential	B	66.1	61.5	4.6
38	Residential	B	75.3	63.9	11.4
39	Residential	B	66.2	62.0	4.2
40	Residential	B	75.2	64.4	10.8
41	Residential	B	66.7	62.2	4.5
42	Residential	B	75.0	64.7	10.3
43	Residential	B	68.3	62.7	5.6
Other Benefitted	Residential	B			5.2
				Total dB(A) Reduction (5 dB(A) or greater)	**724.5**

In summary, the Autumn Chase, Copper Canyon and Canyon Ranch area has 87 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

4.8 Colorado Boulevard to Quebec

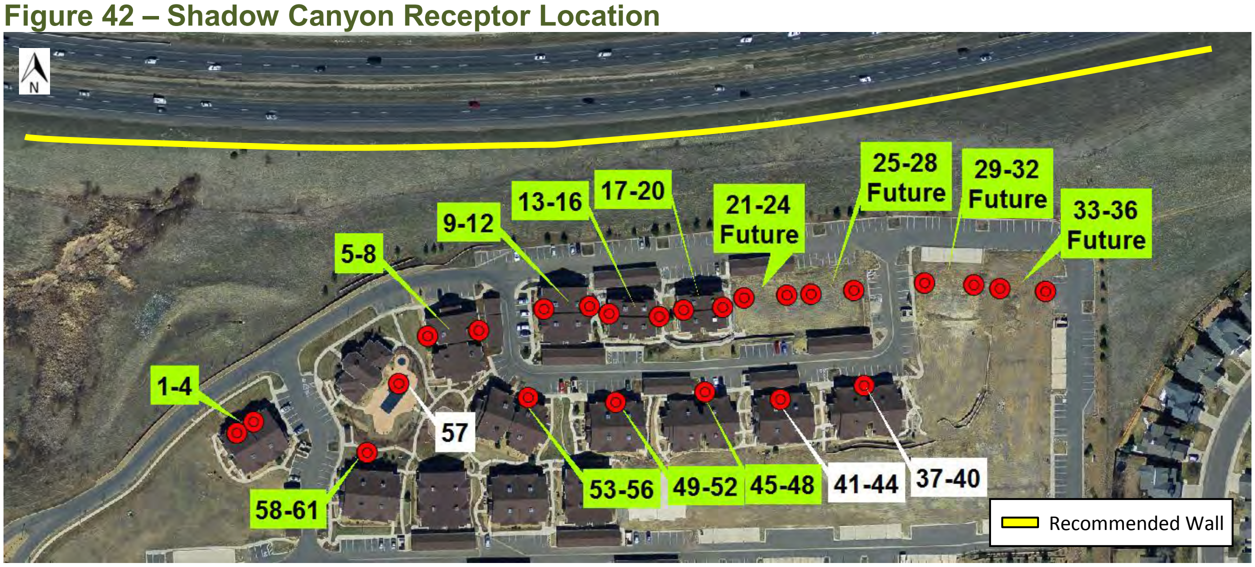
The Colorado Boulevard to Quebec area includes the communities of Highlands Ranch Shadow Canyon, Gleneagles Village, and Palomino Park as shown in **Figure 41**.

Figure 41 – Colorado Boulevard to Quebec

Shadow Canyon

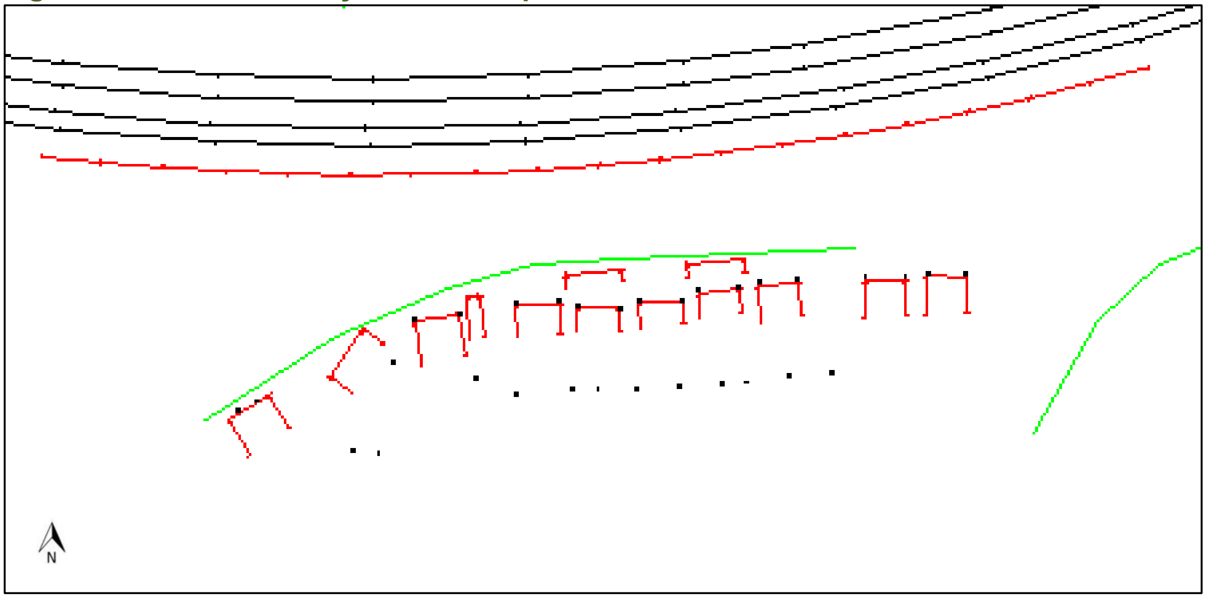
Shadow Canyon is a multi-storied residential complex south of C-470 between Colorado Boulevard and Quebec as shown in **Figure 41**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 42. Figure 43** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 61 receptor locations for both existing and Proposed Action conditions and are shown in **Table 31.**

Figure 42 – Shadow Canyon Receptor Location



Note: Impacted receptors are shaded green

Figure 43 – Shadow Canyon TNM Proposed Action Model View



Shadow Canyon Noise Impact Assessment

Table 31 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 42** and **Table 31.** Forth-one receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 74.6 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Shadow Canyon Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,700 feet long and averaging 18.7 feet tall. With this optimized wall many impacted property are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 9.2 dB(A), achieving the design goal of 7 dB(A). This meets the design goal reduction of 7 dB(A) or more for at least one receptor. The insertion losses are presented in **Table 32**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,430,550	(Cost of wall = 1,700 feet long x 18.7 feet tall x $45/sf = $1,430,550)
÷ 251.7	(Total dB(A) reduction for the 39 receptors with equal to or greater than 5 dB(A) reduction)
$5,684	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 31 – Shadow Canyon Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	60.9	64.1	3.2	No	No
2	Residential	B	65.5	69.7	4.2	Yes	No
3	Residential	B	61.5	65.1	3.6	No	No
4	Residential	B	66.1	70.2	4.1	Yes	No
5	Residential	B	64.1	68.1	4.0	Yes	No
6	Residential	B	69.9	73.6	3.7	Yes	No
7	Residential	B	63.5	67.6	4.1	Yes	No
8	Residential	B	70.0	73.3	3.3	Yes	No
9	Residential	B	67.2	71.2	4.0	Yes	No
10	Residential	B	71.3	74.6	3.3	Yes	No
11	Residential	B	69.1	73.0	3.9	Yes	No
12	Residential	B	71.6	74.8	3.2	Yes	No
13	Residential	B	68.4	72.1	3.7	Yes	No
14	Residential	B	71.4	74.6	3.2	Yes	No
15	Residential	B	66.3	69.9	3.6	Yes	No
16	Residential	B	71.2	74.3	3.1	Yes	No
17	Residential	B	66.1	70.1	4.0	Yes	No
18	Residential	B	71.3	74.5	3.2	Yes	No
19	Residential	B	64.7	69.0	4.3	Yes	No
20	Residential	B	70.9	74.0	3.1	Yes	No
21	Residential	B	62.9	66.5	3.6	Yes	No
22	Residential	B	70.1	73.1	3.0	Yes	No
23	Residential	B	58.2	62.9	4.7	Yes	No
24	Residential	B	66.7	69.7	3.0	Yes	No
25	Residential	B	60.9	66.2	5.3	Yes	No
26	Residential	B	69.4	72.7	3.3	Yes	No
27	Residential	B	60.3	64.7	4.4	Yes	No
28	Residential	B	70.0	73.5	3.5	Yes	No
29	Residential	B	65.5	70.3	4.8	Yes	No
30	Residential	B	70.9	73.8	2.9	Yes	No
31	Residential	B	65.7	70.5	4.8	Yes	No
32	Residential	B	70.6	73.7	3.1	Yes	No
33	Residential	B	66.0	70.6	4.6	Yes	No
34	Residential	B	70.6	73.8	3.2	Yes	No
35	Residential	B	65.5	70.2	4.7	Yes	No
36	Residential	B	70.3	73.5	3.2	Yes	No
37	Residential	B	57.6	60.5	2.9	No	No
38	Residential	B	62.2	65.4	3.2	No	No
39	Residential	B	54.3	57.8	3.5	No	No
40	Residential	B	59.6	62.9	3.3	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 31 – Shadow Canyon Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
41	Residential	B	55.5	59.2	3.7	No	No
42	Residential	B	60.1	63.5	3.4	No	No
43	Residential	B	56.5	60.1	3.6	No	No
44	Residential	B	61.0	64.1	3.1	No	No
45	Residential	B	58.1	61.1	3.0	No	No
46	Residential	B	62.9	65.9	3.0	Yes	No
47	Residential	B	59.9	63.3	3.4	No	No
48	Residential	B	64.1	67.2	3.1	Yes	No
49	Residential	B	61.1	64.5	3.4	No	No
50	Residential	B	63.5	66.7	3.2	Yes	No
51	Residential	B	62.5	65.7	3.2	Yes	No
52	Residential	B	64.4	67.5	3.1	Yes	No
53	Residential	B	59.4	63.0	3.6	No	No
54	Residential	B	66.1	69.5	3.4	Yes	No
55	Residential	B	56.9	60.1	3.2	No	No
56	Residential	B	64.7	68.3	3.6	Yes	No
57	Residential	B	59.2	62.7	3.5	No	No
58	Residential	B	56.6	59.9	3.3	No	No
59	Residential	B	61.1	65.3	4.2	No	No
60	Residential	B	56.8	60.6	3.8	No	No
61	Residential	B	62.1	66.0	3.9	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 32 – Shadow Canyon Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
SC2	Residential	B	69.7	66.1	3.6
SC4	Residential	B	70.2	66.2	4.0
SC5	Residential	B	68.1	63.1	5.0
SC6	Residential	B	73.6	65.2	8.4
SC7	Residential	B	67.6	62.4	5.2
SC8	Residential	B	73.3	64.6	8.7
SC9	Residential	B	71.2	64.6	6.6
SC10	Residential	B	74.6	66.7	7.9
SC11	Residential	B	73.0	66.4	6.6
SC12	Residential	B	74.8	68.6	6.2
SC13	Residential	B	72.1	66.0	6.1
SC14	Residential	B	74.6	68.3	6.3
SC15	Residential	B	69.9	64.7	5.2

Table 32 – Shadow Canyon Impacted Receptors with Mitigation (cont)

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
SC16	Residential	B	74.3	67.5	6.8
SC17	Residential	B	70.1	64.2	5.9
SC18	Residential	B	74.5	67.2	7.3
SC19	Residential	B	69.0	62.2	6.8
SC20	Residential	B	74.0	66.8	7.2
SC21	Residential	B	66.5	60.6	5.9
SC22	Residential	B	73.1	66.3	6.8
SC24	Residential	B	69.7	64.1	5.6
SC25	Residential	B	66.2	59.4	6.8
SC26	Residential	B	72.7	64.5	8.2
SC28	Residential	B	73.5	64.3	9.2
SC29	Residential	B	70.3	64.4	5.9
SC30	Residential	B	73.8	66.8	7.0
SC31	Residential	B	70.5	65.2	5.3
SC32	Residential	B	73.7	67.4	6.3
SC33	Residential	B	70.6	65.6	5.0
SC34	Residential	B	73.8	67.8	6.0
SC35	Residential	B	70.2	65.6	4.6
SC36	Residential	B	73.5	67.9	5.6
SC46	Residential	B	65.9	63.0	2.9
SC48	Residential	B	67.2	64.5	2.7
SC50	Residential	B	66.7	64.3	2.4
SC51	Residential	B	65.7	62.6	3.1
SC52	Residential	B	67.5	64.3	3.2
SC54	Residential	B	69.5	64.0	5.5
SC56	Residential	B	68.3	62.1	6.2
SC61	Residential	B	66.0	62.5	3.5
Other Benefitted	Residential	B			44.9
			Total dB(A) Reduction (5 dB(A) or greater)		**251.7**

In summary, the Shadow Canyon area has 39 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and mitigation is recommended.

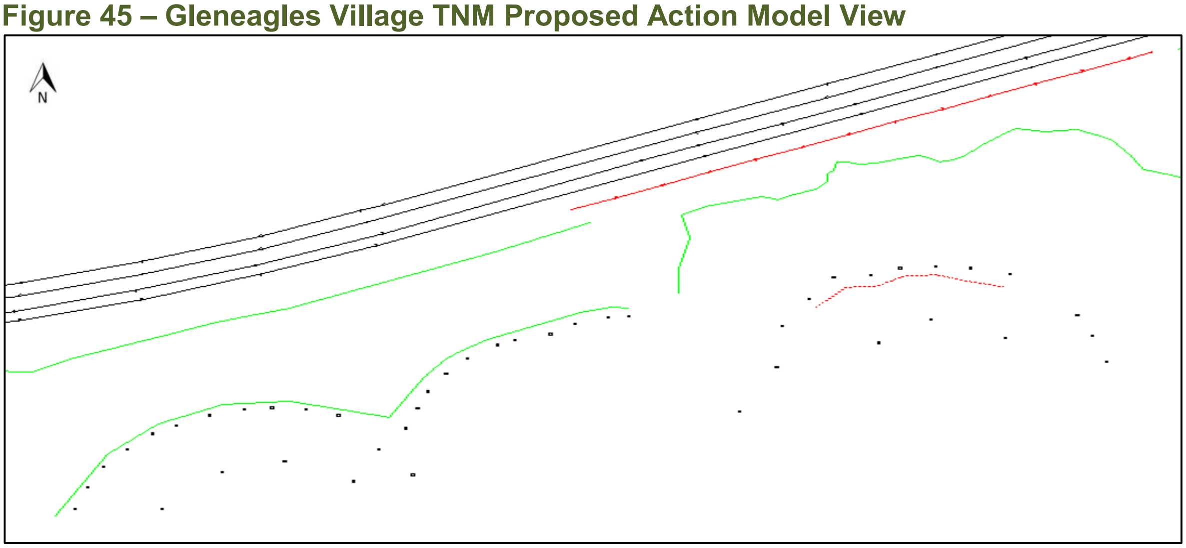
Gleneagles Village

Gleneagles Village is a single-family residential development south of C-470 between Colorado Boulevard and Quebec as shown in **Figure 41**. Using the prediction methodology described in Section 3.0, receptors were developed for each front row and select second row outdoor use area as shown in **Figure 44. Figure 45** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each receptor location for both existing and Proposed Action conditions and are shown in **Table 33.**

Figure 44 – Gleneagles Village Receptor Locations

Note: Impacted receptors are shaded green

Figure 45 – Gleneagles Village TNM Proposed Action Model View



Gleneagles Village Noise Impact Assessment

Table 33 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 45** and **Table 33.** Seven receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 67.9 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Gleneagles Village Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 1,100 feet long and averaging 16.9 feet tall. With this optimized wall many impacted property are predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one up to 7.0 dB(A), achieving the design goal of 7 dB(A) insertion loss. The insertion losses are presented in **Table 34**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Index calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$836,550	(Cost of wall = 1,100 feet long x 16.9 feet tall x $45/sf = $836,550)
÷ 54.6	(Total dB(A) reduction for the 9 receptors with equal to or greater than 5 dB(A) reduction)
$15,321	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 33 – Gleneagles Village Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	55.1	59.4	4.3	No	No
2	Residential	B	54.5	58.7	4.2	No	No
3	Residential	B	55.7	59.5	3.8	No	No
4	Residential	B	57.9	61.7	3.8	No	No
5	Residential	B	58.2	61.9	3.7	No	No
6	Residential	B	58.5	62.4	3.9	No	No
7	Residential	B	59.1	63.0	3.9	No	No
8	Residential	B	59.3	63.1	3.8	No	No
9	Residential	B	59.3	63.2	3.9	No	No
10	Residential	B	59.5	63.6	4.1	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 33 – Gleneagles Village Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
11	Residential	B	59.6	63.4	3.8	No	No
12	Residential	B	58.8	63.0	4.2	No	No
13	Residential	B	58.3	62.6	4.3	No	No
14	Residential	B	57.9	62.2	4.3	No	No
15	Residential	B	57.3	61.2	3.9	No	No
16	Residential	B	56.0	60.2	4.2	No	No
17	Residential	B	55.9	60.1	4.2	No	No
18	Residential	B	57.4	61.3	3.9	No	No
19	Residential	B	58.4	62.4	4.0	No	No
20	Residential	B	58.5	62.5	4.0	No	No
21	Residential	B	59.1	63.0	3.9	No	No
22	Residential	B	59.3	63.3	4.0	No	No
23	Residential	B	59.8	63.9	4.1	No	No
24	Residential	B	59.9	64.2	4.3	No	No
25	Residential	B	60.2	64.8	4.6	No	No
26	Residential	B	60.5	65.3	4.8	No	No
27	Residential	B	60.3	65.1	4.8	No	No
28	Residential	B	60.1	65.1	5.0	No	No
29	Residential	B	56.5	61.5	5.0	No	No
30	Residential	B	58.1	63.2	5.1	No	No
31	Residential	B	60.1	65.2	5.1	No	No
32	Residential	B	61.5	66.5	5.0	Yes	No
33	Residential	B	63.0	67.9	4.9	Yes	No
34	Residential	B	63.0	67.9	4.9	Yes	No
35	Residential	B	62.9	67.9	5.0	Yes	No
36	Residential	B	62.7	67.7	5.0	Yes	No
37	Residential	B	62.3	67.3	5.0	Yes	No
38	Residential	B	61.0	66.3	5.3	Yes	No
39	Residential	B	58.1	63.3	5.2	No	No
40	Residential	B	57.4	62.4	5.0	No	No
41	Residential	B	56.5	61.3	4.8	No	No
42	Residential	B	57.7	62.6	4.9	No	No
43	Residential	B	59.6	65.1	5.5	No	No
44	Residential	B	59.4	64.6	5.2	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 34 – Gleneagles Village Impacted Receptors with Mitigation

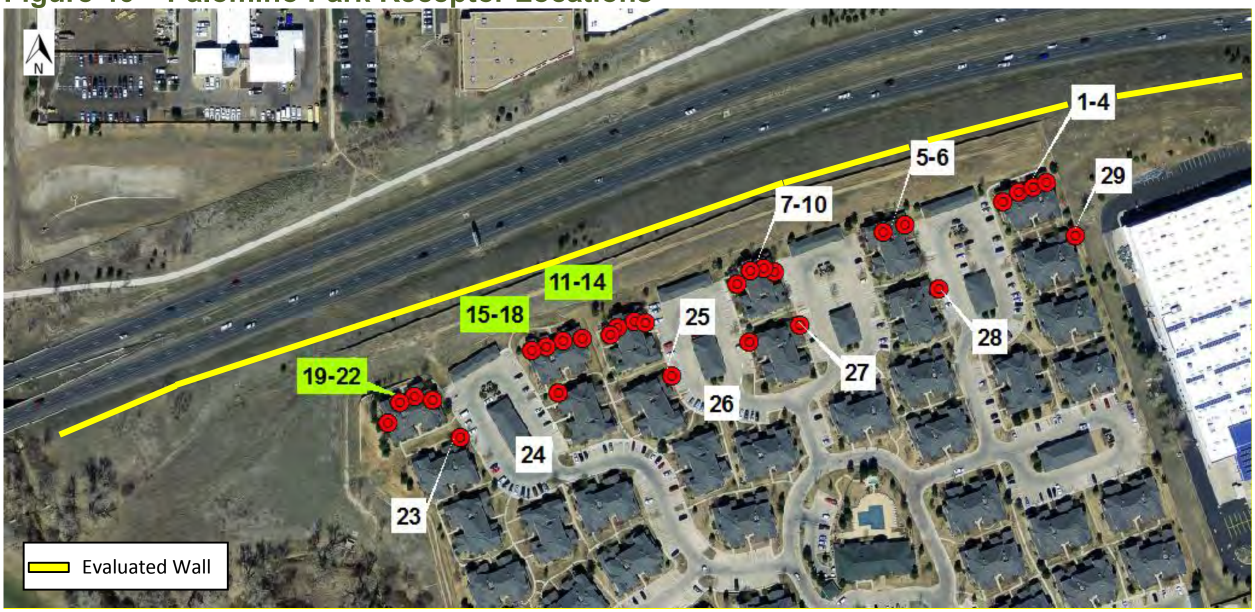
Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
32	Residential	B	66.5	60.3	6.2
33	Residential	B	67.9	60.9	7.0
34	Residential	B	67.9	61.2	6.7
35	Residential	B	67.9	61.0	6.9
36	Residential	B	67.7	61.4	6.3
37	Residential	B	67.3	61.8	5.5
38	Residential	B	66.3	61.3	5.0
Other Benefitted	Residential	B			11.0
				Total dB(A) Reduction (5 dB(A) or greater)	54.6

In summary, the Gleneagles Village area has nine receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. However, the CBI is over CDOT's cost threshold and mitigation is not recommended.

Palomino Park

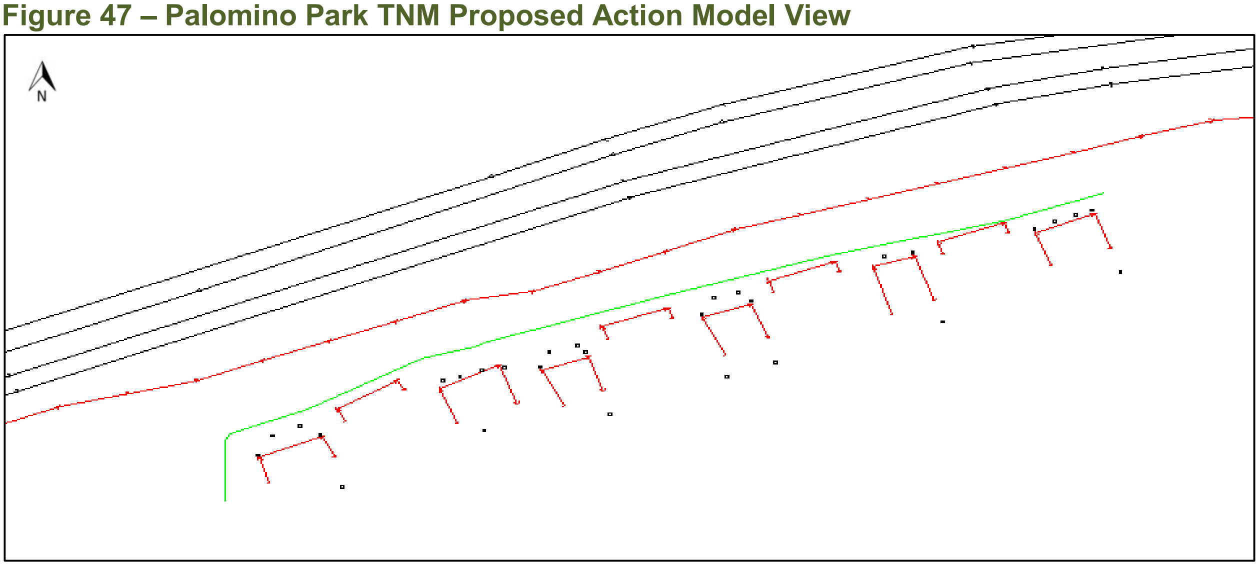
Palomino Park is a multi-storied residential complex south of C-470 between Colorado Boulevard and Quebec as shown in **Figure 41**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 46**. **Figure 47** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted at each of 38 receptor locations for both existing and Proposed Action conditions and are shown in **Table 35.**

Figure 46 – Palomino Park Receptor Locations



Note: Impacted receptors are shaded green

Figure 47 – Palomino Park TNM Proposed Action Model View



Palomino Park Noise Impact Assessment

Table 35 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 46** and **Table 35.** Eight receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 74.3 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Palomino Park Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 800 feet long and 17.5 feet tall. With this optimized wall many impacted property is predicted to receive at least a 5 dB(A) of noise reduction (insertion loss) with one receptor receiving 7.2 dB(A) insertion loss, achieving the design goal of 7 dB(A) insertion loss. Some second level receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. The insertion losses are presented in **Table 36**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$630,000 (Cost of wall = 800 feet long x 17.5 feet tall x $45/sf = $630,000)
÷ 42.0 (Total dB(A) reduction for the 8 receptors with equal to or greater than 5 dB(A) reduction)
$15,000 (Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 35 – Palomino Park Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
1	Residential	B	59.2	63.7	4.5	No	No
2	Residential	B	58.7	63.1	4.4	No	No
3	Residential	B	58.3	62.5	4.2	No	No
4	Residential	B	57.9	61.9	4.0	No	No
5	Residential	B	57.9	61.6	3.7	No	No
6	Residential	B	58.6	62.5	3.9	No	No
7	Residential	B	58.1	61.8	3.7	No	No
8	Residential	B	59.4	63.5	4.1	No	No
9	Residential	B	60.0	64.0	4.0	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 35 – Palomino Park Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
10	Residential	B	59.3	63.2	3.9	No	No
11	Residential	B	59.2	63.7	4.5	No	No
12	Residential	B	61.0	65.5	4.5	Yes	No
13	Residential	B	62.2	66.7	4.5	Yes	No
14	Residential	B	60.0	64.7	4.7	No	No
15	Residential	B	55.5	59.8	4.3	No	No
16	Residential	B	60.2	65.0	4.8	No	No
17	Residential	B	60.7	65.5	4.8	Yes	No
18	Residential	B	61.3	66.1	4.8	Yes	No
19	Residential	B	66.2	71.0	4.8	Yes	No
20	Residential	B	68.9	73.0	4.1	Yes	No
21	Residential	B	70.6	74.3	3.7	Yes	No
22	Residential	B	70.0	73.7	3.7	Yes	No
23	Residential	B	59.3	63.2	3.9	No	No
24	Residential	B	56.4	60.2	3.8	No	No
25	Residential	B	53.9	57.7	3.8	No	No
26	Residential	B	53.3	57.1	3.8	No	No
27	Residential	B	53.0	57.0	4.0	No	No
28	Residential	B	53.7	58.0	4.3	No	No
29	Residential	B	57.4	62.3	4.9	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 36 – Palomino Park Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
12	Residential	B	65.5	63.1	2.4
13	Residential	B	66.7	63.3	3.4
17	Residential	B	65.5	60.3	5.2
18	Residential	B	66.1	60.4	5.7
19	Residential	B	71.0	65.7	5.3
20	Residential	B	73.0	66.3	6.7
21	Residential	B	74.3	67.1	7.2
22	Residential	B	73.7	67.6	6.1
				Total dB(A) Reduction (5 dB(A) or greater)	**42.0**

In summary, the Palomino Park has eight receptors that could benefit from noise mitigation. However, the CBI is not within CDOT's cost threshold and mitigation is not recommended.

4.9 I-25

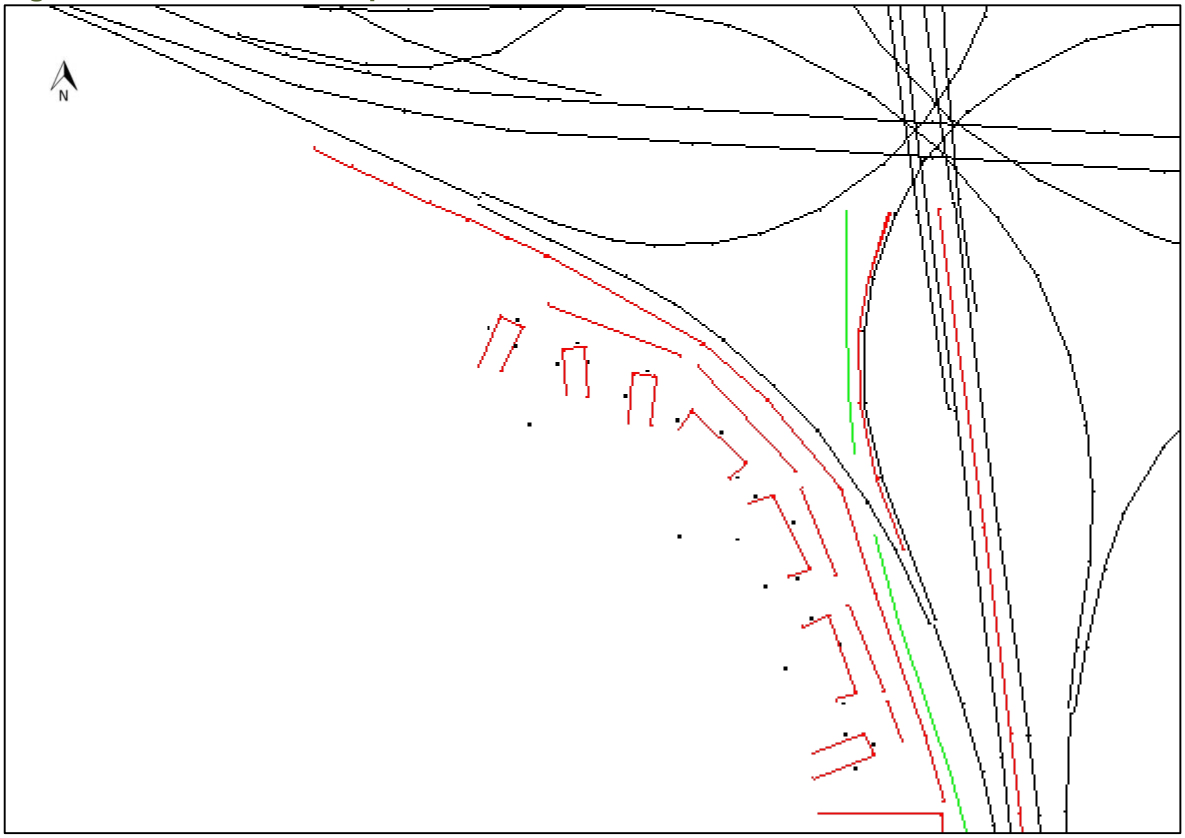
Crest

Crest is a multi-storied residential complex in the southwest quadrant of the C-470 and I-25 interchange as shown in **Figure 48**. Using the prediction methodology described in Section 3.0, receptors were developed for front row and select second row outdoor use areas and for each level of living units as shown in **Figure 48. Figure 49** shows a screen shot of the TNM model of the Proposed Action. Noise levels were predicted for both existing and Proposed Action conditions and are shown in **Table 37.**

Figure 48 – Crest Receptor Locations (each site has multiple levels)

Note: Impacted receptors are shaded green

Figure 49 – Crest TNM Proposed Action Model View



Crest Noise Impact Assessment

Table 37 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 48** and **Table 37.** Seventy-six receptors equal or exceed CDOT impact criteria for residential, primarily on the upper floors, and thus per CDOT policy are considered impacted. The highest predicted future noise level is 74.2 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was conducted.

Crest Noise Mitigation Assessment

The optimal wall, providing the greatest noise reduction for impacted receptors per square foot of wall, was roughly 2,300 feet long and 18.2 feet tall. Some impacted receptors did not receive the minimal 5 dB(A) reduction with the optimal wall. However, the design goal reduction of 7 dB(A) or more was met by at least one receptor. The insertion losses are presented in **Table 38**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,883,700	(Cost of wall = 2,300 feet long x 18.2 feet tall x $45/sf = $1,883,700)
÷ 493.0	(Total dB(A) reduction for the 82 receptors with equal to or greater than 5 dB(A) reduction)
$3,821	(Cost Benefit Index, cost per dB(A) per receptor)

This wall does meet CDOT/FHWA feasibility criteria and the Cost Benefit Index is within the $6,800 threshold for a reasonable barrier. **Mitigation, a noise wall, at this location is recommended.** A benefitted resident/owner survey will be conducted and further review is recommended during final design. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 37 – Crest Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B1-1-1	Residential	B	62.5	63.3	0.8	No	No
B1-1-2	Residential	B	66.5	67.6	1.1	Yes	No
B1-1-3	Residential	B	68.5	71.1	2.6	Yes	No
B1-2-1	Residential	B	61.9	63.3	1.4	No	No
B1-2-2	Residential	B	65.8	68.0	2.2	Yes	No
B1-2-3	Residential	B	67.0	69.6	2.6	Yes	No
B1-3-1	Residential	B	55.0	54.7	-0.3	No	No
B1-3-2	Residential	B	58.6	59.6	1.0	No	No
B1-3-3	Residential	B	62.5	65.0	2.5	No	No
B2 - 1 -1	Residential	B	60.3	62.4	2.1	No	No
B2 - 1 - 2	Residential	B	67.1	68.3	1.2	Yes	No
B2 - 1 - 3	Residential	B	69.1	71.5	2.4	Yes	No
B2 - 2 -1	Residential	B	60.0	60.4	0.4	No	No
B2 - 2 - 2	Residential	B	64.2	65.9	1.7	Yes	No
B2 - 2 - 3	Residential	B	64.9	67.0	2.1	Yes	No
B2 - 3 -1	Residential	B	55.7	56.5	0.8	No	No
B2 - 3 - 2	Residential	B	61.4	61.9	0.5	No	No
B2 - 3 - 3	Residential	B	66.3	68.7	2.4	Yes	No
B3-1- 1	Residential	B	60.8	62.4	1.6	No	No
B3-1- 2	Residential	B	67.4	69.4	2.0	Yes	No
B3-1 - 3	Residential	B	69.7	71.8	2.1	Yes	No
B3-1- 1	Residential	B	60.3	60.7	0.4	No	No
B3-1- 2	Residential	B	63.9	65.8	1.9	Yes	No
B3-1 - 3	Residential	B	64.6	66.8	2.2	Yes	No
B3-1- 1	Residential	B	57.1	57.0	-0.1	No	No
B3-1- 2	Residential	B	61.9	62.2	0.3	No	No
B3-1 - 3	Residential	B	65.2	67.3	2.1	Yes	No
B4-1 - 1	Residential	B	60.1	61.6	1.5	No	No
B4-1 - 2	Residential	B	65.8	68.0	2.2	Yes	No
B4-1- 3	Residential	B	69.1	71.5	2.4	Yes	No
B4-2 - 1	Residential	B	60.1	60.4	0.3	No	No
B4-2 - 2	Residential	B	64.6	66.8	2.2	Yes	No
B4-2- 3	Residential	B	66.4	68.4	2.0	Yes	No
B4-3 - 1	Residential	B	54.0	56.7	2.7	No	No
B4-3 - 2	Residential	B	57.8	61.2	3.4	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 37 – Crest Noise Model Results without Mitigation (cont)

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
B4-3- 3	Residential	B	62.4	66.1	3.7	Yes	No
B5-1 - 1	Residential	B	59.2	62.0	2.8	No	No
B5-1 - 2	Residential	B	65.3	69.8	4.5	Yes	No
B5-1- 3	Residential	B	68.4	72.7	4.3	Yes	No
B5-2 - 1	Residential	B	57.4	59.4	2.0	No	No
B5-2 - 2	Residential	B	62.6	65.6	3.0	Yes	No
B5-3 - 1	Residential	B	65.6	68.4	2.8	Yes	No
B5-3 - 2	Residential	B	62.2	68.1	5.9	No	No
B5-3- 3	Residential	B	64.8	71.0	6.2	Yes	No
B6-1- 1	Residential	B	58.5	63.0	4.5	No	No
B6-1- 2	Residential	B	65.0	70.8	5.8	No	No
B6-1- 3	Residential	B	67.8	74.2	6.4	Yes	No
B6-2- 1	Residential	B	57.5	62.5	5.0	No	No
B6-2- 2	Residential	B	60.8	66.9	6.1	No	No
B6-2- 3	Residential	B	63.2	68.9	5.7	Yes	No
B6-3- 1	Residential	B	58.6	61.7	3.1	No	No
B6-3- 2	Residential	B	63.0	67.8	4.8	Yes	No
B6-3- 3	Residential	B	65.4	72.4	7.0	Yes	No
B7-1- 1	Residential	B	61.4	64.6	3.2	No	No
B7-1- 2	Residential	B	65.5	71.3	5.8	No	No
B7-1- 3	Residential	B	68.4	75.1	6.7	Yes	No
B7-2- 1	Residential	B	57.5	61.6	4.1	No	No
B7-2- 2	Residential	B	61.7	68.3	6.6	No	No
B7-2- 3	Residential	B	64.0	71.0	7.0	Yes	No
B7-3- 1	Residential	B	60.0	62.6	2.6	No	No
B7-3- 2	Residential	B	62.5	67.4	4.9	Yes	No
B7-3- 3	Residential	B	64.9	71.7	6.8	Yes	No
B8 - 1	Residential	B	52.0	54.4	2.4	No	No
B8- 2	Residential	B	52.9	55.8	2.9	No	No
B8 - 3	Residential	B	55.6	58.8	3.2	No	No
B9 - 1	Residential	B	52.8	55.2	2.4	No	No
B9 - 2	Residential	B	54.2	57.3	3.1	No	No
B9 - 3	Residential	B	55.7	59.7	4.0	No	No
B10	Residential	B	54.3	58.4	4.1	No	No
B11- 1	Residential	B	52.4	55.0	2.6	No	No
B11- 2	Residential	B	54.2	56.9	2.7	No	No
B11- 3	Residential	B	56.0	59.0	3.0	No	No
B12 - 1	Residential	B	55.7	57.5	1.8	No	No
B12 -3	Residential	B	59.1	60.8	1.7	No	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Table 38 – Crest Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))			Receptor Represents X Residents
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels	
B1-1-2	Residential	B	67.6	62.0	5.6	2
B1-1-3	Residential	B	71.1	63.6	7.5	2
B1-2-2	Residential	B	68.0	62.4	5.6	2
B1-2-3	Residential	B	69.6	64.6	5.0	2
B2 - 1 - 2	Residential	B	68.3	61.6	6.7	2
B2 - 1 - 3	Residential	B	71.5	64.5	7.0	2
B2 - 2 - 2	Residential	B	65.9	57.6	8.3	2
B2 - 2 - 3	Residential	B	67.0	61.4	5.6	2
B2 - 3 - 3	Residential	B	68.7	59.5	9.2	2
B3-1- 2	Residential	B	69.4	62.0	7.4	2
B3-1 - 3	Residential	B	71.8	66.2	5.6	2
B3-1- 2	Residential	B	65.8	59.1	6.7	2
B3-1 - 3	Residential	B	66.8	61.3	5.5	2
B3-1 - 3	Residential	B	67.3	60.6	6.7	2
B4-1 - 2	Residential	B	68.0	62.6	5.4	4
B4-1- 3	Residential	B	71.5	67.0	4.5	4
B4-2 - 2	Residential	B	66.8	60.7	6.1	2
B4-2- 3	Residential	B	68.4	65.1	3.3	2
B4-3- 3	Residential	B	66.1	57.2	8.9	2
B5-1 - 2	Residential	B	69.8	64.5	5.3	4
B5-1- 3	Residential	B	72.7	69.3	3.4	4
B5-2 - 2	Residential	B	65.6	58.4	7.2	2
B5-2- 3	Residential	B	68.4	62.4	6.0	2
B5-3 - 2	Residential	B	68.1	64.2	3.9	2
B5-3- 3	Residential	B	71.0	69.8	1.2	2
B6-1- 2	Residential	B	70.8	65.2	5.6	4
B6-1- 3	Residential	B	74.2	72.7	1.5	4
B6-2- 2	Residential	B	66.9	61.5	5.4	2
B6-2- 3	Residential	B	68.9	67.8	1.1	2
B6-3- 2	Residential	B	67.8	61.7	6.1	2
B6-3- 3	Residential	B	72.4	65.8	6.6	2
B7-1- 2	Residential	B	71.3	64.2	7.1	2
B7-1- 3	Residential	B	75.1	68.5	6.6	2
B7-2- 2	Residential	B	68.3	61.4	6.9	2
B7-2- 3	Residential	B	71.0	66.3	4.7	2
B7-3- 2	Residential	B	67.4	61.2	6.2	2
B7-3- 3	Residential	B	71.7	65.3	6.4	2
Other Benefitted	Residential	B			84.0	
			Total dB(A) Reduction (5 dB(A) or greater)			**493.0**

In summary, the Crest area has 82 receptors that could benefit, receive 5 dB(A) or more insertion loss, from noise mitigation. The CBI is within CDOT's cost threshold and therefore mitigation is recommended.

4.10 Recreational Resources

Recreational resources are distributed across the entire C-470 corridor. These resources include a pool, golf courses, athletic fields, trails, playgrounds, and non-profit institutional offices. One receptors was identified for each location adjacent to C-470 where people congregate, e.g. golfing tee boxes, golfing greens, pools, benches, major path connections, and athletic fields. Using the prediction methodology described in Section 3.0, receptors were developed for these outdoor use areas as shown in **Figures 50 through 55**. Noise levels were predicted at each of 24 receptor locations for both existing and Proposed Action conditions and are shown in **Table 39**.

Table 39 – Recreational Resources Noise Model Results without Mitigation

Impacted Receptors				Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
	ID No. Receptors	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Kipling to Wadsworth	1 Golf #15Green	Recreational	C	66.5	66.5	0.0	Yes	No
	2 Golf #15Tee	Recreational	C	68.9	68.9	0.0	Yes	No
	3 Track	Recreational	C	53.4	58.7	5.3	No	No
	4 Deer Crk Pool	Recreational	C	66.7	69.3	2.6	Yes	No
	5 Swingate Park	Recreational	C	55.2	58.9	3.7	No	No
Wadsworth to Platte Canyon	6 Massey Xing N	Recreational	C	64.2	65.1	0.9	No	No
	7 Massey Xing S	Recreational	C	61.5	63.0	1.5	No	No
	8 Trail stop	Recreational	C	73.9	76.9	3.0	Yes	No
	9 Dam	Recreational	C	56.7	59.2	2.5	No	No
Platte Canyon to Santa Fe	10 Park Trail	Recreational	C	63.3	69.1	5.8	Yes	No
	11 Trail N	Recreational	C	68.6	69.8	1.2	Yes	No
	12 Johnny's Pond	Recreational	C	64.9	65.9	1.0	Yes	No
	13 Fly'n B Dock	Recreational	C	58.7	59.7	1.0	No	No
	14 Highline Trail	Recreational	C	69.5	65.4	-4.1	No	No
Univ.	15 Baseball Field	Recreational	C	68.9	72.0	3.1	Yes	No
Colorado to Quebec	16 David Lorenz Field	Recreational	C	63.5	67.6	4.1	Yes	No
	17 Frisbee Hole	Recreational	C	59.2	62.4	3.2	No	No
	18 Frisbee Tee	Recreational	C	62.5	67.5	5.0	Yes	No
	19 Golf#5Tee	Recreational	C	69.3	74.1	4.8	Yes	No
	20 Golf#4Green	Recreational	C	65.8	70.3	4.5	Yes	No
	21 Golf#4Tee	Recreational	C	62.3	67.4	5.1	Yes	No
	22 Golf#5Green	Recreational	C	60.4	66.0	5.6	Yes	No
	23 Soccer Field	Recreational	C	69.2	73.6	4.4	Yes	No
Quebec to I-25	24 Willow Creek N	Recreational	C	60.2	64.2	4.0	No	No
	25 Willow Creek S	Recreational	C	65.1	67.3	2.2	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Kipling Parkway to Wadsworth Boulevard Area

Figure 50 – Recreational Receptor Locations in the Kipling Parkway to Wadsworth Boulevard Area

Note: Impacted receptors are shaded green

Kipling Parkway to Wadsworth Boulevard Area Noise Mitigation Assessment

The optimal walls, providing the greatest noise reduction for impacted receptors per square foot of wall, were developed for the impacted receptors.

Deer Creek Golf Course

A wall roughly 1530 feet long and 14.8 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. Receptor 1 achieved this goal. However, because of the proximity of receptor 2 to Kipling Parkway neither 7.0 dB(A) nor 5.0 dB(A) was achievable. The insertion losses are presented in **Table 40**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,018,980	(Cost of wall = 1,530 feet long x 14.8 feet tall x $45/sf = $1,018,980)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$145,568	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Deer Creek Pool

A wall roughly 1,250 feet long and 11.6 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 40**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$652,500	(Cost of wall = 1,250 feet long x 11.6 feet tall x $45/sf = $652,500)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$93,214	(Cost Benefit Index, cost per dB(A) per receptor)

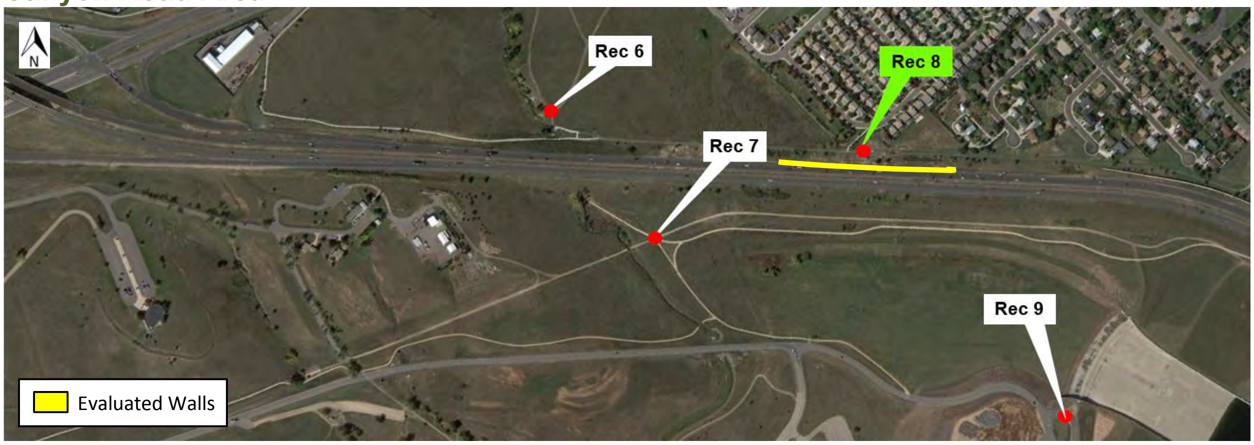
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 40 – Kipling Parkway to Wadsworth Boulevard Area Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Deer Creek Golf Course					
1	Recreational	C	66.5	59.5	7.0
2	Recreational	C	68.9	68.9	0.0
Deer Creek Pool					
4	Recreational	C	69.3	62.3	7.0

Wadsworth Boulevard to Platte Canyon Road Area

Figure 51 – Recreational Receptor Locations in the Wadsworth Boulevard to Platte Canyon Road Area



Note: Impacted receptors are shaded green

Wadsworth Boulevard to Platte Canyon Road Area Noise Mitigation Assessment

A wall roughly 200 feet long and 7 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 41**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$63,000	(Cost of wall = 200 feet long x 7 feet tall x $45/sf = $63,000)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$9,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 41 – Wadsworth Boulevard to Platte Canyon Road Area Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
8	Recreational	C	76.9	69.7	7.2

Platte Canyon Road to Santa Fe Drive Area

Figure 52 – Recreational Receptor Locations in the Platte Canyon Road to Santa Fe Drive Area

Note: Impacted receptors are shaded green

Platte Canyon Road to Santa Fe Drive Area Noise Mitigation Assessment

The optimal walls, providing the greatest noise reduction for impacted receptors per square foot of wall, were developed for the impacted receptors.

Park Trail (Rec 10)

A wall roughly 1,270 feet long and 17.5 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 42**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,000,125	(Cost of wall = 1,270 feet long x 17.5 feet tall x $45/sf = $1,000,125)
÷ 7.1	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$140,863	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Trail North (Rec 11)

A wall roughly 1,270 feet long and 17.3 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 42**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$ 988,695	(Cost of wall = 750 feet long x 17.3 feet tall x $45/sf = $583,825)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$ 141,242	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Johnny's Pond

A wall roughly 1,550 feet long and 20 feet tall provided 4.2 dB(A) insertion and was not able to provide the design goal of 7.0 dB(A) insertion loss for the receptor. Thus there is no Benefit Cost Index. The insertion losses are presented in **Table 42**.

Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated. However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 42 – Kipling Parkway to Wadsworth Boulevard Area Impacted Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Park Trail					
10	Recreational	C	69.1	62.0	7.1
Trail North					
11	Recreational	C	69.8	62.8	7.0
Johnny's Pond					
12	Recreational	C	65.9	61.7	4.2

University Boulevard Area

Figure 53 – Recreational Receptor Locations in the University Boulevard Area

Note: Impacted receptors are shaded green

University Boulevard Area Noise Mitigation Assessment

A wall roughly 1,290 feet long and 19 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 43**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$1,102,950	(Cost of wall = 1,290 feet long x 19 feet tall x $45/sf = $1,102,950)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$157,564	(Cost Benefit Index, cost per dB(A) per receptor)

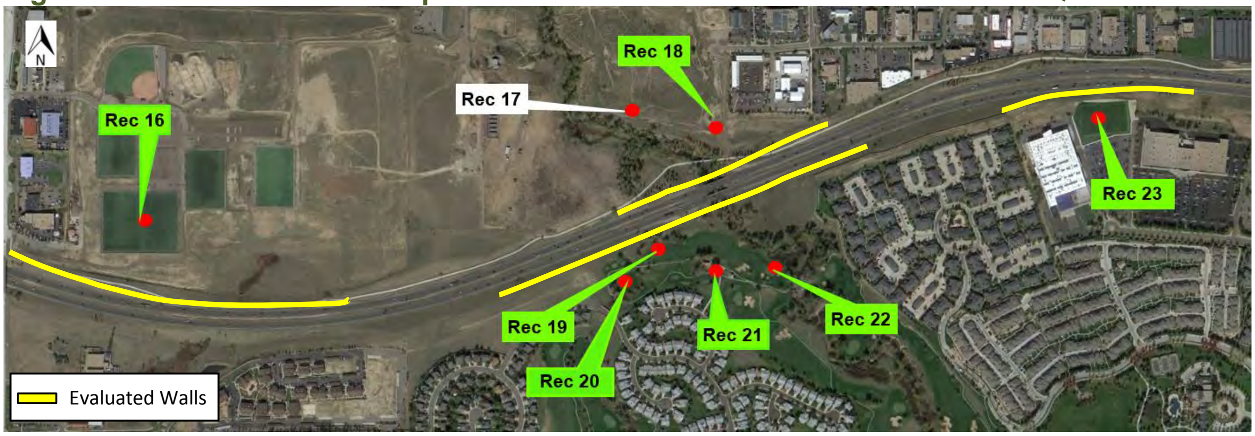
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 43 – University Boulevard Area Impacted Receptor with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
15	Recreational	C	72.0	65.0	7.0

Colorado Boulevard to Quebec Area

Figure 54 – Recreational Receptor Locations in the Colorado Boulevard to Quebec Area



Note: Impacted receptors are shaded green

Colorado Boulevard to Quebec Area Noise Mitigation Assessment

The optimal walls, providing the greatest noise reduction for impacted receptors per square foot of wall, were developed for the impacted receptors.

David Lorenz Park

A wall roughly 2,500 feet long and 20 feet tall was not able to provide the design goal of 7.0 dB(A) insertion loss for the receptor. Thus there is no Benefit Cost Index.

Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated. However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Frisbee Golf Course

A wall roughly 1,400 feet long and 15.2 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in Table 44. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$957,600	(Cost of wall = 1,400 feet long x 15.2 feet tall x $45/sf = $957,600)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$136,800	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Gleneagles Golf Course

A wall roughly 1,000 feet long and 12 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 44**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$540,000	(Cost of wall = 1,000 feet long x 12 feet tall x $45/sf = $540,000)
÷ 12.3	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$43,902	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Skyview Soccer Field

A wall roughly 750 feet long and 18.5 feet tall was developed to provide the design goal of 7.0 dB(A) insertion loss for the property. The insertion losses are presented in **Table 44**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

The Benefit Cost Index for this wall location within CDOT ROW is calculated as:

$624,375	(Cost of wall = 750 feet long x 18.5 feet tall x $45/sf = $624,375)
÷ 7.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$89,196	(Cost Benefit Index, cost per dB(A) per receptor)

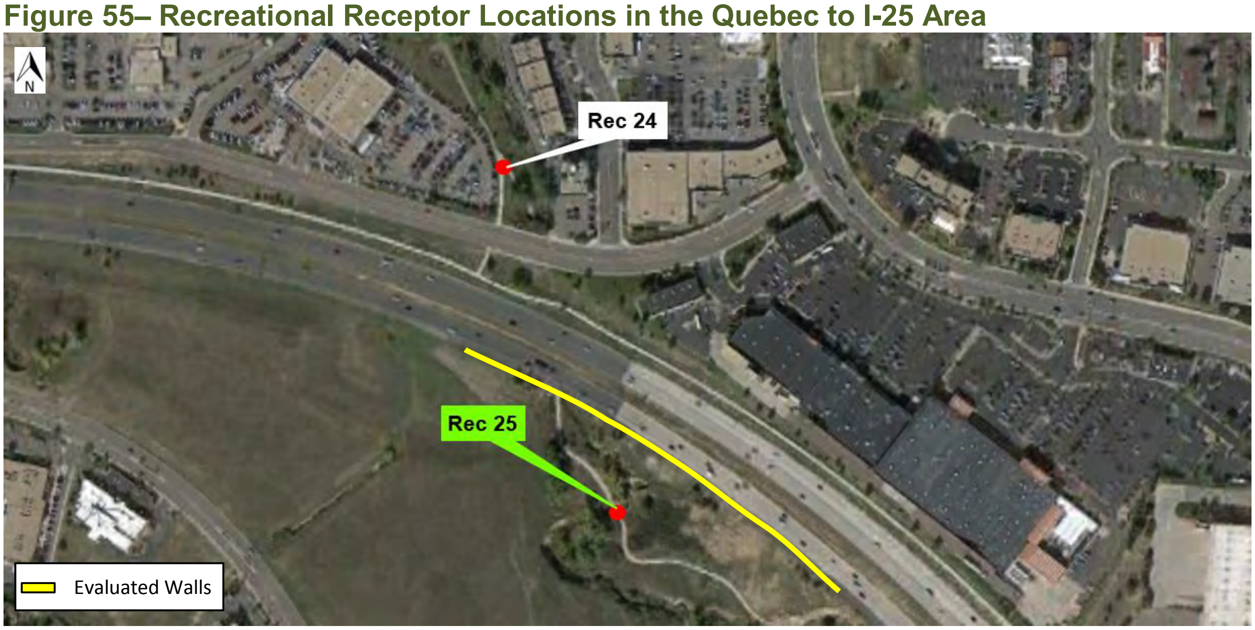
The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 44 – Colorado Boulevard to Quebec Area Receptors with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
David Lorenz					
16	Recreational	C	67.6	61.1	6.5
Frisbee Golf					
17	Recreational	C	62.4	58.2	4.2
18	Recreational	C	67.5	60.5	7.0
Gleneagles Golf					
19	Recreational	C	74.1	66.9	7.2
20	Recreational	C	70.3	65.2	5.1
21	Recreational	C	67.4	64.0	3.4
22	Recreational	C	66.0	64.9	1.1
Skyview Soccer Field					
23	Recreational	C	73.6	66.6	7.0

Quebec to I-25 Area

Figure 55– Recreational Receptor Locations in the Quebec to I-25 Area



Note: Impacted receptors are shaded green

Willow Creek South

A wall roughly 1,670 feet long and 20 feet tall was not able to provide the design goal of 7.0 dB(A) insertion loss for the receptor. Thus there is no Benefit Cost Index. Insertion loss is presented in Table 45.

Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated. However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 45 – Quebec to I-25 Area Impacted Receptor with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
25	Recreational	C	67.3	60.5	6.8

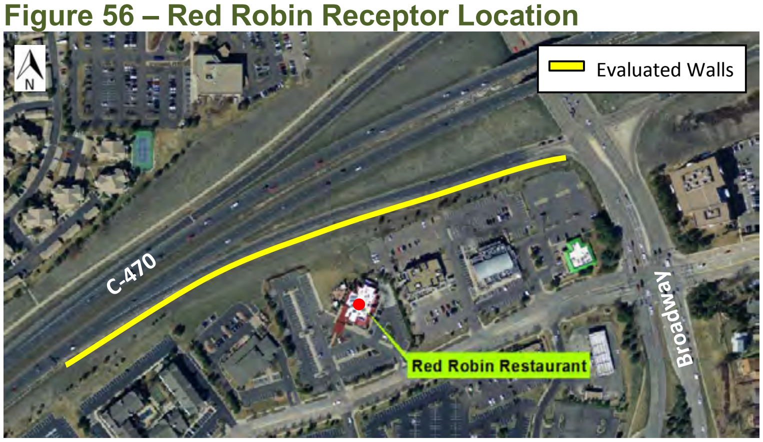
4.11 Noise Sensitive Commercial Properties

This corridor has mix of residential and commercial land uses along the entire length. CDOT guidelines call for a review of noise sensitive commercial properties. These properties can include restaurants, hotels, and other businesses that have a noise sensitive outdoor use. A review of the corridor identified four businesses with outdoor uses, restaurant seating, within 300 feet of the roadway. 300 feet was used as an initial screening based on the 71 dB(A) contour line being roughly 225-275 from the roadway. 71 dB(A) is considered to be an impact on these types of businesses.

The businesses identified below and shown in **Figures 56** and **57** are:

- Red Robin restaurant, south of C-470 and west of Broadway, which has an outdoor seating area;
- On the Border restaurant, south of C-470 and west of Quebec, which has an outdoor seating area;
- LODO restaurant, south of C-470 and west of Quebec, which has a roughly third level deck/seating area; and
- Brothers Bar & Grill restaurant, south of C-470 and east of Quebec, which has an elevated deck.

Figure 56 – Red Robin Receptor Location



Note: Impacted receptors are shaded green

Figure 57– On the Border, LODO, & Brothers Receptor Locations

Note: Impacted receptors are shaded green

Noise Sesitive Commercial Properties Noise Impact Assessment

Table 46 shows the predicted noise levels at each receptor, the increase between existing and Proposed Action, and whether or not each receptor is considered impacted. Impacted receptors are shown in green in both **Figure 56, 57** and **Table 46.** Red Robin, LODO, and Brothers equal or exceeds CDOT impact criteria for commercial properties and thus per CDOT policy are considered impacted. The highest predicted future noise level is 72.1 dB(A). An assessment of the feasibility and reasonableness, as described in Section 4.2, of constructing noise mitigation measures for these impacted receptors was not conducted. Per CDOT Noise abatement guidelines each outdoor use area is given one receptor.

Table 46 – Noise Sensitive Commercial Properties Noise Model Results without Mitigation

Receptors			Modeled Noise Levels (dB(A))			CDOT Noise Abatement Criteria	
ID No.	Description	NAC Activity Category	Existing 2013 / 2035 No-Action	Proposed Action 2035	Change in Levels	Approach or Exceed Activity Value	Increase Over Existing
Red Robin	Restaurant	E	67.4	70.9	3.5	Yes	No
On the Border	Restaurant	E	63.2	66.8	3.6	No	No
LODO	Restaurant	E	67.8	71.4	3.6	Yes	No
Brothers	Restaurant	E	70.0	72.1	2.1	Yes	No

Note: Model values are calculated to the nearest tenth decimal; however, for impact identification, CDOT requires noise level values to be arithmetically round to the nearest whole number e.g. 65.5 is round to 66. Impacted receptors are shaded green.

Commercial Noise Mitigation Assessment

Walls were reviewed for each site. The maximum 20 feet high walls, provided the greatest noise reduction for impacted receptors but did not provide the design goal of 7 dB(A) for any of the sites. The insertion losses are presented in **Table 47**. All receptors that received at least 5 dB(A) of noise reduction, whether they met the NAC impact criteria or not, were included in the Cost Benefit Calculation. CDOT has set a noise barrier cost of $45 per square foot, for the purposes of conducting the reasonable analysis.

Red Robin - The Benefit Cost Index for the Red Robin wall location within CDOT ROW is calculated as:

$1,062,000	(Cost of wall = 1,180 feet long x 20 feet tall x $45/sf = $1,062,000)
÷ 6.0	(Total dB(A) reduction for the 1 receptor with equal to or greater than 5 dB(A) reduction)
$177,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. A 20 feet high wall also does not meet the design goal of 7 dB(A) insertion loss. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

On the Border, LODO, & Brothers - The Benefit Cost Index for the combined wall location within CDOT ROW is calculated as:

$1,350,000	(Cost of wall = 1,500 feet long x 20 feet tall x $45/sf = $1,350,000)
$1,260,000	(Cost of wall = 1,400 feet long x 20 feet tall x $45/sf = $1,260,000)
$2,610,000	(Cost of combined walls)
÷ 11.6	(Total dB(A) reduction for the 2 receptors with equal to or greater than 5 dB(A) reduction)
$225,000	(Cost Benefit Index, cost per dB(A) per receptor)

The Cost Benefit Index is over the $6,800 threshold and thus fails the criteria for a reasonable barrier. A 20 feet high wall also does not meet the design goal of 7 dB(A) insertion loss. **Noise mitigation at this location does not meet CDOT/FHWA criteria for implementation and thus mitigation at this location is not recommended and no further abatement criteria need to be evaluated.** However, during final design alignment shifts or profile changes beyond project tolerances can trigger a re-evaluation and re-analysis of noise impacts and mitigation. The Noise Abatement Determination Worksheet is included in Appendix B.

Table 47 – Noise Sensitive Commercial Properties Noise Model Results with Mitigation

Impacted Receptors			Modeled Noise Levels (dB(A))		
ID No.	Description	NAC Activity Category	Proposed Action 2035	Proposed Action 2035 with Mitigation	Change in Levels
Red Robin	Restaurant	E	70.9	64.9	6.0
				Total dB(A) Reduction (5 dB(A) or greater)	6.0
On the Border	Restaurant	E	66.8	61.2	5.6
LODO	Restaurant	E	71.4	65.4	6.0
Brothers	Restaurant	E	72.1	69.1	3.0
				Total dB(A) Reduction (5 dB(A) or greater)	**11.6**

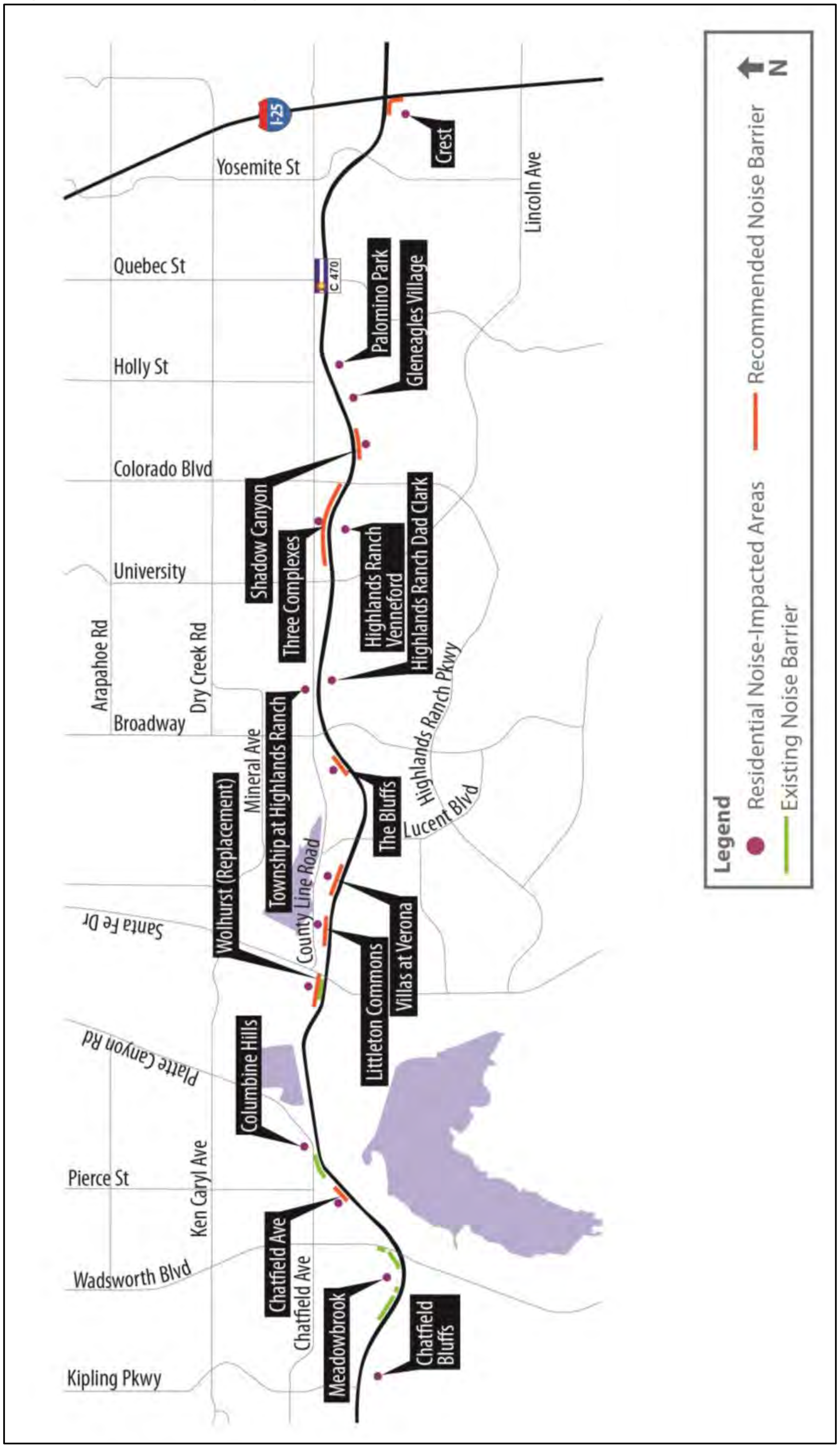
4.12 Statement of Likelihood and Summary of Recommendations

The feasibility and reasonableness of the mitigation recommendations in this document are based on the preliminary analysis using current level of design and available information. The ultimate feasibility and reasonableness determinations may change due to changes in final project design after approval of the environmental document. The preliminary location and physical description of noise abatement measures determined to be feasible and reasonable are described throughout this document and summarized in **Table 48** and shown in **Figure 58**. The final noise abatement decision will be made during the completion of the project's final design and the public involvement processes.

Table 48 – Summary of Recommended Noise Mitigation

Location	NAC	Type	Mitigation Type	Description (approximate)	Detailed Figure and Location
Chatfield Avenue	B	Single Family	Wall	900 feet long x 13.5 feet tall	Figure 16, page 30
Wolhurst (replacement)	B	Single Family	Wall	1,500 feet long x 15.5 feet tall	Figure 20, page 39
Littleton Commons	B	Multi-family	Wall	2,200 feet long x 7 feet tall	Figure 23, page 41
Villas at Verona	B	Multi-family	Wall	1,720 feet long x 18.5 feet tall	Figure 25, page 48
Bluffs at Highlands Ranch	B	Multi-family	Wall	1,200 feet long x 17.7 feet tall	Figure 27, page 55
Autumn Chase, Copper Canyon, and Canyon Ranch	B	Multi-family	Wall	4,330 feet long x 15.75 feet tall	Figure 39, page 74
Shadow Canyon	B	Multi-family	Wall	1,700 feet long x 18.7 feet tall	Figure 42, page 82
Crest	B	Multi-family	Wall	2,300 feet long x 18.2 feet tall	Figure 48, page 94

Figure 58 – Summary of Recommended Noise Mitigation



5.0 CONSTRUCTION NOISE IMPACTS

Construction of the project will generate noise from diesel-powered earth moving equipment such as dump trucks and bulldozers, back-up alarms on certain equipment, and compressors. Construction noise at off-site receptor locations will usually be dependent on the loudest one or two pieces of equipment operating at the moment. Noise levels from diesel-powered equipment range from 80 to 95 dB(A) at a distance of 50 feet. Impact equipment such as rock drills and pile drivers can generate louder noise levels. Construction noise, while temporary, can be mitigated by limiting work to daylight hours, requiring the contractor to use well-maintained equipment (particularly with respect to mufflers), and through the use of mitigation measures such as temporary noise barriers where applicable.

REFERENCES

CDOT. 2015. Colorado Department of Transportation Noise Analysis and Abatement Guidelines.

Appendix A

CDOT Noise Analysis and Abatement Guidelines

(January 15, 2015)

COLORADO DEPARTMENT OF TRANSPORTATION

NOISE ANALYSIS AND ABATEMENT GUIDELINES

JANUARY 15, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
Department of Transportation Development (DTD)
Environmental Programs Branch
4201 E. Arkansas Avenue, Denver, Colorado 80222
Noise Program (303) 757-9016

This document supersedes CDOT Noise Analysis and Abatement Guidelines dated February 8, 2013

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1. INTRODUCTION

Pursuant to requirements set forth by the Federal Highway Administration (FHWA), the Colorado Department of Transportation (CDOT) *Noise Analysis and Abatement Guidelines* provide the procedural and technical requirements for the evaluation of highway project traffic noise and consideration of noise mitigation alternatives where noise impacts are identified. The resultant goal of these guidelines is to provide the citizens of the State of Colorado with as compatible a relationship as possible between highway improvements and noise sensitive land uses. CDOT understands the importance of the issue of highway traffic noise and is committed to evaluating traffic noise impacts during the planning, design, and construction of highways and transportation improvements.

The following guidelines are intended to provide a consistent, equitable approach in addressing highway traffic noise and to foster a rational abatement decision-making process for highway projects within the State of Colorado. In addition, the guidelines include the protocol for providing thorough documentation of these activities in technical noise study reports as a part of National Environmental Policy Act (NEPA) documents.

These guidelines are based on currently accepted best management practices and procedures used by Federal and state transportation agencies and will be subject to review every three years. Interim amendments to these guidelines will be made on an as needed basis and will be considered, when approved, to be an integral part of these guidelines.

APPLICABILITY AND SCOPE

1.1 Purpose

The regulations that govern highway traffic noise for Federal-aid and Federal action projects are contained in Part 772 of Title 23 of the Code of Federal Regulations (23CFR772), which is the Federal highway noise standard. The CDOT guidelines describe the CDOT policy and program to implement 23CFR772. Where FHWA has given the highway agency flexibility in implementing the noise standard, these guidelines describe CDOT's approach to implementation.

1.2 Federal Requirements

The NEPA process provides broad authority and responsibility for evaluating and mitigating adverse environmental effects of transportation projects, including highway traffic noise, but it was the Federal-Aid Highway Act of 1970 that mandated FHWA develop noise standards for the mitigation of highway traffic noise.

23CFR772 describes the methods that must be followed in the evaluation and abatement of highway traffic noise in Federal-aid and Federal action highway projects. FHWA will not approve the plans and specifications for any federally-aided or Federal action highway project unless the project includes noise abatement measures that are deemed to be feasible and reasonable to adequately reduce noise impacts. When warranted, noise abatement is to be considered as an integral component of the total project development process and incorporated as such.

The final amended 23CFR772 requires each state highway agency to prepare and adopt written guidelines specific to that state which must demonstrate compliance with 23CFR772. State highway agencies are allowed flexibility to establish their own definitions and quantifications of different criteria and decision items that are used in the guidelines to make noise abatement determinations. All highway projects that are developed in conformance with the CDOT guidelines will be deemed to be in conformance with the Federal regulations and with FHWA noise standards.

1.3 State Requirements

In addition to the Federal regulatory requirements, the CDOT guidelines are also required to be in accordance with CDOT Policy Directive 1601, Interchange Approval Process. The 1601 process applies to governmental and quasi-governmental (e.g., E-470) entity projects which require a new interchange on the system or major modifications to an existing interchange. Included in the 1601 process is the provision that potential environmental impacts must be evaluated, including those from projected traffic noise. The noise regulation broadens the general definition of Type I projects as defined in Section 2.4.1, to include not only Federal-aid projects, but also state, local, and public-private partnership projects overseen by CDOT and requiring CDOT and FHWA approval. The 1601 process also requires compliance with NEPA.

To assure the citizens of Colorado are afforded consistent application and implementation of noise analyses and abatement consideration, the CDOT *Noise Analysis and Abatement Guidelines* includes not only Federal-aid and Federal action projects as Type I projects, but also includes state, local, and public-private partnership projects overseen by CDOT or requiring CDOT approval.

1.4 Project Classification

The following discussion describes which CDOT highway projects require a noise analysis.

1.4.1 Type I Projects

Under 23CFR772, it is mandatory for all states to comply with the regulations for projects that are classified as Type I projects that may result in increased noise levels at sensitive receptors. Some projects may cause noise reductions; however, analyses are required to assess the exact nature of noise level changes resulting from a Type I project. The CDOT guidelines are applicable to all Type I projects. Type I projects include, but are not limited to, the following activities:

- Construction of a roadway on a new location.
- Addition of through-travel lane(s) by new construction or restriping an existing highway. This includes the addition of a through-traffic lane that functions as a high-occupancy vehicle lane, high-occupancy toll lane, bus lane, or truck climbing lane.
- Addition to a highway of an auxiliary lane of accumulated length greater than 2500 feet, by new construction or restriping, including lanes that function as passing lanes or continuous access lanes, except for when the auxiliary lane is a turn lane. See **Appendix A** for lane-specific determinations and definitions.
- Addition of new interchanges or alterations of existing interchanges. This includes the addition or relocation of ramps, or ramps added to a quadrant to complete an existing partial interchange.
- A project which consists of a substantial change in vertical profile of 5 feet or more.
- A project which removes or alters shielding (either natural or man-made) thereby exposing the line-of-sight between the receptor and the traffic noise source. An example of this would be a case where, to improve sight distance on a highway, an existing earth berm or hillside is flattened, resulting in a direct line-of-sight between the highway and an existing residence. Vegetation does not have sufficient noise abatement properties, and thus cannot be considered for these shielding effects.
- Alteration of highways such that the horizontal distance between the nearest edge of travel lane and existing sensitive receptors is approximately halved.
- Addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot, or toll plaza.

In general, actions such as the above are considered to be Type I projects due to capacity increases, alignment changes, or addition of weigh stations, rest stops, ride-share lots, and toll plazas. In all cases in which a project is identified as Type I, a noise analysis study is required if noise sensitive receptors are present within the project study zone. It is important to stress that noise abatement must still be considered for Type I projects where impact level noise has been identified at noise-sensitive receptors, even though the project itself may not cause or contribute to an increase in traffic noise.

The study zone is defined as the area contained within the environmental study or a 500-foot distance in all directions from the proposed edge of traveled lane(s) throughout the extents of the project, whichever is larger. This 500-foot halo defines the extents for the noise analysis and shall include noise-sensitive receptors on all sides of the highway. The 500-foot study zone represents the minimal noise study zone, so that if there is a reasonable expectation that noise impacts would extend beyond that boundary, the study zone must be expanded to include those receptors. This concept also includes addressing upstream or downstream resultant traffic changes where at least a doubling of volume would occur as a result of the project, but are located outside the traditional study zone for noise. Case-by-case consideration can be given to expanded noise abatement measures for impacted neighborhoods located contiguous with the project mitigation. This should be interpreted to mean that a noise abatement measure should treat the most logical extent or break point of an existing impacted neighborhood and is not required to terminate at the 500 foot study boundary. Any length of extended abatement should be optimized to the least cost per most benefited receptors present in that contiguous neighborhood. Logical break points may include cross streets, alleys, commercial property, waterways, or other manmade and natural features interfering with the continuum of the barrier.

1.4.2 Type II Projects

23CFR772 defines Type II projects as projects that provide noise abatement on an existing highway (retrofit noise barrier) in a location where there will not be any new highway construction.

Type II noise abatement projects were constructed on an existing federal or federal-aid highway. Projects were proposed for federal-aid participation based upon the outcome of a noise analysis and prioritization, at the option of the highway department. The monies spent on the Type II abatement were be deducted from the funds which otherwise be available for highway construction. This was a voluntary program in which FHWA funded 80% of the cost of Type II barrier construction. The state portion of Type II projects are funded through the Colorado Transportation Commission.

The Colorado Transportation Commission had participated in the Type II Noise Barrier Program beginning in the 1970’s; however, state funding has been unavailable for this program since 1999. Thus, Colorado currently has no active Type II program or projects.

1.4.3 Type III Projects

All projects that do not meet the Type I or Type II criteria are Type III projects and are not required to undergo noise analysis. Such projects and activities would include many roadway maintenance operations, bridge rehabilitations, resurfacing or white-topping projects, adding shoulders, and ride-sharing programs that pair riders with carpools, commuting assistance, etc. Minor operational projects, such as the changing of a speed limit (that does not involve other construction activity), would not require a noise analysis.

Chain-up areas along highways are used to provide heavy trucks and vehicles with designated facilities for safe refuge to abide with state chain law requirements during inclement weather. These facilities in Colorado are consistently signed with 30 minute occupancy restrictions or are access controlled as needed. Due to the occupancy (idling) time restrictions and seasonal nature of chain-up area use, these facilities are considered both a temporary and infrequent use, and are therefore considered a Type III project.

The following template language should be used for Type III documentation:

> *This project meets the criteria for a Type III project established in 23CFR772. Therefore, the project requires no analysis for highway traffic noise impacts. Type III projects do not involve added capacity, construction of new through lanes or auxiliary lanes, other than those associated with a turn motion, changes in the horizontal or vertical alignment of the roadway, exposure of noise sensitive land uses to a new or existing highway noise source, or any other activity classified as a Type I or Type II project. CDOT acknowledges that a noise analysis is required if changes to the proposed project result in reclassification to a Type I project.*

1.5 Project Timing

Each state highway agency is required to identify when the public is officially notified of the adoption of a location of a proposed highway project. CDOT, within the scope of these guidelines, defines the "date of public knowledge" as the date on which the final environmental project document (signed CE Form 128, Finding of No Significant Impact, or Record of Decision) is approved. After this date, CDOT will be responsible for analyzing and documenting changes in traffic noise impacts, but will not be required to provide noise abatement for new development which occurs adjacent to the proposed highway project. Decisions concerning such noise abatement are left to the local government agencies and private developers. Section 7.2 contains further discussion concerning noise-compatible land use planning and development.

1.6 Noise Sensitive Receptors

A noise sensitive receptor is any location where highway traffic noise may be detrimental to the enjoyment and functional use of the property as defined by the Noise Abatement Criteria (NAC. The residential outdoor activity and areas of frequent human use, such as schools, parks, hotels, and commercial centers, are considered for evaluation (**Exhibit 1**). All dwelling units on all floors of multifamily dwellings that have an outdoor activity area, such as a balcony, and are exposed to traffic noise are considered to be noise sensitive receptors.

Normally, these uses must be in existence at the time of the project construction, but special provisions can apply to undeveloped lands if applicable (Section 2.6.2).

1.6.1 Currently Developed Lands

All properties within the study zone are to be considered as existing receptors in the noise analysis. Each property must be classified as to the type of land use and the extent of the activity (Section 4.1). As mentioned above, all sensitive receptors present within the defined study zone must be included in the analysis.

1.6.2 Permitted Development

Normally, the noise analysis does not consider lands that are not developed, except to provide noise impact contours for local planning agencies; however, noise analysis is required for undeveloped lands for which development has been permitted before the date of public knowledge. This indicates that a definite commitment, with official public knowledge, has been made to develop the property in question and has reached a point where the developer's plans can no longer be changed in a practical manner. Any area which fits this category must be treated in the noise analysis as though the development has already been constructed.

The State of Colorado will consider a proposed development as being permitted when a formal building permit has been issued to the developer by the local agency of authority. During the NEPA re-evaluation process, if undeveloped land was not permitted for development by the date of public knowledge, FHWA and CDOT financial participation in abatement measures will no longer be considered for that property.

For example, when a project re-evaluation for NEPA is undertaken after a project has been shelved for more than 3 years, noise impacts will be re-analyzed and will include any new receptors built or permitted after the original NEPA document date of public knowledge, however; no new abatement analysis will be required for those receptors built or permitted after the original date of public knowledge. FHWA and CDOT will participate in noise abatement only for those receptors that were previously identified in the original NEPA noise study. FHWA and CDOT will not participate in abatement measures for new receptors which were not in existence or permitted prior to the original NEPA document date of public knowledge.

If a re-evaluation initiates a new NEPA document with a second, new NEPA decision document, all receptors identified within the new study zone up to the second date of public knowledge, will be analyzed for traffic noise impacts and considered for abatement measures.

There is no date of public knowledge for a Tier I document. The date of public knowledge is considered in the Tier II stage of NEPA documentation. Tiered NEPA documents such as Tier I Environmental Impact Statements (EISs) are discussed in Section 5.8.

2. NOISE FUNDAMENTALS AND TRAFFIC NOISE IMPACT CRITERIA

Sound can be defined as mechanical energy generated by movement or vibration from a source that can be sensed by the ear. Noise, generally, is defined as unwanted sound, and is the description usually given to sound that emanates from highway traffic. Each sound (noise) can be expressed in terms of three primary characteristics: magnitude, frequency, and time element.

The magnitude of a sound event can be measured in terms of its acoustic pressure. Because the range of absolute pressure values can vary over several orders of magnitude, the unit typically used to describe sound levels is the decibel (dB), which is a relation of the sound pressure level to a standard reference pressure. This ratio is then converted to a more compact logarithmic scale.

Since sound travels in waves, there are also varying frequencies associated with each sound event. The human ear does not respond equally to all frequencies, however, and filtering of these frequencies must be done in order to obtain accurate measurements and descriptions of highway traffic noise, as this noise is comprised of many frequencies. The filtering (weighting of frequencies) of the "A" scale on sound-level meters most closely approximates the average frequency response of the human ear, and is the scale that is used for traffic noise analyses. Decibel units described in this manner are referred to as A-weighted decibels, or dBA.

As sound intensity tends to fluctuate with time, a method is required to describe a noise source, such as a highway, in a steady state condition. The descriptor most commonly used in environmental noise analysis is the equivalent steady state sound level, or Leq. This value is representative of the same amount of acoustic energy that is contained in a time-varying sound measurement over a specified period. For highway traffic noise analyses in Colorado that time period is one hour, and the value then reflects the hourly equivalent sound level, or Leq(h).

For highway projects that require noise analyses in Colorado, the accepted noise descriptor is the worst-hour Leq (h) for determining existing and future noise levels and impacts. The worst-hour is specified and defined as such to reflect the conditions that will produce the worst traffic noise. In general, this is highest traffic volume traveling at the highest possible speed. If traffic volume continues to increase past these conditions, the traffic is eventually forced to slow down, which in turn decreases the noise levels generated.

A traffic noise impact is considered to occur when any noise sensitive receptor is subjected to either 1) future noise levels that approach or exceed the Noise Abatement Criteria (NAC), or 2) future noise levels that substantially exceed the existing noise levels. Both of the above must be analyzed to adequately assess the noise impact of a proposed project. When noise sensitive receptors are present and are found, during the course of the analysis, to be impacted under either case, noise abatement measures must be considered and evaluated for those receptors under the feasibility and reasonableness factors as described in Sections 5.4 and 5.5.

2.1 *Approach or Exceed Noise Abatement Criteria*

The NAC are noise levels which are compared to existing or future levels to determine impact threshold. The levels that are specified are based on the certain types of existing activities that are present.

CDOT defines "approach" as noise levels that are 1 dBA less than the national NAC specified in 23CFR772. The values shown in **Exhibit 1** reflect the values that CDOT considers when evaluating noise levels for each corresponding activity category.

Any receptor that is subjected to noise levels that either currently reach or are predicted to reach the values stated in **Exhibit 1** are considered to be impacted by noise. It is important to note that these values do not have to be exceeded to result in an impact, and there is no difference in the severity of the impacts in either case.

The levels expressed in **Exhibit 1** are intended to strike a balance between noise levels that are desirable and those that are feasible. Numerous approaches were considered in establishing the criteria, to include hearing impairment, annoyance, sleep interference, and speech communication interference. Highway traffic noise levels do not normally reach the levels that result in hearing damage, and what constitutes an annoyance or hindrance to sleep is very difficult to quantify on a large scale. Speech impairment, however, was usefully applied as a condition that reflects a compromise between noise levels that are desirable and those that are achievable and was found not to be arbitrary or capricious.

It is very important to understand that the CDOT NAC are impact criteria only; the absolute threshold levels for which abatement consideration must take place. There is not a specific *absolute* noise level that abatement measures must reach for noise impacts to be considered successfully mitigated.

When evaluating abatement, the NAC activity category Leq(h) values are not to be considered as the goals for which abatement must be designed. The overall objective of mitigation is to obtain the noise reduction design goal (Section 5.5.1), which may or may not result in noise levels below the NAC levels.

NAC Activity Category A receptors are extremely rare and apply only to extraordinary special public needs where the existing environment is of a serene nature that needs to be preserved to allow the area to continue to serve its purpose. Determination of whether or not a specific receptor qualifies as a NAC Activity Category A will be made on a case-by-case basis in consultation with CDOT and FHWA.

Most sensitive receptors that will be encountered on highway traffic noise analysis efforts will be categorized as NAC Activity Category B (residential) receptors and NAC Activity Category C receptors, which are both subject to the 66 dBA approach criterion. NAC Activity Category D describes criteria for interior evaluations when all exterior analytical methods have been exhausted, and then only applies to certain NAC Activity Category C uses.

NAC Activity Category E describes lands that are commercial in nature, and exhibit characteristics less sensitive to traffic noise. It should be cautioned that hotels and motels often have permanent residential occupation and should be surveyed for such before designating the appropriate categorical criterion of NAC Activity Category C or E. NAC Activity Categories F and G receptors are non-sensitive to traffic noise or undeveloped land uses, and are not subject to a NAC value.

Exhibit 1. CDOT Noise Abatement Criteria

Activity Category	Activity Leq(h)*	Evaluation Location	Activity Description
A	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[1]	66	Exterior	Residential
C[1]	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[1]	71	Exterior	Hotels, motels, time-share resorts, vacation rental properties, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	NA	NA	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, ship yards, utilities (water resources, water treatment, electrical), and warehousing.
G	NA	NA	Undeveloped lands that are not permitted for development.

1 Includes undeveloped lands permitted for this activity category.
* Hourly A-weighted sound level in dBA, reflecting a 1-dBA approach value below 23CFR772 values

When determining impacts, primary consideration is to be given to exterior areas of frequent human use where a lowered noise level will be of benefit. CDOT will consider interior noise abatement only for NAC Activity Category D facilities (Section 5.7).

2.2 *Substantial Increase over Existing Noise Levels*

The second manner in which a noise sensitive receptor can be impacted by highway traffic noise is to be subjected to a substantial increase of noise due to a highway project.

CDOT defines that a noise impact occurs if a receptor is to receive an increase in noise levels of at least 10 dBA over the existing noise levels. This impact criterion takes effect regardless of the absolute noise levels. For example, an increase of noise from an existing 45dBA to a predicted build condition of 57 dBA for a NAC Activity Category B receptor will result in a noise impact, as the net noise increase of 12 dBA is greater than the 10 dBA substantial increase threshold. A change in noise levels from 62 to 69 dBA for NAC Activity Categories B or C would not be an impact under the substantial increase criteria, but would still result in an impact as the NAC of 66 dBA has been exceeded.

As long as one of the impact criteria is met for a receptor, abatement must be considered for that receptor. No subjective descriptor terms are used to describe traffic noise impacts.

3. HIGHWAY TRAFFIC NOISE ANALYSIS

The main purpose of the highway traffic noise analysis is to identify noise sensitive receptors that will be subjected to traffic noise impacts. Any and all receptors that are identified as impacted must be considered for noise abatement. The abatement alternatives must be evaluated under the feasibility and reasonableness criteria. The noise analysis technical report (**Appendix B**) serves as proof that the analysis was performed and provides all necessary documentation as required by the regulations.

As early as is reasonably possible in the process, an initial assessment must be made to determine whether or not the project will require a detailed noise analysis as described in Section 4.1. This is best done in conjunction with the environmental scoping of the project.

The analysis consists of two major parts. The first consists of identification of noise sensitive receptors, assessment of the noise levels that these receptors are currently experiencing and are predicted to experience in the future, and determination of whether or not traffic noise impacts exist. If no traffic noise impacts are found, the analysis is then considered to be complete with no further evaluation required. If traffic noise impacts are expected, then the second part of the analysis, abatement consideration and evaluation, must be performed. The requirements for the first part of the analysis will be described below, while the mitigation consideration protocol will be discussed in Section 5.

Common misunderstandings arise when the subject and requirements of performing noise analyses are discussed. The requirement to perform a noise analysis, in and of itself, does not imply that impacts are present or that any other future actions are inevitable. The analysis will identify any noise impacts, which will then be considered for noise mitigation. Noise abatement will be provided if it is determined to be both feasible and reasonable.

3.1 Identification of Land Uses

The proper identification and quantification of the noise sensitive receptors adjacent to a highway improvement project is essential to the success of the analysis. Each receptor that is present within the extents of the project study zone must be examined in accordance with the regulations. The study zone has been defined to encompass the most likely area within which, a receptor may experience impacts resulting from project related traffic noise.

A project that does not border any existing or permitted noise sensitive land use area will not require a noise analysis. Receptors that are outside of the study zone of 500 feet around the extents of work for the individual project do not need to be considered for analysis, unless there is a reasonable expectation that noise impacts would extend beyond that boundary. The CDOT Environmental Programs Branch (EPB) noise specialist should be consulted for clarification as necessary.

The primary focus with the noise sensitive receptors is the exterior areas of frequent human use that are adjacent to the individual properties. For identified receptors, the consideration point will be the outside area that is immediately facing the highway, which in most cases will be the front/back yard, communal gathering/activity area, or porch area. To summarize the land-use activities that are present, each NAC Activity Category should be listed and the number of receptors identified in the project documentation.

The following metrics are intended to provide guidelines to facilitate statewide consistency of receptor identification. Coordination among CDOT, federal land management agencies and local jurisdictions is encouraged to provide appropriate context for and resolve identification of complex receptor-land use issues. (See **Exhibit 1** for tabulation of activity types and land uses.)

3.1.1 NAC Activity Category A

Determination of whether or not a specific receptor qualifies as a NAC Activity Category A will be made on a case-by-case basis in consultation with FHWA.

3.1.2 NAC Activity Category B

This NAC includes residential and multiple family dwellings, which includes mobile home parks and apartment buildings. All apartments that have an outdoor activity area, such as a balcony, and with exposure to traffic noise should be considered in the noise analyses – regardless of floor. Evaluation of the upper floors in multi-storied buildings is required to provide a basis for reasonable expectation of effective noise abatement for impacted receptors. Pragmatically, for a multi-storied residential building, the evaluation can be undertaken in multi-floor increments until no impacted dwelling is detected on that floor. Note that multi-family common areas belong to NAC Activity Category B. Special attention should be given to identify permanent or long-term residences that may be incorporated in hotels (NAC Activity Category E) or RV parks (NAC Activity Category C), as these should be evaluated under NAC Activity Category B.

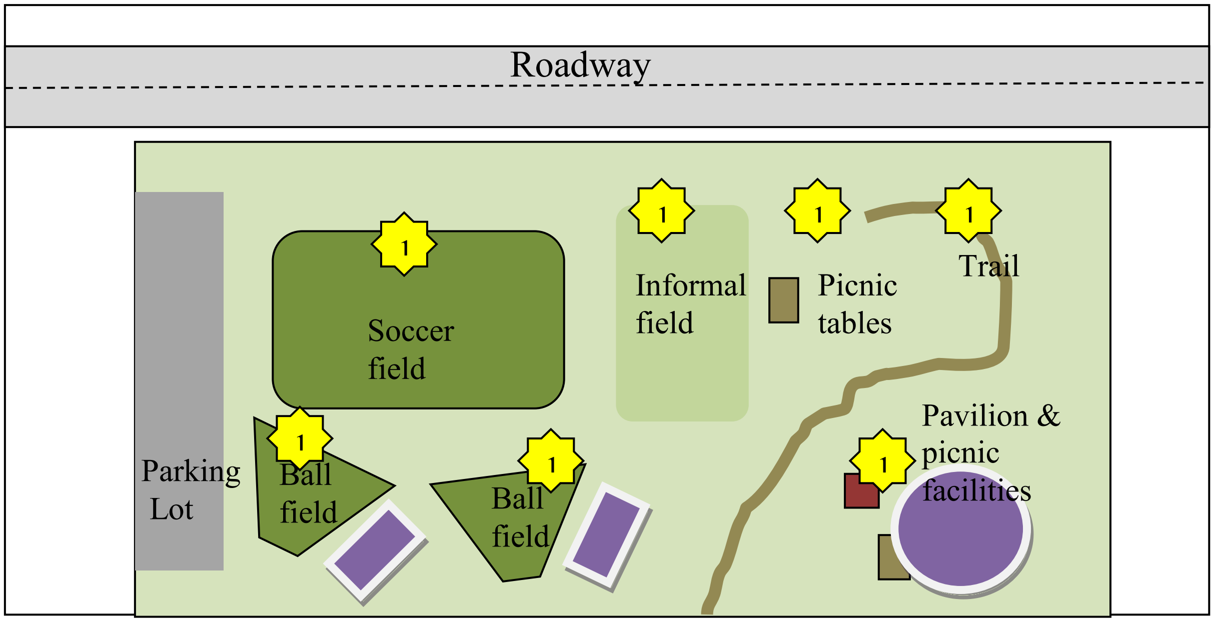
If a group of individual receptors share similar acoustical properties and settings, a representative, consolidated receptor site may be used in modeling. The total number of individual receptors represented by the consolidated receptor site must be clearly documented in the impact tables and reporting.

3.1.3 NAC Activity Category C

NAC Activity Category C land uses are identified as either individual sites, such as buildings, or can involve properties with multiple areas of diverse activity and usage characteristics, such as parks. The receptor identification metrics defined for NAC Activity Category C are purposely general to allow easy identification and inclusion of noise sensitive receptors, yet includes enough specific parameters to remove ambiguity in receptor site quantification.

This category follows an activity focused theme, using consolidated facilities and related uses as the basis of receptor identification. Communal or recreational properties may be divided into individual receptors based on individual activity areas (**Exhibit 2**); however multiple receptors must not be counted for individual pieces of a single common activity functional area. For activity areas that are spread across a property or for properties that lack defined facilities or formalized activity areas, a single generalized receptor should be placed within the property that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist. Consultation with the local jurisdiction is recommended to best resolve these issues.

Exhibit 2. Illustration of Park or Recreation Area Receptor Identification



Note: This hypothetical property would have a total of seven receptors based upon activity area identification.

Parks and Recreation Areas – Parks range in size and amenities from neighborhood pocket parks, to linear green belts accommodating drainages or trails, to large regional parks and natural preserves with multiple trails and outdoor use facilities. Recreation areas may also encompass multiple activity areas within a large parcel of land. Receptors should be located within the park or recreation area boundary for each area with a discrete outdoor activity as conceptually defined under this section. If the park or recreational area has no discernable formal activity areas (trails, camping facilities, picnic areas, ball fields, etc.) as defined within this section, a minimum of one (1) receptor should be sited to be representative of typical traffic noise on the property by using best professional judgment and by consultation with the jurisdictional authority for the property.

Picnic Areas and Fire Pits – One (1) receptor should be counted for each area of clustered tables and/or fireplaces which could be considered oriented or situated as a single functional area.

Campgrounds – One (1) receptor should be counted for each formal campsite or camping cabin capable of human occupation. Informal campsite areas located within formalized campgrounds should be counted as 1 collective receptor per separated area.

Pavilions – One (1) receptor should be counted for each complex of tables, outdoor cooking facilities, covered pavilions, gazebos; etc. that could be considered oriented or situated to provide a single use area.

Sporting fields – One (1) receptor should be counted for each formalized sporting field inclusive of its associated seating, access, pathways, and/or stadium complex which could be considered oriented or situated to facilitate use of the sporting field. Less formalized activity areas such as grassy areas of a park or recreation area, which are commonly utilized for informal sporting activity, should be counted as one (1) receptor per area which has been observed or exhibits attributes that demonstrate common active use.

Golf Courses – One (1) receptor should be placed within each hole (tee-off areas or fairway-green combination) of the golf course that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist. If other outdoor activity areas exist within the course such as practice areas, picnic facilities, restaurant outdoor area, etc., each course segment and formalized activity area shall be identified with a separate receptor.

Jurisdictionally-Controlled Forests and Other Areas Officially Managed for Outdoor Recreational Activity – Jurisdictionally controlled managed areas generally are federal lands that must have a management plan including defined outdoor activity use. Receptors should be located within the activity managed area boundary for each identified management area that defines outdoor activity areas as conceptually defined under this section. If the management area has no discernable activity areas (trails, camping facilities, picnic areas, etc.) as defined within this section, a minimum of one (1) generalized receptor shall be placed no closer than 50 feet from the edge of pavement within the management area that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist. Consultation with the local jurisdiction is recommended to best resolve these issues.

Trails/Trail crossings – One (1) receptor should be counted for each formal trail crossing regardless of the pathway orientation. The receptor should be placed no closer than 50 feet from the edge of pavement on the trail that best represents the worst expected traffic noise condition, based on professional judgment of the noise specialist.

Individual trails should also be assigned receptors at all areas where user congregating would be expected along the trail, such as rest areas with benches or scenic viewing areas. Consultation with the local jurisdiction is recommended to best resolve these issues.

Community activity areas – Apartment and residential community common areas may include pools, ball courts, or other formalized outdoor activity areas. Each of these outdoor activity areas should be counted as one (1) receptor.

Cemetery – One (1) receptor should be counted for each area of a formalized memorial gathering facility. Individual grave sites, access ways, and informal activity areas are not considered individually sensitive receptors; however, each section of the cemetery as defined through consultation with the operator, may have formal gathering areas, and should be assigned a receptor. If there are no formalized gathering areas, then no receptor is required for the property.

Section 4(f) Sites – Section 4(f) sites encompass three types of sites – parks and recreation areas, wildlife refuges, and historic sites:

- Parks and Recreation Areas – addressed above.
- Wildlife Refuges – wildlife or wildfowl refuges or preserves typically have limited or no human activity area and thus would not be subject to noise analysis. However, on-site trails or observation areas should be considered under NAC Activity Category C as defined in this section.
- Historic Sites – For historic sites that have exterior areas with frequent human use (historic houses), one (1) receptor should be counted for each site with such use. For historic sites without frequent human use, no noise analysis is necessary. Coordination with staff historian is required for all historic Section 4(f) site receptor identification and reporting. Noise levels may be required for Section 106 purposes, which may differ from highway traffic noise requirements.

When no noise analysis is necessary for a site due to an absence of an exterior area with frequent human use, this finding should be documented in the project file or noise report.

3.1.4 NAC Activity Category D

This activity category includes the interior impact criteria for certain land use facilities. CDOT would conduct an indoor analysis only for Activity Category D receptors after first examining if there are potential exterior areas of frequent human use.

Unless an actual interior noise measurement has been taken, the interior building noise level predictions shall be calculated by subtracting noise reduction factors from the predicted exterior levels for the building in question, using the information in **Exhibit 3**. Noise analysts should take interior noise measurements for the final noise analysis and abatement design for locations where noise insulation is being considered as an abatement measure.

Exhibit 3. Building Noise Reduction Factors for Interior Noise Evaluation

Building Type	Window Condition	Noise Reduction Factor (Due to Exterior of Structure)
All	Open	10 dB
Light Frame	Ordinary Sash (closed)	20 dB
	Storm windows	25 dB
Masonry	Single Glazed	25 dB
	Double Glazed	30 dB

The windows shall be considered open unless there is firm knowledge that the windows are in fact closed almost every day of the year. See FHWA-DP-45-1R, *Sound Procedures for Measuring Highway Noise: Final Report*

Source: FHWA A-HEP-10-025 *Highway Traffic Noise: Analysis and Abatement Guidance* (2010)

3.1.5 NAC Activity Category E

This activity category contains receptors which are less sensitive to highway traffic noise. These include hotels, motels, time-share resort facilities, offices with outdoor noise-sensitive uses, and other developed lands not included in NAC Activity Categories A-D, and F. Special attention will be given to ascertain if motel/hotel properties could include permanent or long term residents, thus qualifying as NAC Activity Category B.

3.1.6 NAC Activity Category F

This activity category includes industrial, commercial and other land uses that are not sensitive to noise. Some examples are agricultural uses, airports, maintenance yards, warehousing, emergency services, mining, rail yards, and utility facilities (water treatment, water resources, electrical). These uses are not considered noise sensitive, and no noise analysis is required for these locations.

3.1.7 NAC Activity Category G

This activity category includes all undeveloped lands which do not have a building permit prior to the date of public knowledge. These uses are not considered noise sensitive, and no noise analysis is required for these locations. However, noise impact contours for these properties should be provided to the local jurisdictional agency, including local planning, zoning and/or building permit offices, and where applicable, metropolitan planning organizations and transportation planning regions, for future land use planning purposes.

3.2 *Determination of Existing Noise Levels*

The next step in the analysis is to quantify the existing noise environment by determining the noise levels that the identified receptors are currently experiencing. Determination of existing noise levels shall be made by field measurement and use of the most current version of the TNM noise prediction modeling software. Protocol for the use of TNM for CDOT projects can be found in the *Traffic Noise Model User's Guide for Colorado DOT Projects* (2006). All measurement procedures must be performed by an ANSI Type I or Type II integrating sound meter in accordance with report FHWA-PD-96-046, *Measurement of Highway Related Noise*.

Although TNM analytical results are expressed to the nearest tenth decimal, all noise levels shall be rounded to the nearest whole number for reporting purposes in the NEPA general document. Technical reports and modeling appendices including TNM output files should retain their original decimal data format.). The intention here is to be inclusive of near impact noise levels (greater than 65.4 dBA) in mitigation considerations.

3.2.1 New Roadway at New Location.

Data siting the proposed new alignment and construction footprint should be superimposed on a base map illustrating existing and permitted buildings, features and facilities to define the appropriate noise study zone and identify noise sensitive receptors. Field measurements will provide the basis of existing noise conditions for projects involving the construction of a new highway in a new location. Noise field measurements at existing and permitted receptors (or representative receptors) located within the study zone of the project will be taken to a) provide adequate context for existing noise levels and b) to provide sufficient information to compare sensitive receptor noise levels to future noise levels derived from analytical modeling for the purposes of defining substantial noise impacts along the proposed highway corridor study zone.

3.2.2 Modifications to Existing Roadways.

Field measurements should be sufficient to provide adequate definition of the existing noise condition to validate the TNM model for existing conditions (Section 4.2.1.).

A minimum of two (2) existing field measurements are required within the study zone. Field measurements should represent sensitive receptors best illustrating the existing traffic noise environment, as free from the influence of local non-traffic generated noise sources and shielding as practical. Measurements can be taken at any time; however, it is best to measure when traffic is relatively free flowing at or near the posted speed limit. For high-volume roads, a 10-minute sample is usually statistically accurate enough to obtain a good measurement, but sample times of 30 minutes but not more than 1 hour may be needed for measurements along lower volume roads. Two readings are recommended at each site. A directional count of all light duty vehicles, medium truck 2-axle and multi-axle heavy truck traffic should be taken for relevant roadways adjacent to the measurement site. Tabulation of motorcycle and bus counts is also desirable. Determination of the approximate speed that the vehicles were traveling can be determined by either driving a test vehicle through the traffic stream or by use of a radar gun. Posted speed limits may be used if actual travel speed readings are unavailable.

3.3 TNM Model Validation

Most often, the purpose for taking field measurements will be to gather data that is used to develop a comparison between those measurements and results obtained with the noise prediction model. This exercise is performed to validate the model so that it can be used with confidence to determine the worst-hour existing noise levels and predict the future noise levels. It is not required to perform measurements at each individual receptor; however, enough representative measurement locations (a minimum of two measurements) in the project area must be utilized in order to reasonably characterize conditions for the validation effort. Once these data have been collected, each of the locations is then input into the model for comparison purposes.

In order to arrive at a valid comparison between measured and modeled results, traffic and speed data must be collected at the measurement locations at the same time the noise measurements were taken. This will involve actual counting of vehicles, being sure that truck (heavy and medium) counts are taken separately, and a determination of the approximate speed that the vehicles were traveling. For the purposes of validation, field measurement data should be normalized to an hourly basis as that will be needed for input into the computer model. The collection of relevant data will allow the modeling of the same conditions as was observed during the measurement exercise and does not require the analyst to attempt to measure during the worst noise hour. This effort is to be thoroughly documented within the noise study report.

The maximum acceptable difference between the actual noise measurements and the modeling results is 3 dBA. If the difference between the measured and predicted levels is not within 3 dBA, an examination of the measured and modeled data shall be performed to determine the reason for the difference and shall be adequately explained in the noise technical report. This may require that a second measurement be taken in some instances. Standard validation practices are described in **Appendix C** and in *Traffic Noise Model: Frequently Asked Questions FAQs* at www.fhwa.dot.gov/environment/noise/traffic_noise_model/tnm_faqs/faqs06.cfm#miroadways1.

3.4 Noise Modeling for Existing Conditions

Unless the project involves the construction of a new highway on a new location, the worst-hour noise levels are determined by the validated TNM computer model.

In selecting model locations, each individual receptor does not have to be modeled separately. A modeling location can be chosen that represents several actual receptors. This is acceptable as long as all the identified sensitive receptors are represented in the analysis. The number of the actual modeling points that are used will vary depending on the nuances of the individual project. For each modeled location, a table that shows the location identification and exactly how many receptors are being represented by that location must be included in the noise study report. These locations are then modeled at a height of 5 feet (1.5 meters) above the ground level elevation to approximate the height of the average human ear. For analysis of areas above the ground level, those locations shall be modeled at a height 5 feet above the elevation level of the use area.

To perform the noise modeling for the existing conditions, the analyst will need to gather the following input data:

- Current roadway alignment for roadways in the immediate area which may contribute to the noise environment. For areas containing roadways of a minor residential nature, only throughways carrying substantial traffic volume need be modeled (on a professional judgment basis).
- Existing traffic volumes, which include a breakdown of numbers of automobiles, medium trucks (2-axle, 6-tire), and heavy trucks (3+ axles) for all roadways, and buses and motorcycles as possible.
- Current posted speed limit for all roadways.
- Receptor locations.
- Terrain features, such as natural berms.
- Other features which result in a shielding effect (i.e. buildings).
- Any existing noise barriers present.
- Other TNM parameters such as pavement type can be utilized as a TNM option in existing condition modeling; however, the default average pavement type must be utilized in future condition modeling.

To model the worst hour existing condition, the traffic data that shall be used are the highest volume of traffic that can travel at the highest relevant speed for the particular roadway. In the past, this situation has often been represented by the Design Hour Volume of the roadway modeled at the posted speed limit. A new approach was evaluated (**Appendix E**) to identify the worst-hour traffic noise that is based on methodology found in the *Highway Capacity Manual* (2000). **Exhibit 4** summarizes the highest traffic volumes per lane at various posted speed limits for different highway classifications that were found to produce the loudest noise conditions.

For TNM modeling, the estimated traffic volumes from the project traffic analysis are to be used if they are less than the volumes presented in **Exhibit 4**. Although not referenced in the TNM User's Guide, if the estimated traffic volumes for a project roadway are higher than the corresponding volumes shown in **Exhibit 4**, the traffic volumes from **Exhibit 4** are to be used in the noise analysis because added traffic would cause speeds to slow which in turn will reduce noise levels. Proper documentation of the source of the traffic volumes is required to be included in the noise study.

Exhibit 4. Suggested Maximum Traffic Volumes for Worst Noise Hour

Posted Speed Limit (MPH)	Maximum Traffic Volumes by Facility Type (vehicles/lane/hour)[1]		
	Freeway	Non-Freeway Multiple Lane	Two-lane Roadway
75 or above	1600	NA	NA
70	1700	NA	NA
65	1800	1700	1300
60	1900	1800	1300
55	2000	1900	1300
50	2100	2000	1400
45	2200	2100	1500
40	Not applicable	2200	1600
35 or below	Not applicable	2200	1600

[1] **Appendix E** contains technical support documentation for worst noise hour equivalent capacity.

It is critical in the TNM modeling to account for all features affecting the noise environment, such as existing noise walls, partial barriers, jersey barriers, solid panel bridge walls, landscape berms, and other features that contribute to reduction, shielding or reflection of traffic noise.

3.5 Existing Noise Barriers and Privacy Fences

A situation where a barrier is already present can be confusing. To be considered a noise barrier, the structure must be solid and designed specifically to abate noise. Wooden privacy fences, which are not normally constructed to abate noise, are not considered to be noise barriers, because they generally do not provide an appreciable amount of noise reduction. These fences contain many gaps, each of which allows transmission of noise, and often are not made of sufficiently dense material to provide negligible noise transmission through them. Privacy fences should not be included as a TNM barrier feature in analytical modeling unless they are constructed gap-free and provide a suitable transmission loss (add value).

When privacy or other development-related fences are present, consideration shall be given as to whether the fence is a continuous, double-sided-wooden, masonry or composite-material fence and whether the fence will remain in good condition over the life of the project (20 years for projected future noise levels). If there is doubt as to the durability of the fence, it should not be modeled as a barrier providing noise abatement. When a noise barrier is currently in place, the existing conditions noise model must have the barrier included. The noise levels that are then reported for the existing conditions are those calculated with the barrier included in the model.

Additionally, if the existing barrier can be shown to meet the 7-dBA noise reduction design goal (Section 5.5.1) for the affected receptors in the future by comparing to a no wall and existing wall conditions, then effective noise abatement has already been provided and no additional noise abatement is required from the proposed project.

If the existing barrier is to be demolished under a new project, a replacement barrier meeting current noise regulatory requirements must be constructed as a part of the project unless another abatement measure adequately accounts for the required design goal level reduction and equivalent area abatement, or unless the noise and/or land use setting has changed sufficiently that no noise impacts remain to be mitigated (Section 5.3). An example of an adequate abatement measure replacing the need for a recommended barrier might be a new roadway profile that substantially lowers the roadway elevations, thus reducing noise levels below impacted levels for the previously impacted receptors.

The language often used for replacement walls "in kind" is meant here to mean acoustically equivalent insertion loss for the impacted area, using adequate barrier materials to meet the design goal noise reductions. In kind does not mean that a demolished or unrepairable wooden wall must be replaced (or should be replaced) with another wooden barrier; upgraded materials are expected.

It is desirable for any replacement barrier to be aesthetically consistent with project designs and area context.

3.6 Prediction of Future Noise Levels

Once the existing noise levels have been determined, the future design-year noise levels for each receptor are calculated using TNM. The future model shall reflect the design year conditions (usually 20 years post-construction) into the future (traffic counts and speeds, roadway alignments, changes to terrain) for the worst-hour noise condition. Each alternative alignment being considered for the project must be examined, including the no-action alternative. Although no analysis of the future no action alternative is required by 23CFR772, for the purposes of NEPA, CDOT requires that a no action scenario noise analysis is conducted. For minor projects, there will likely only be one alternative, but in the cases of projects which are either part of an Environmental Assessment (EA) or EIS, there may be several alternatives to consider and analyze.

Although TNM analytical results are expressed to the nearest tenth decimal, noise values shall be rounded to the nearest whole number for reporting purposes (impact tables) in both the NEPA documentation and supporting technical reporting. (Technical modeling, Cost-Benefit Index calculations, and appendices including TNM output files should retain their original decimal format.)

The traffic projections that are used must be consistent with the applicable adopted long-range plan traffic model, if available. When a long-range plan traffic study is not available, the best available data shall be used. Annual average daily traffic volumes and truck compositions for most state highways are located at http://dtdapps.coloradodot.info/otis. In the absence of any better traffic data, the traffic volumes used shall be the applicable volumes from **Exhibit 4** at the recommended future posted speed conditions for the new highway design.

The same traffic noise prediction modeling software that was used in the determination of the existing conditions shall also be used for future modeling, with the modeled receptors in the same locations as they were for the existing model, as appropriate. Receptors which are identified as potential ROW takes will not normally need to be included in the future modeling, but do need to be included in the no-action case. As was the case in the existing condition evaluation, if a noise barrier is currently present it must also be included in the analysis of the future conditions, unless it will be demolished as part of future condition.

3.7 Determination of Traffic Noise Impacts

The final step in the first part of the noise study is to compare the future predicted noise levels to the applicable NAC and to the existing noise levels to determine traffic noise impacts. As discussed earlier, any receptor which either equals or exceeds the NAC (**Exhibit 1**) under the existing or future conditions or is subjected to a 10 dBA substantial increase in noise levels is considered to be impacted by highway traffic noise. This is to be done for each alternative, including the no-action alternative.

It is important to remember that the determination of traffic noise impacts only results in consideration of abatement for the receptors, which will be performed in the next part of the analysis. It is not a guarantee that abatement will be provided.

If no traffic noise impacts are identified under the future conditions for any of the proposed alternatives, as defined by the provisions set in these guidelines, the analysis is considered complete and further consideration of noise abatement is not required. This determination, if applicable, shall be stated as such in the final noise study report.

To provide for a detailed and thorough review of all noise modeling efforts and inclusion of analyses done to predict the future noise levels as described in Section 4.3, the noise study must either include a electronic media copy of the TNM model files or a computer printout of TNM input and results tables generated during the modeling analysis.

3.8 Noise Effect on Wildlife

Procedures for Abatement of Highway Traffic Noise and Construction Noise, requires the identification of noise impacts, consideration of noise abatement and the construction of feasible and reasonable noise abatement for humans. Traffic noise effects on wildlife populations are not considered under 23 CFR 772. Information describing the effect of traffic noise on wildlife populations is available at: http://www.fhwa.dot.gov/environment/noise/noise_effect_on_wildlife/. This report contains a summary of ongoing work on the effects of noise on wildlife populations to date. Additionally, this website provides links to data regarding bird collisions with transparent noise barriers.

4. EVALUATION OF HIGHWAY TRAFFIC NOISE ABATEMENT

Any and all receptors which were determined to be impacted by noise must be evaluated for traffic noise abatement. This requires that the overall social, economic, and environmental effects of the abatement be evaluated against the benefits. When determining abatement measures, primary consideration is to be given to exterior areas surrounding residential areas or areas of frequent human use for other uses such as parks and commercial districts where a reduced noise level would be of benefit. All feasible and reasonable mitigation measures are required to be included in the highway project. It is not considered to be a prudent investment of public funds to consider construction of a noise barrier that will not result in at least a readily perceptible noise reduction.

4.1 Abatement Options

The following are common abatement measures that may be incorporated in highway projects to reduce traffic noise impacts.

- Traffic management measures, such as lane-use restrictions, designated truck routes, and speed limit reductions. Measures such as these may or may not be beneficial or possible given the constraints of the project and the immediate area. While lesser speeds do decrease noise levels, it generally will take a reduction in speed of approximately 20 miles per hour to achieve a readily perceptible (5 dBA) reduction of noise at its source.
- Alteration of horizontal and vertical alignments to reduce noise impacts, where practical.
- Acquisition of undeveloped land for buffer zone creation. While buffer zones are a very good strategy in overall noise compatible land use planning, it is often not a practical solution, due to the large amount of land that must be purchased. In many instances, the existing developments already border the highway. Federal dollars cannot be used to purchase developed property for noise mitigation.Vegetation and/or landscaping are not considered viable abatement measures.
- Noise insulation, but for NAC Activity Category D structures only.
- Construction of noise barriers within highway right-of-way, or acquisition of property rights for construction of noise barriers outside of the highway right-of-way.

A related topic that has been researched for many years is the noise emissions that are due to the tire-pavement interaction. While it is accepted that different tires, pavements, and pavement surfacing textures do result in varying noise levels, it is difficult to forecast the overall pavement surface condition 20 years into the future. Due to this fact, and the requirement that noise mitigation must provide a readily perceptible reduction in noise levels over a long period of time (i.e., permanent), the use of different pavement types or surface textures cannot be considered as a noise abatement measure.

4.2 Noise Barriers

There are two common abatement measures employed by CDOT: the vertical noise wall and the earthen berm. Both barriers work by blocking the path of sound waves from the highway, forcing the sound to travel around or over the barrier. If a noise barrier is tall enough to break the line of sight between the highway and the receptor, constructed of sufficiently dense material (4 pounds per square foot minimum density), and does not have any openings or gaps, a noise reduction will be possible that will range from being readily perceptible to less than half as loud (5-15 decibels for most barriers) depending on the height and location of the barrier. CDOT has determined that a barrier design must achieve a minimum 7 dBA noise reduction design goal (Section 5.5.1) for at least one receptor and at least a readily perceptible noise reduction (5 decibels) at one or more receptors to be considered reasonable and feasible, respectively, for construction as a prudent investment of public funds.

The most common types of highway noise barriers are vertical walls, which can be constructed out of a variety of materials: concrete, masonry block, composite synthetic materials, as well as transparent acrylic/plastic products.

CDOT Research and Innovative Technology Branch conducted a worldwide scan of noise reduction strategies resulting in Technical Report 2013-11 An Investigation into Effective Traffic Noise Abatement Design Solutions for Mountain Corridors, which can be found at http://www.coloradodot.info/programs/research/pdfs/2013/mountain.pdf/view.

4.2.1 Reflected Noise

The primary purpose of traffic noise barriers is to reduce noise levels at sensitive receptors behind the barrier; however, under some conditions, barriers may reflect traffic noise and negatively affect the noise conditions at other nearby receptors. Generally, this occurs when there are receptors on the opposite side of the subject road from the noise barrier. In these circumstances, the barrier is acting as a secondary noise source because of the reflected sound. It is possible that reflective noise from a noise barrier could increase noise overall levels by as much as 3 dBA, but in practice will normally change noise levels by 1 dBA or less. Some of the more common situations where reflective barriers may be a concern include:

- Sensitive receptors are present across the subject road from a proposed barrier, but are not being considered for a separate noise barrier.
- A frontage road is located between the proposed barrier and the sensitive receptors.
- Parallel barriers would be present on each side of a road and the ratio of the distance between the barriers versus the height of the barriers is 10:1 or less (For more information please refer to **Appendix C** Traffic Noise Model User's Guide for Colorado DOT Projects.).
- A large building or other man-made reflective surface is immediately across the subject road from a proposed barrier may simulate a parallel barrier effect.
- A large rock cut or other natural reflective surface is immediately across the subject road from a proposed barrier may simulate a parallel barrier effect.

Decisions regarding modeling reflective noise should be made on a case-by-case basis, through consultation with the CDOT Noise Specialist(s).

4.2.2 Absorptive Treatments

In situations as described in Section 5.2.1, surface treatment of the proposed barrier to reduce reflections may be beneficial. Such treatments could include sound-absorptive surfacing or an irregular barrier surface. Therefore, CDOT will consider special barrier surface treatments for projects where a sensitive receptor or a large sound-reflecting object (natural outcrop, highly reflective building or man-made feature) is present across the subject road from a proposed noise barrier and at a distance no greater than 10 times the proposed barrier height. Absorptive noise barriers must be designed so that the absorptive portion on the highway side has a minimum noise reduction coefficient of 0.70 when measured in accordance with the requirements of ASTM C423-08 (ASTM, 2008a). Decisions regarding barrier materials and finishes will be made in compliance with CDOT's materials selection process.

Reflective and absorptive material criteria are defined in CDOT sound wall materials specifications, located at http://apps.coloradodot.info/apl/SearchRpt.cfm?cid=Environmental.

4.2.3 Berms

An earthen berm is essentially a linear natural or man-made soil or soil/debris mound. Berms, while more natural in appearance, do require a great deal of land and a very large footprint. Noise walls require much less space to be constructed, but may be subject to height limits due to structural and aesthetic reasons. Barriers have also been constructed by placing walls on top of berms to create a combination barrier. More detailed information concerning design, structural, and aesthetic considerations of noise barrier construction at CDOT can be found in the Chapter 18 of the CDOT Roadway Design Guide, 2005 at:
www.coloradodot.info/business/designsupport/bulletins_manuals/roadway-design-guide.

4.3 Noise Barrier Abatement Evaluation

Evaluations of possible noise barriers are to be conducted using the most current, FHWA approved TNM software using the future conditions data. Various locations and heights of barriers can be input into the model, which will calculate the noise levels with the barrier. The amount of reduction, also known as insertion loss, is defined as the future barrier noise levels subtracted from the future no-barrier condition.

Acoustically, the most effective noise barriers are generally located closest to the source (i.e. highway) or closest to the receptors. As a result, initial barrier placement should be considered and evaluated for either of these locations. In many cases, however, the CDOT right-of-way line is the most practical location for the barrier. Multiple barrier locations should be considered in the analysis if more than one effective location can be used within the right-of-way. Barrier locations should first be evaluated within the CDOT right-of-way. If effective noise reduction cannot be achieved by a barrier located within the right-of-way, adjacent or nearby land can be evaluated for placement of an abatement measure.

The overall length of barrier, different barrier heights, and design compensation for situations that require breaks in the barrier (overlapping or wrapped end-segment barriers) should also be considered in abatement analyses. Performing this evaluation is an iterative process, done by altering certain inputs and barrier siting. The best judgment of the noise analyst should be used to determine the optimal feasible and reasonable barrier dimensions and location. As always, this process needs to be documented in the noise analysis report.

Noise barriers are installed and maintained in perpetuity to protect the noise sensitive environment impacted by the roadway project. When a new project alters or proposes to alter the terrain with potential to remove or disrupt the ability of the existing barrier to abate as designed (Section 4.5), an assessment must be made of the existing barrier in terms of both effectiveness and remaining service life. The remaining service life of the existing barrier (either Type I or Type II) as defined within an engineering evaluation must also be considered to ensure that it is a permanent solution as required by FHWA. If an existing barrier poses ongoing functionality or maintenance problems, it should be replaced with currently acceptable materials either as a part of the Type I highway project or as a state funded noise wall replacement project.

An example case is where an older wooden noise barrier has been installed, but has deteriorated over time. An engineering assessment can determine that an acceptable service life remains with cost-effective repair. This would be an acceptable decision. The engineering assessment can determine that repair of the existing wall is not cost-effective and can replace the wall with suitable materials that furnish acoustically feasible and current design goal noise reductions. Decisions concerning these situations will be made on a case-by-case basis in consultation with CDOT and FHWA.

Federal funds can be used only if there will be impacts in design year caused by a Type I project and the replacement barrier is feasible and reasonable.

Effectiveness of the existing barrier will be assessed through the noise modeling software by calculating the noise reduction from the barrier for the project design year with the proposed improvements in place. If the existing barrier is found meet the noise reduction design goal, no further action is necessary for the existing barrier. If the barrier will not meet the design goal, examination of alterations to the existing barrier so that it will meet the current noise reduction design goal (Section 5.5.1) will be necessary and appropriate recommendations made to improve the barrier. If structural integrity, inadequate footing design, load carrying capacity, or other construction issues prevent the existing wall from being adequately modified and no remedy is readily found, consultation with FHWA and CDOT Project Management Team will determine whether a replacement wall shall be built to meet the 7 dBA noise reduction design goal. At a minimum, any existing noise barrier removed for construction of a new transportation project shall be replaced in kind (see Section 4.5) at a new location. All noise abatement analyses recommendations must be documented on a CDOT Form 1209, the Noise Abatement Determination Worksheet (**Appendix D**).

As noise abatement measures other than the construction of noise barriers are not usually practical, the following discussions concerning feasibility and reasonableness are presented in the context of considering noise barriers and noise barrier construction.

4.4 *Feasibility*

Feasibility criteria describe the physical considerations and concerns with the construction of an acoustically effective noise barrier at a particular site and project. If a noise barriers that has been evaluated for a particular location is deemed not to be feasible, an assessment of the reasonableness criteria is not required and the noise abatement analysis is considered complete. This analysis and decision is to be fully discussed and documented in the noise study technical report.

4.4.1 Noise Reduction

The major feasibility criterion that is to be considered is whether or not a substantial noise reduction can be obtained based on constraints that are inherent to the individual project. If a reduction of 5 dBA cannot be provided to at least one impacted receptor, the abatement measure is not considered a feasible mitigation and will not be recommended for inclusion in the project.

A very common issue to consider in this case is the ability to construct a continuous barrier for the entire length of the impacted area. A barrier is typically not effective if built with frequent breaks for driveways, sidewalks, streets, utilities, drainage facilities or streams as the resultant short wall lengths may drastically reduce the barrier's acoustic performance. One possible solution in a case such as this is to consider wrapping barrier end-segments or overlapping the barriers. The analysis indicating that a 5 dBA feasible noise reduction cannot be achieved must be documented in the technical report.

4.4.2 Safety and Maintenance Considerations

As is the case with any structure, there are obvious engineering, safety and maintenance issues that must be considered to determine its feasibility. If any of these issues are significant enough to cause a fatal flaw condition, then the barrier is deemed to not be feasible. The geographic setting and weather conditions inherent to Colorado dictate very different feasibility concerns when it comes to winter maintenance. Four-fifths of Colorado is non-urban/non-suburban in nature and most roadways are situated at altitudes from 4000 feet to 9800 feet. Many highly traveled roadways traverse terrain that is mountainous, steep valley sided with limited sun exposure. In these cases, there is little room to negotiate noise barrier locations within the physical constraints of the terrain.

Examples of situations which can be considered fatal flaws include, but are not limited to, the following:

- Excessive reduction of sight distance.
- Creation of a continuous shadowing condition that may cause excessive icing of driving lanes through the winter months.
- Inability to provide for adequate snow/debris removal or snow storage during winter months.

CDOT uses consultation with maintenance and traffic engineering staff to determine when these types of maintenance/safety issues can be redesigned to an acceptable level, can safely incorporate transparent barriers, or are severe enough to cause a feasibility fatal flaw to noise barrier installation at any project site.

4.4.3 Constructability

If reliable and common engineering practices could be employed to construct a noise barrier, then that barrier is considered feasible. If it is obvious that the constructability of a noise barrier due to location limitations, critical environmental factors or engineering considerations is not possible without major modifications to the site or technological efforts, or extraordinary costs, the barrier can be considered not to be feasible and no further analysis is required. However, this should only be used for situations that are very clear. Decisions such as these shall be thoroughly documented and justified in the noise study report.

A special constructability consideration is when the minimum barrier height required to achieve the noise reduction design goal (Section 5.5.1) for at least one receptor is found to be greater than 20 feet. CDOT has determined that for Colorado terrain and weather conditions, including common high wind events, 20 feet is the maximum allowable height without compromising structural integrity under typical construction design specifications. CDOT views this condition as infeasible and the barrier will be re-evaluated for feasibility at a lower wall height (possibly sited at a different location).

Feasible constructability extends to extraordinary costs related to implementation of engineering design, structural reinforcement, or right-of-way purchase for the purpose of noise abatement implementation. Typically these types of extraordinary costs are not identified until final design has been rendered.

4.4.4 Considerations for Berms

Most of the above feasibility discussions have focused on the construction of noise barrier walls. Berms, however, can be considered as an alternative to walls where possible, as they are generally more aesthetically pleasing and have a more natural appearance. Limitations with berms do need to be considered in the feasibility evaluation, because a much larger footprint is required. Ideally, berm flanks will be no steeper than a 3:1 slope. An earthen berm is deemed not feasible if the necessary slope ratio is steeper than 2.5:1 or adequate ROW cannot be acquired to construct the berm to safety or slope ratio specifications.

4.4.5 Considerations for Parallel Barriers

Due to multiple sound reflections, performance degradation of parallel barriers needs to be investigated if the width-to-height ratio is less than 10:1 (distance between the barriers is less than 10 times the height of the barriers) or if the barriers are closer together than 200 feet. Analysis of individual walls under these specific parallel configurations could lead to incorrect abatement calculations (**Appendix C**). Possible solutions include raising the height of the barriers to overcome the degradation or investigating the use of absorptive treatments on either or both barriers to reduce the reflections. In these cases, retaining walls or vertical rock face cut slopes, if they are present, should be treated as barriers in the analysis.

4.5 *Reasonableness*

Reasonableness of abatement measures evaluates the combination of environmental, economic, and social factors affected by the noise abatement measure. This analysis ensures a prudent use of public funds.

Reasonable noise abatement must at a minimum collectively achieve the criteria of the noise reduction design goal, the cost-benefit evaluation and the benefited receptors desire for an abatement measure. Failure to achieve all of these criteria (Sections 5.5.1 through 5.5.3) will result in the noise abatement measure to be deemed unreasonable.

4.5.1 Noise Reduction Design Goal

CDOT defines the noise reduction design goal as the insertion loss that is predicted to result from a barrier that results in a 7 dBA noise reduction at a minimum of one benefited receptor. The initial barrier evaluation shall be performed to determine what dimensions and siting will be required to achieve a 7 dBA reduction.

Barrier dimensions must be optimized in terms of overall noise reduction and cost-benefit, which are two of the factors for reasonableness. It is desirable that a design be identified where a potential noise barrier provides the best balance between cost and noise reduction benefit. This is not a trivial task, as the benefit versus cost relationship is not linear and a point of diminishing returns will be reached. An iterative process, however, can result in a barrier that will provide optimal benefit with a noise reduction design goal of at least 7 dBA.

A benefited receptor, whether impacted or not, is one that receives at least 5 dBA of noise reduction. This 5 dBA reduction is based on the addition of the noise barrier only, and is only considered after any shielding effects, such as for rows of buildings, are taken into account.

Often times, noise sources such as aircraft, rail, ground transit modes, or industrial noise contribute substantially to the noise environment. The quantitative context of these non-roadway noise sources is not addressed within the approved FHWA TNM modeling software. Therefore, in cases where substantial noise contribution is expected from other transportation (or non-transportation) noise sources, consultation among CDOT noise specialist(s), CDOT project manager, local agency project sponsor(s) (if applicable), and FHWA is required to resolve the noise impact and abatement evaluation methodologies.

Other considerations that need to be taken into account are situations where a barrier will shield a main highway, but not a frontage road. In these cases, the overall noise environment shall be the basis for the determination if the noise reduction design goal is possible.

4.5.2 Cost Benefit Index

In consideration of the cost of each potential noise barrier segment, the barrier cost benefit index shall be calculated based on an estimate of cost per receptor per decibel of reduction caused by the abatement. This will determine the cost-reasonableness of the abatement measure. To be considered reasonable, the cost benefit index must calculate to a dollar value no more than **$6,800** per receptor per decibel of reduction.

The cost benefit index, calculated as a ratio, is ***not*** intended to function as an accurate cost itemization for the design and construction of a noise barrier, but rather to provide a consistent level of consideration that will be used for CDOT noise abatement decision-making under these guidelines. The genesis of this cost-benefit baseline derives from the average wall dimensions necessary to provide prudent noise reduction benefit to a suburban/urban neighborhood housing density.

The cost benefit index value will be determined by dividing the approximate cost of the barrier (length * height * unit cost) by the total decibel reduction that is predicted to occur for all benefiting receptors of 5 dBA or more. For purposes of the abatement evaluation, the unit cost that will be used for this cost calculation will be a generic wall cost of $45 per exposed square foot (on one-side of feature), which approximates the typical costs in construction of a standard concrete/masonry barrier that does not require special site considerations. This cost is based on an average of 2005 to 2009 noise wall square footage costs collected from CDOT cost tabulations.

If berms are potentially feasible, use the unit cost of $15 per cubic yard of earth for the berm portion of the calculation. If the berm will be constructed utilizing on-site excess materials or recycled excess roadside sand, resulting in a trivial cost or a net benefit to the project, a unit cost of $2.50 per cubic yard shall be used in the calculation. It will be a matter of CDOT noise specialist discretion to determine which berm unit cost will be utilized in the cost-benefit calculation.

For example, consider a barrier 10 feet high and 1000 feet long to protect a development of 16 homes. If 6 receptors are predicted to receive a 5 dBA benefit and 10 are predicted to receive a 7 dBA benefit, the cost benefit index value will be calculated as follows:

- Cost = (10 ft. ht.) * (1000 ft. l.) * ($45/sq. ft) = $450,000;
- Benefit = (6 rec. * 5 dBA) + (10 rec. * 7 dBA) = 100 total dBA reduction;
- Cost-Reasonableness Value = $450,000/100 dBA = $4500/receptor/decibel.

This example barrier would be considered reasonable because when the cost of the barrier ($450,000) is divided by the total amount of decibel reductions for the 16 benefitted receptors (100 dBA), the cost per benefitted receptor, per dBA ($4,500) is less than the cost per benefitted receptors allowance of $6,800.

As mentioned earlier, receptor points that were used in the modeling usually represent several actual receptors. It is very important to properly quantify these receptors to obtain an accurate count of the benefits achieved and used for the calculation. For the calculation, each benefited individual residence, business, etc. is to be counted as one receptor. For multi-family residences, each dwelling unit adjacent to the highway should count as one receptor. If the multi-family structure is represented by a single modeled receptor and it is predicted to receive an overall benefit of 8 dBA, for example, but there are 4 separate units, then an overall benefit of 32 dBA (4*8) must be used in the calculation. Receptor identification for special land uses captured under the NAC is described in Section 4.1.

4.5.3 Benefited Receptor's Desires

The opinions and desires of the benefited community must be considered in the evaluation of reasonableness of a noise barrier. The decision to build or not build noise abatement measures recommended from noise mitigation analysis should result from a simple majority response consisting of greater than 50% of the responding benefited property owners and residents. The CDOT or consultant noise specialist shall identify the applicable benefited receptors within each abatement analysis. A benefited receptor is any property containing a noise sensitive receptor(s) that receives 5 dBA or more noise reduction caused by the abatement measure.

In order to take both owner and resident desires into account, each dwelling unit is provided two votes – one for the owner and one for the resident. For owner-occupied dwellings, both votes would be cast by the same individual(s). For owners of multiple dwelling units (e.g. apartment buildings), the owner would have the same number of votes as the number units that are benefited. Each residential unit would get one vote. In the instance with multiple owners or multiple residents of a single dwelling unit, a consensus is required.

NEPA Documentation

CDOT will evaluate and recommend feasible and reasonable noise abatement measures for the preferred alternative through the NEPA process and will use the public involvement process, which can include, but is not limited to, open houses, public hearings and/or neighborhood mailers, to inform the public of the recommended mitigation. A noise abatement station providing noise abatement displays and analyses adequate to inform the public on the recommendations should be present at NEPA-related public venues. Abatement recommendations will be documented in the NEPA noise technical documentation and Statement of Likelihood (Section 5.6). A statement disclosing that a Benefited Receptor Preference Survey will be conducted for benefited owners and residents affected at each recommended mitigation site at the time of final design of the construction project should be included in the Statement of Likelihood.

In the special case of the Categorical Exclusion project where there is typically only one build alternative under consideration, public involvement may be limited, and the timeframes between NEPA noise analyses, engineering design and construction are generally more compressed, the Benefited Receptor Preferences Survey can be solicited after the Final Office Review, but during the NEPA process.

Benefited Receptor Preference Survey

Once final design of the project and the re-evaluated abatement analyses are completed, a public involvement process shall be utilized to solicit the views of current residential occupants' and property owners' on whether to build noise abatement or not. This final design public involvement process shall be devised by CDOT Construction or Project Management and the CDOT noise specialist responsible for the re-evaluation analyses of the final abatement design. At a minimum, one attempt to contact each identified benefited receptor site (both property owner and resident, see Appendix A) must be made and documented – utilizing the US Postal Service or commercial mailing services, door-to-door contact, or other defensible, targeted means. Written and spoken communications will be in English and in the dominant secondary language of the community, if applicable. The benefited receptor preference survey process must be thoroughly documented and attached to the Form 1209 for that abatement measure. A vote of equal standing will be provided one resident and one owner per benefited dwelling unit as described above.

The noise barrier preference survey is normally based on residential areas; however, mitigation for commercial and special-use areas would be based on a survey of the business operators and property management/owners and/or the officials with jurisdiction.

Whichever preference option (for or against the abatement action) that receives the most votes will become the stated preference of the affected persons and determine whether or not the abatement measure is built. An example of a preference survey is included in **Appendix D**. If the preference survey results in a tie vote, it is understood that no majority has been reached, and therefore, no abatement action would be built.

Survey Results Example
As an example of the voting process, suppose an Environmental Assessment recommends sound walls at 2 different locations within the project area. The noise specialist identified 60 dwelling units benefited from Noise Wall #1 and 25 benefited dwelling units from Noise Wall #2. A Benefited Receptor Preference Survey was conducted after the final design noise analytical evaluation was completed. The survey resulted in 35 votes (25 affirmative, 10 negative) from benefited owners/residents received for Noise Wall #1 and only 5 affirmative and 11 negative votes received for Noise Wall #2.

The decisions would be as follows:

- Noise Wall #1 received 35 total responses- a total of 25 of 35 or 71% affirmative votes and 10 of 35 or 29% negative votes from benefited owners and residents. The decision would be to construct Noise Wall #1 as a part of the project.
- Noise Wall #2 received 16 total responses - a total of 5 of 16 or 31% affirmative votes and 11 of 16 or 69% negative votes from benefited owners and residents. The resulting decision is to not construct Noise Wall #2. This wall does not meet the required reasonableness criterion because of this vote and would not be built.

These decisions would be documented and attached to the appropriate CDOT Form 1209 in the project file and NEPA administrative archive.

4.6 *Statement of Likelihood*

The environmental document shall identify (1) locations where noise impacts are predicted to occur, (2) where noise abatement appears feasible and reasonable, (3) locations with impacts that have no feasible or reasonable noise abatement alternative, and (4) the recommendations for construction of noise abatement measures. For an environmental decision, this analysis shall be completed to the extent that design information is available at the time the environmental decision document is completed. A Statement of Likelihood shall be included in the environmental document since feasibility and reasonableness determinations may change due to changes in final project design after approval of the environmental document. The Statement of Likelihood shall include the preliminary location and physical description of noise abatement measures determined to be feasible and reasonable in the preliminary analysis. The final noise abatement decision will be made during the completion of the project's final design and the public involvement processes.

To aid in this documentation, completion of CDOT Form 1209 is required and is to be included within the noise study report (**Appendix D**). This form is to be filled out for each barrier segment or each distinct area of the project that were evaluated in the abatement analysis.

4.7 Special Insulation Abatement Considerations

Noise insulation of NAC Activity Category D land use facilities, such as places of worship and schools, may be considered for an abatement measure in accordance with 23CFR772.13(c)(5). This evaluation will be made on a case-by-case basis. Any decisions in this regard must be thoroughly and completely documented in the text of the noise report. Post-installation maintenance, repair and operational costs for noise insulation are not eligible for Federal-aid or CDOT funding.

4.8 Tiered Environmental Impact Statement

Tiered EIS documents are a special case requiring consultation with FHWA. The level of noise analyses required for a Tier 1 EIS would be more general in nature, deferring a Type I project noise analysis, as described herein, for a subsequent Tier 2 NEPA study. CDOT and FHWA will jointly determine the appropriate scope of noise analysis for the Tier 1 EIS. When the Tier 1 EIS is intended to narrow the range of alignment alternatives and/or modal alternatives, the Tier 1 EIS may provide more general estimates of existing noise levels and future noise level changes than a project-specific Tier 2 analysis. The Tier 2 analysis will include more detailed information about the design concept and scope and surrounding land uses than Tier 1. The Tier 2 document will include alternative specific impact and mitigation analyses.

4.9 Design-Build Project Implementation

The preliminary technical noise study shall document all considered and proposed noise abatement measures for inclusion in the NEPA document (EIS, EA or CE). Design-build noise abatement measures shall be based on the preliminary noise abatement design developed in the technical noise analysis for the Preferred Alternative design. Noise abatement measures shall be considered, developed, and constructed in accordance with this standard and in conformance with the provisions of 40CFR1506.5(c) and 23CFR636.109.

The following items should be included in all Type I design-build bid engineering design plan sets and/or specifications to provide consistency and clarity to the contractor. All items listed below must be compiled by the CDOT Project and Noise Teams and clearly documented in the Bid Package. A contractual mechanism shall be developed by CDOT Project Management and Contracts personnel to assure that the following elements are fulfilled as required or in cases of optional features, as best practicable:

- Definition of geographic siting, dimensions and material requirements of the recommended noise abatement measures.
    - Aesthetic treatments

- Absorptive treatment if required
- Materials selection
- Construction method (e.g. post and panel, pour in place)
- Any required structural element

- Definition of the alignment shifts and profile elevation tolerances triggering a re-analysis of noise impacts and abatement. Definition of process for re-evaluation of original recommended abatement in response to alignment shifts or profile changes.
  - Identification of required deliverables and submittals for potential changes in design
  - Identification of phasing issues where salient features such as existing noise walls or existing shielding once removed or significantly regraded during construction would trigger temporary noise abatement requirements during construction period until final abatement measure is re-evaluated and/or constructed.
- A ***Benefited Receptor Preference Survey*** shall be conducted for abatement recommended for the final alternative in the NEPA process as defined in Section 5.5.3. If new abatement is added to the design-build project, the Project Management Team in conjunction with the contractor noise analyst shall initiate a new ***Benefited Receptor Preference Survey*** for any new abatement measure(s).
- A final noise analysis will be conducted to determine effectiveness of constructed or proposed abatement measures. This includes evaluation of new impacts and new abatement as a result of design changes.
- Clear responsibility of contractor for monitoring and reporting of alignment and profile changes; communication chain and authority to instigate new noise impact and abatement evaluation.
- Clear responsibility of conducting, reporting, recommending, and documenting of new noise impact evaluation in the office.
- Clear responsibility for development, siting and communicating construction requirements for new abatement measures in the field.

As design-build project construction proceeds, noise abatement measures shall be carefully monitored by CDOT and contractor noise personnel to document barrier inclusion and barrier placement.

Noise abatement measures recommended by the NEPA decision document or the CDOT noise specialist cannot be removed or ‘value engineered’ from a project as a cost-savings device unless adequate replacement acoustic benefit is restored. Adequate abatement must be provided to sensitive receptors as identified in CDOT noise abatement analysis. Altered barrier conditions will be evaluated on an ongoing basis to assure that abatement is constructed that continues to meet noise 7 dBA reduction design goals at one receptor at each recommended feasible and reasonable barrier location. Alterations in dimensions and deviations from proposed siting plans should be well-documented. Larger or more complex projects, which are likely to result in modified roadway horizontal or vertical alignments during the design-build process, should develop an abatement verification procedure to formalize and document changes and alterations to the preliminary recommended abatement parameters and siting.

4.10 Noise Impact Compensation and Third Party Funding

Property owners or residents cannot receive Federal funds as monetary compensation in lieu of noise abatement. Neither can property owners and residents receive direct monetary compensation for unmitigated damages caused by highway traffic noise impacts.

Federal-Aid Project or Project in Interstate ROW

Private or third party funding can be used on projects to make functional enhancements to a noise abatement measure already determined to be feasible and reasonable, such as adding absorptive treatment, access doors, or aesthetic enhancements. Private or third party funding is not allowed on a Federal or Federal-aid Type I or Type II project to discount the cost of the noise abatement measure in order to influence the determination of feasible and/or reasonable. Private or third party funding cannot be used to augment the dimensions or change the cost-benefit index of abatement measures recommended on a federal-aid project. Other landscape or hardscape features may be constructed with private or third party funding as part of a non-federal aid project in interstate right of way that may provide some noise abatement without meeting the feasible and reasonable determination.

Non-Federal Aid Project on non-Interstate ROW

Local agency sponsored and non-CDOT, non-federally funded noise abatement can be constructed on CDOT right of way only if the local agency establishes that no other reasonable alternative to the use of public property is available, and meets the requirements of the CDOT Noise Analysis and Abatement Guidelines. Again, other landscape or hardscape features may be constructed with private or third party funding as part of a non-federal aid project that may provide some noise abatement without meeting the feasible and reasonable determination. (See **Section 7.3**)

5. CONSTRUCTION CONSIDERATIONS

The approach to this discussion in the project report should be general in scope and consider the temporary nature of construction activities. Included should be the types of activities that are expected to be performed and the equipment that will be used. If desired, noise levels that are associated with these activities can be researched through product or process literature and presented in the report. Computerized prediction models have been developed for the calculation of noise from construction but are very sophisticated and require a great deal of construction staging and planning input that is not available to CDOT during the NEPA process. As a result, use of these models to analyze construction noise is not required.

5.1 Construction Noise

All Type I and II projects will identify land uses or activities that may be affected by construction noise caused by the project. No detailed analysis is required; however, CDOT recommends use of the FHWA construction noise model and suggested mitigations, which can be found at www.fhwa.dot.gov/environment/noise/construction_noise. The noise analysis must at a minimum identify low-cost, readily implemented abatement measures that can be included on the project. Examples are limitations of work to daytime (or specified) hours, ensuring that equipment utilized properly maintained mufflers, modification of backup alarm systems, location of haul roads, and public outreach.

A construction noise plan may be developed to detail mitigation needs and abatement measures employed during construction activities, especially in large, complex projects in major urban areas that are anticipated to have duration of one year or more. In these cases, a more detailed discussion of the impacts and mitigation measures is necessary for the project. This type of mitigation plan could include, but is not limited to construction noise monitoring, heavy truck routing, temporary noise abatement measures, noise complaint hotlines, establishing project construction noise limits and violation procedures. This plan should be identified as a NEPA mitigation strategy for noise or construction, and be fully developed and approved prior to final project design implementation (pre-construction).

5.2 Construction Vibration

A vibration analysis is generally not necessary for construction activities unless there are vibration-sensitive businesses in the area and high vibration construction methods are proposed. Before construction begins, each vibration-sensitive area must be identified and a temporary vibration mitigation plan be developed.

5.3 Local Ordinances

Some local governments have passed local noise ordinances which may restrict the amount of noise that can be emitted from a construction operation during certain hours or in certain areas (i.e. residential neighborhoods). Although CDOT is ultimately responsible to assure that local noise ordinances are observed by the contractor, acquisition of noise related permits and variances required by the local ordinances are the responsibility of the contractor. This is something that may be needed if the work is envisioned to be very extensive or lengthy in nature. County, city or local noise ordinances and noise control plans should be investigated with local agencies and variances fully resolved with identified jurisdictional authorities, councils and/or boards prior to commencing work.

6. COMMUNITY CONSIDERATIONS

6.1 *Public Involvement*

Decisions concerning noise abatement should include involvement from the public, in particular the citizens who reside or perform business adjacent to the proposed noise barrier. Education should also be provided to members of the general public within the scope of public meetings and publications that describe noise, noise-related impacts, traffic noise mitigation, and enforcement issues. Various publications that explain many of these concepts are available on the FHWA web site www.fhwa.dot.gov/environment/noise.htm. Section 5.5.3 outlines the public involvement requirements for a Benefited Receptor Preference Survey.

6.2 *Coordination with Local Agencies*

Upon completion of the noise study technical report, information shall be provided to local government agencies within whose jurisdiction the highway project is located as to the traffic noise implications of the project on that particular local community in the future. The overall goal of this effort will be to prevent future traffic noise impacts on currently undeveloped lands and to promote noise compatible land use planning.

Proper noise compatible land use planning is very likely the best approach in dealing with the issue of highway traffic noise. The premise is very simple: Refrain from placing noise sensitive developments adjacent to highways. In reality, this is very difficult to do. As the jurisdiction over most of the land in these cases belongs to local governments, it is up to them to determine what activities to pursue in consideration of the best interests of their citizens. While the State of Colorado encourages local governments to plan their developments in such a manner to minimize the impacts of highway traffic noise, such as the creation of buffer zones or placing less sensitive land uses near the highway, there are no mandates currently in effect that prohibit noise sensitive development adjacent to highways.

Information shall be provided to the local officials as to the best estimation of future noise levels at various distances away from the centerline of the project for both un-developed and developed lands. In particular, the distance estimate of the projected 66 dBA contour (related to NAC Activity Categories B and C) should be emphasized. Noise contour maps of the project area clearly delineating the future 66 dBA and 71 dBA contours on the most current available base mapping or aerial photography of the CDOT project including the surrounding community shall be supplied to the local agency planning department, the zoning department and the building permit department. The noise study report should be forwarded to the local authorities, as well as any other explanation or information that will aid the local officials in planning for future traffic noise impacts, such as the FHWA publications *The Audible Landscape: A Manual for Highway Noise and Land Use* and *Guidelines for Considering Noise in Land Use Planning and Control*. Upon request, CDOT will provide additional available material and technical support and guidance which may be of assistance.

6.3 Non-CDOT, Non-federally Funded Noise Abatement on Public Right-of-Way

The purpose of this section is to establish consistent criteria regarding the review, evaluation and approval of requests for non-CDOT, non-federally funded projects that provide for the installation of noise barriers on state highway rights of way.

6.3.1 Policy Discussion

CDOT recognizes that "retrofitting" noise barriers on existing state highways (Type II Noise Program under 23 CFR Part 772) can be a desire of local residents and local officials. CDOT does not currently fund a Type II noise program but will consider approving non-CDOT, non-federally funded noise barrier projects provided that these projects meet criteria established by CDOT consistent with Federal Highway Administration (FHWA) guidance.

Non-CDOT, non-federally funded noise barrier projects should be placed on private property. Private property is not subject to CDOT's jurisdiction. Non-CDOT, non-federally funded noise barrier projects may be placed on public rights-of-way only if the applicant establishes that no other reasonable alternative to the use of public property is available. All requests for non-CDOT, non-federally funded noise barriers will be reviewed and evaluated in a fair and consistent manner, which balances the concerns of the general public at large and meets statutory requirements set forth in § 43-2-400, *et seq.,* C.R.S. and 2 CCR 601-17, Rules Regarding the Use of Waste Tires for Noise Mitigation Purposes Along Colorado State Highways pursuant to § 43-2-401, C.R.S. In evaluating each request, CDOT will consider justification of need based upon the appropriate criteria established in the following Procedural Requirements, the appropriate environmental documentation, plans for future transportation construction, and any other impacts or consequences of the proposed barrier.

6.3.2 Procedural Requirements

So that each non-CDOT, non-federally funded noise barrier request is treated fairly and consistently, the following general requirements apply to all proposals unless otherwise agreed to by CDOT:

1. All applicants for non-CDOT, non-federally funded noise barriers shall be governmental or quasi-governmental entities that have authority to issue local land use approvals. Co-applicants are permitted provided that a governmental entity with authority to issue local land use approvals is the primary applicant and all land use approvals are secured.

2. The governmental entity or agency, hereinafter referred to as the applicant, must notify CDOT and the applicable Transportation Planning Region (TPR) or Metropolitan Planning Organization (MPO) of its desire to initiate development of a noise barrier within the state highway right of way. Prior to submitting an application, the TPR or MPO shall approve the non-CDOT, non-federally funded noise barrier request. If CDOT

initiates the application for a non-CDOT, non-federally funded noise barrier, CDOT will be required to follow the same steps outlined in this procedure.

3. All costs for the development of the proposal including all studies, engineering design, ROW, and construction, will be the responsibility of the applicant. The application shall include a financial plan that identifies the responsible parties for all costs associated with the project. A decision will be made on a case-by-case basis whether to seek reimbursement for the cost of CDOT's review and coordination. Costs consistent with a typical permit review will be absorbed by CDOT.

4. The application shall include a study documenting the justification; need and effectiveness of the proposed noise barrier consistent with the criteria and requirements defined in Sections 3.0 through 5.0 of this document.

5. The application shall justify why placement of the noise barrier on the state highway right of way is necessary.

6. The application shall identify environmental actions required for the proposed noise barrier pursuant to 23 CFR Part 771 http://www.coloradodot.info/programs/environmental/nepa-program/nepa-manual and shall identify a plan and schedule for completion of environmental actions by the applicant and final approval by CDOT and FHWA. All environmental actions shall include a public meeting held by the applicant.

7. All applications for a non-CDOT, non-federally funded noise barrier shall include a design of the proposed barrier, which shall contain the endorsement seal of a Professional Engineer registered in the State of Colorado. CDOT will approve final design of the proposed noise barrier. The design shall include all geometric, structural, and materials details and comply with the most recent CDOT Standard Specifications for Road and Bridge Construction. Designs shall not impair the highway nor interfere with the free and safe flow of traffic. CDOT will provide at no cost to applicants, standard noise barrier specifications, noise abatement guidelines, and noise barrier standard drawings and details.

8. All applications for a non-CDOT, non-federally funded noise barrier shall be subject to approval by CDOT. CDOT's approval of a non-CDOT, non-federally funded noise barrier shall expire after three years unless actual construction of the project has been initiated, and unless otherwise agreed to by CDOT.

9. In addition to CDOT's approval, all noise barriers located on the interstate highway system shall be separately reviewed and approved by the FHWA.

10. CDOT and the applicant shall agree to ownership of the proposed barrier including responsibility for all repair and maintenance in an intergovernmental agreement. All noise barriers located on interstate highway rights-of-way shall be owned by CDOT.

    All non-CDOT, non-federally funded noise barrier applications approved by CDOT shall be subject to execution of an intergovernmental agreement that identifies, at a minimum:

    - The applicant's responsibility for all costs, including, as discussed above, CDOT's costs from initial application review through project management and completion.

    - Ownership, repair and maintenance responsibility for the noise barrier following completion of construction.

    - The applicant's responsibility to obtain all applicable permits, including a permit from CDOT.

6.3.3 Application Submittal

It is deemed necessary that proposals for non-CDOT, non-federally funded noise barriers be submitted and includes all required information to the appropriate CDOT Region Land Management and Access/Permitting Unit management. It will be the responsibility of the CDOT Land Management and Access/Permitting staff to coordinate with Region Engineering, Region Right-of-Way, and EPB and/or Region Noise Specialist(s) to determine CDOT project management of the non-CDOT, non-federally funded noise wall request. State statute C.R.S. 43-4-402 and 403 should be consulted for details of application criteria and timing (see http://www.coloradodot.info/programs/environmental/noise).

CDOT Roles and Responsibilities

Region Land Management and/or Access Management & Permitting of the CDOT Region where the proposed noise abatement measure and the local sponsoring agency are located is considered to be the first contact for requests from local agencies and interested citizens. As such, the Land Management and/or Access Management and Permitting Unit is responsible to provide a timely receipt notification and forward a copy of the formal application or the application request to each of the following intra-agency entities for that Region: Right-of-Way, Engineering Residency, Environmental Noise Specialist and/or DTD Environmental Programs Branch noise manager.

The EPB and/or Region Noise Specialist will provide the applicant (local agency) with technical environmental and noise analysis coordination. All noise impact and abatement analysis will be coordinated and quality assured through this staff prior to engineering, right-of-way and access and permit approvals of abatement measure construction.

7. NEPA DOCUMENT REQUIREMENTS

All Type I projects, regardless of which level of documentation (CE, EA, or EIS) is being used for that particular project, a detailed noise study report will be required to be submitted for CDOT review and comment. This finalized report will be submitted and included with all project information and documentation.

For all highway traffic noise evaluations on a CDOT project or a project requiring CDOT approval, the noise analyst performing the highway traffic noise evaluation must, at a minimum, hold a certificate of completion from an FHWA approved training course for use of TNM. An educational background including principals of highway traffic noise, such as NHI Principals of Highway Noise, and FTA transit noise screening evaluation (as appropriate) are the expected minimum threshold of understanding for all noise specialists on CDOT projects.

7.1 *Categorical Exclusions*

For CE projects, there is usually no published environmental document. Rather, CDOT CE Form 128 is used to document the environmental decisions, to include noise. Completion of the detailed noise technical report, which has addressed the comments and concerns of the CDOT environmental review process, will suffice as far as project documentation is concerned. This documentation can be used in the public desires survey and for notification of public planning agencies and departments of future noise levels on undeveloped lands. The date that the noise analysis and abatement analysis have been accepted will be noted on the CE Form 128. The final approval of the CE Form 128 represents the date of public knowledge.

7.2 *Environmental Assessments and Environmental Impact Statements*

EAs and EISs will provide a summary of the noise technical report within the body of the document. In particular, this summary will include the existing noise condition, impacts that are expected and an evaluation of any potential abatement measures. Although final design information is not available at the early stages of the environmental analysis and documentation effort, every effort must be made to make an initial determination of impacts and evaluation of abatement measures, even though final decisions will not be made until the final design process for the project.

Before the adoption of the decision document, noise abatement measures which are reasonable and feasible and are likely to be incorporated into the project and noise impacts for which no apparent solution is available must be identified by a Statement of Likelihood (Section 5.6). This information should be included to the extent practicable in all NEPA documentation, and must be included in the final environmental document. The purpose of this requirement is that the intentions concerning noise abatement must be made as early as possible in the process. If it is determined that mitigation cannot be provided, the decision must be thoroughly documented with strong supporting evidence provided. (See **Appendix B**.)

The noise study report shall be available for review within the technical appendix section of the environmental document. The noise study report must be finalized and approved by the CDOT EPB noise specialist before the environmental decision document is approved and signed.

7.3 Noise Abatement Measure Reporting

In accordance with 23CFR772.13(f), prescribed FHWA requirements to report a triennial inventory of noise abatement measures and their characteristics, each project shall report the following information on all constructed noise abatement measures. Each region shall report the following information to CDOT EPB noise specialist as each project incorporating a noise abatement measure is constructed.

The inventory shall include the following parameters:

- Type of abatement (wall, berm, composite);
- Cost (overall cost, unit cost per square foot);
- Average height (feet);
- Length (feet);
- Location (county, city, route, and GPS coordinates with identified datum and projection system if appropriate, for wall end points);
- Year of construction;
- Average noise reduction as reported by the model in the noise analysis;
- NAC Activity Category(s) protected;
- Material(s) used (precast concrete, berm, block, cast in place concrete, brick, metal, wood, fiberglass, combination, plastic [transparent, opaque, other]);
- Features (absorptive, reflective, surface texture);
- Foundation (ground mounted, on structure);
- Project type (Type I, Type II, and optional project types such as State funded, county funded, toll way/turnpike funded, experimental, unknown).

CDOT will report this information to FHWA every three years, in accordance with Office of Management and Budget's Information Collection Requirements.

APPENDIX A
DEFINITIONS

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23CFR772—Title 23, Code of Federal Regulations, Part 772 (the FHWA Noise Regulation).

Abatement—Measures used to substantially reduce traffic noise levels.

Applicant – A homeowner or renter residing in an eligible area, or the operator of a temporary housing facility or public housing facility located in an eligible area, who submits an application [for non-CDOT, non-federally funded noise mitigation] to the transportation commission in accordance with C.R.S. 43-2-401.

Approach—Noise levels which are within 1 dBA of the Noise Abatement Criteria for a corresponding NAC Activity Category.

Automobiles—All vehicles with 2 axles and 4 tires. Includes passenger cars, vans, and light panel and pick-up trucks.

Auxiliary Lane – Auxiliary lanes are not intended to increase road capacity, but to facilitate the operations of the roadway. Examples include, but are not limited to, any lanes that connect the on-ramp of one interchange with the off-ramp of the next interchange, truck climbing lanes, passing lanes, acceleration and deceleration lanes, and turn lanes. Auxiliary lanes which are turn lanes are exempt from Type I projects (see turning lane definition).

Background Noise—The total of all noise in a system or situation, independent of the presence of the source of interest (ambient noise).

Benefited Receptor— A receptor that is calculated to receive a noise reduction of at least 5 dBA from an abatement action.

Berm— An earthen mound constructed for use as a noise barrier.

CDOT— Colorado Department of Transportation.

CDOT Form 1209—Noise abatement determination worksheet is required to be filled out for each noise analysis for CDOT projects.

C.R.S. 43-2-401 – Colorado Revised Statute, Title 43. Transportation Highways and Highway Systems, Article 2. State, County, and Municipal Highways, Part 4. Noise Mitigation. The state noise mitigation sections 401 through 404 define the general parameters for noise mitigation measures, privately funded noise mitigation, and noise related rule-making authority.

Cost Benefit Index—A value used to determine the cost-reasonableness of noise abatement based on an average barrier cost per unit area.

Date of Public Knowledge—The date of approval of the appropriate environmental decision document for a highway project (signed CE Form 128, FONSI, or ROD).

Decibel—The basic unit for measuring the difference of sound pressure levels of a sound event from a reference pressure. To approximate the range of frequencies of sound most audible to the human ear, an A-weighting factor is applied. Sound levels are usually reported in A-weighted decibels, abbreviated dBA.

Department – The Colorado Department of Transportation.

Design Year—The future year used to estimate the probable traffic volume for which a highway is designed (usually 20 years from start of construction). This year is used as the basis for calculating the predicted future noise levels.

Eligible Area – According to state statute C.R.S. 43-2-401, an eligible area [for non-CDOT, non-federally funded noise mitigation] means a residential area that a) is located adjacent to a state highway; b) existed as a residential area before the state highway was constructed or widened; and c) is located within the boundaries of a local government that, as of the date of the application [for noise mitigation], has adopted an ordinance or resolution to mitigate the effects of noise in the future residential or other noise-sensitive development adjacent to the state highways within the boundaries of the local government.

Existing Noise Levels—The level of noise measured or modeled at a receptor for the pre-construction condition of the highway project area.

Feasibility - The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure.

Federal Action – A Federal action includes actions with effects that potentially subject Federal control and responsibility to projects, programs, funding, or regulatory application.

FHWA —Federal Highway Administration.

Heavy Trucks—Any vehicle with three or more axles.

Impacted Receptor—Any receptor which, under future conditions, is either subjected to noise levels that approach or exceed the noise abatement criteria or a substantial increase in noise levels.

Insertion Loss—The predicted reduction in noise levels resulting from implementation of noise abatement measures.

Leq(h)—Hourly Equivalent Noise Level; the equivalent steady-state sound level that contains the same amount of acoustic energy as the time-varying sound level over a one hour period; the noise descriptor that is used for all traffic noise analyses for CDOT projects.

Local government – A city, town, county or city and county. *See* § 43-2-401(4), C.R.S.

Loudness—The perceived assessment of the intensity of sound/noise.

Medium Trucks—Any vehicle with 2 axles and 6 tires.

Multifamily Dwelling - A residential structure containing more than one residence. All dwelling units on all floors of multifamily dwellings that have an outdoor activity area, such as a balcony, and are exposed to traffic noise, are considered noise sensitive receptors.

NEPA—National Environmental Policy Act.

Noise—Unwanted sound; any sound that is generally considered annoying or offensive.

Noise Abatement Criteria (NAC)—Absolute noise levels used to determine that a noise impact occurs when the level is equaled or exceeded.

Noise Barrier—A solid structure (wall or berm) constructed between a noise source and noise impacted receptors to abate the highway traffic noise.

Noise Reduction Design Goal - The optimum desired dBA noise reduction determined from calculating the difference between future build noise levels with abatement, to future build noise levels without abatement. The noise reduction design goal shall be at least 7 dBA.

Parallel Barriers—Two barriers which face each other on opposite sides of a highway.

Permitted—Planned development on currently undeveloped land that has obtained a formal building permit.

Predicted Noise Levels—Post-construction noise levels as determined via use of a traffic noise prediction model for the design year.

Privacy Fence—Fence constructed on private property or edge of development that is primarily used to separate individual lots from a roadway, and not constructed for noise abatement purposes.

Property Owner - An individual or group of individuals that holds a title, deed, or other legal documentation of ownership of a property or a residence.

Quasi-Governmental Entity -- For the purposes of this Guidance, shall mean an entity with authority to issue local land use approvals.

Reasonableness - The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

Receptor—Any location of an outdoor area where frequent human activity occurs that may be impacted by highway traffic noise and may benefit from reduced noise levels.

Resident – A resident occupies a primary home or place of abode, in which a person's habitation is fixed. The intended distinction between a resident and a property owner is that a resident secures a lease to occupy a permanent building or part of a building and may include a house, condominium, apartment, room in a house, or mobile home. No vacant lot shall be considered a residence. To further refine the definition of a resident for the sole purpose of traffic noise abatement preference survey, the lease must be intended for long term residence and is not intended for vacation, holiday or seasonal occupancy.

Shielding—Noise reduction attributable to any structures or terrain features which are located between a noise source and receptor. The presence or absence of landscaping or vegetation does not affect shielding.

Sound—Mechanical energy produced by pressure fluctuations in a medium (air, water, etc.) that travels in waves and can be detected by the human ear.

Statement of Likelihood - A statement provided in the environmental decision document based on the feasibility and reasonableness analysis completed at the time the environmental document is being approved.

Substantial Noise Increase—For a Type I project, the predicted noise levels increase by 10 dBA or more over the existing noise levels as a result of a highway project.

Study Zone—The area encompassed within a 500 foot halo around the extents of a project which must be considered in the noise analysis. The 500 foot halo is measured from the edge of the roadway pavement, not the highway centerline. If there is a reasonable expectation that noise impacts would extend beyond 500 feet from the edge of the travel way, the study zone will be expanded to include those receptors.

Through Lane – A through lane is any general purpose or managed lane that provides capacity to the roadway.

Traffic Noise Model (TNM) - Current FHWA approved traffic noise prediction software for use on CDOT projects. Former noise modeling program, STAMINA 2.0 has been superseded and is no longer applicable for project analyses.

Traffic Noise Impacts—Impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria or when the predicted traffic noise levels substantially exceed the existing noise levels.

Turn Lane – For the purposes of noise analysis, a turn lane is considered to be the designated lanes required for storage and for completion of a full turning movement. This includes striped deceleration and acceleration lanes that merge into existing through lane traffic. On freeway facilities, extending existing ramp acceleration or deceleration lane(s) to meet current engineering design standard lengths is considered a turn lane(s), including the extension of an existing ramp lane(s) to connect two closely spaced existing interchanges, not to exceed 2500 feet in accumulated length, to accommodate weaving. Under these definitions, the addition of a turn lane would constitute a Type III project.

Type I Projects—A proposed Federal action or Federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through traffic lanes. See full criteria identified in Section 2.3.1.

Type II Projects—A proposed Federal action or Federal-aid highway project for noise abatement on an existing highway. No active Type II program currently exists in Colorado.

Type III Projects - A Federal action or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects are not required to undergo noise analysis.

Undeveloped Lands—Lands on which no current human activity areas already exist or are not currently permitted for future development.

Worst Traffic Noise Condition—Traffic conditions that yield the highest absolute noise levels by consisting of the highest volume of traffic traveling at the highest possible speed. In general, this is the roadway design hour traffic volume at the posted speed limit.

APPENDIX B
NOISE TECHNICAL REPORT REQUIREMENTS

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The purpose of the noise technical report is to provide complete documentation of a highway traffic noise analysis. The noise analysis shall include the following steps for each alternative under detailed study, to include the no-action alternative:

- Identification of existing activities (receptors), developed lands, and undeveloped lands for which development is permitted,
- Determination of existing noise levels,
- Prediction of future noise levels,
- Identification of traffic noise impacts, and, if necessary,
- Documentation of the evaluation of noise abatement measures.
- Development of mapped noise contours to identify future noise impact levels for local land use planning agencies.

Within the body of the report, the above steps taken shall be documented in a manner which allows clear comprehension to the reader of what analysis was done and its underlying reasoning.

The noise report shall include the following (this does not necessarily have to be in the following order and can be included as appendices where appropriate):

- **Introduction and Study Area**. Describe in detail the project location, project purpose, and project alternatives that are being proposed and the study zone that is being considered.
- **Noise Basics and Applicable Guidelines.** Describe general sound and noise terminology and the guidelines and regulations that are being adhered to in the development of the noise analysis.
- **Measurement Procedures.** Describe where and when noise measurements were taken and report the results. List in a table each measurement location and the corresponding results. Not every receptor needs to be measured individually, but enough locations are required in representative points throughout the project. Collect traffic data during the measurements to be used in the validation step.
- **Measurement/Model Comparison (Validation).** Compare the measurement results with the results obtained using the computer model. Report this data in tabular form as well. In general, agreement within 3 dBA will be acceptable. If the difference for any locations is more than 3 dBA, an explanation must be provided as to the reasons for the difference. This may require that the field measurements be repeated.
- **Model Input Data**. Describe the data that is to be included in the modeling of the existing and future conditions. Include and quantify all receptors which are within the study zone of the project. Include and describe which roadways, terrain features, buildings, and ground conditions are present. Describe in detail which traffic data are to be used for the modeling, to include the speeds. Generally, this will be the design hour volume for the roadway. If the design traffic year volumes are higher, use the volumes as

shown in **Exhibit 4**. If they are less, then use those values (do not model to actual capacity of the highway unless the traffic is projected to meet or exceed that capacity). Be sure to obtain as accurate a split as possible on medium truck and heavy truck volumes.

- **Modeling.** For all receptors, model the noise levels for the existing, all future alternatives being considered, and the future no-action alternative. List all data in tabular form for easy comparison. All receptors shall be identified with an address, business name, or location illustrated on a reasonably legible map in addition to whatever modeling convention is used (i.e. R1-1200 Oak Street) and to which activity category they were classified. If any modeled receptors represent more than one actual property, the representative information also needs to be included (R1, 1200 Oak Street, NAC Activity Category B, 5 residences).
- **Mitigation Analysis and Evaluation.** If noise impacts are identified, mitigation must be evaluated under the feasibility and reasonableness guidelines. Evaluate abatement first to attempt to achieve a 7 dBA minimum reduction for at least one receptor (CDOT noise reduction design goal). At least two barrier placements and heights should be analyzed unless it is very obvious that only one location/height will be possible. The goal of this effort is to attempt to optimize the barrier given the feasibility and reasonableness factors.
- **Mitigation Recommendation and Statement of Likelihood**. Explain in detail the final recommendations concerning noise mitigation. This information will also be used in the environmental document, if applicable.
- **Construction Noise.** A brief discussion of the implications of construction noise and typical mitigation measures that can be used is also required.
- **Maps**. To aid in visualization of the project and provide definition of receptor locations, maps should be included as appendices to the noise study report that locate the project, modeled receptors, measurement locations, and barrier locations.
- **CDOT Form 1209**. A copy of a signed CDOT Noise Abatement Determination Worksheet for each evaluated abatement site should be filled out, signed and attached as an appendix as an either hardcopy or an electronic file. Complete one form for each barrier segment or project area analyzed.
- **Benefited Receptor Preference Survey**. A sample blank copy and a scanned copy of all returned Benefited Receptor Preference Surveys must be compiled. Surveys should be independently conducted and tallied for each mitigation area passing feasibility and reasonableness Noise Reduction Design Goal and Cost-Benefit Index criteria. Copies of this compilation should be attached in a technical report appendix as either hardcopy or an electronic file. **Noise Modeling Data**. A copy of the input and output data can either be included in the appendix, or preferably, submitted with the report on electronic media.

APPENDIX C
TRAFFIC NOISE MODEL USER'S GUIDE FOR CDOT PROJECTS

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APPENDIX D
NOISE ABATEMENT WORKSHEET
and
SAMPLE BENEFITED RECEPTOR
PREFERENCE SURVEY

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COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ___________________ Date of Analysis: ___________________

Project Name & Location: ____

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ❒ YES ❒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ❒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ❒ YES ❒ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ❒ YES ❒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❒ YES ❒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ❒ YES ❒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ❒ YES ❒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ❒ YES ❒ NO
2. Are noise mitigation measures reasonable?
   ❒ YES ❒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ❒ YES ❒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Completed by: ____ Date: ___________________

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BENEFITED RECEPTOR PREFERENCE SURVEY

This survey should be accompanied by an explanatory cover letter and either a stamped, self-addressed envelope or an email link for voting.

Colorado Department of Transportation

NOISE WALL SURVEY

VOTE!
Express your opinion in the CDOT Noise Wall Preference Survey

Are You a Benefited Business, Homeowner or Tenant?

I own or lease at a location identified to receive at least 5 decibels of noise reduction from a noise barrier proposed along Hwy as a part of the Project Name.

YES, I want a noise wall. ☐

Name____

Address____

Apt#__________ City_________________________________

Are you the business or home owner or tenant?___________

NO, I do not want a noise wall. ☐

A __ foot tall and __ foot long noise barrier is being recommended along Hwy between Street and Street. This barrier is designed to reduce traffic noise caused by roadway improvements made to Highway with the construction of the Project Name.

One owner and one tenant per dwelling unit that would benefit from 5 decibels of noise reduction from the proposed noise barrier are eligible to vote on whether a noise wall as described above should be built at this location. This survey of your preference will decide whether a noise barrier is built or not built based on a simple majority of votes that CDOT receives by Date, 2013.

Assigned Receptor ID# ______

COLORADO
Department of Transportation

BENEFITED RECEPTOR PREFERENCE SURVEY DOCUMENTATION FORMAT

This spreadsheet format is suggested to capture full receptor location, notification and voting information for each recommended final design noise barrier.

Benefited Recept or ID #s	Pueblo Co. Assessor Parcel #	Resident First Name	Resident Last Name	Benefited Property Address	City	State	Zip Code	Received	Vote			Owner First Name	Owner Last Name	Owner Address	City	State	Zip Code	Received	Vote		
									Yes	No	Abstain								Yes	No	Abstain
101	431305004	Mary Ann and Pedro	a	315 S Bradford Ave	Town	CO	80222					•	•	315 S Bradford Ave	Town	CO	80222				
102	431238003	Angie	b	225 S Bradford Ave	Town	CO	80222					•	•	225 S Bradford Ave	Town	CO	80222				
103	431238010	Dwight	c	221 S Bradford Ave	Town	CO	80222	•	1			Angie	ff	225 S Bradford Ave	Town	CO	80222	•	1		
104	431238011	Steven	d	219 S Bradford Ave	Town	CO	80222	•	2			•	gg	219 S Bradford Ave	Town	CO	80222				
105	431238006	Patrick	e	217 S Bradford Ave	Town	CO	80222	•	2			•	•	217 S Bradford Ave	Town	CO	80222				
106	431235004	Current Resident	f	301 E River St	Town	CO	80222	•			1	Sam	hh	604 N Verbana Dr	Town B	CO	80222	•	2		
107	431235004	Current Resident	g	301 E River St	Town	CO	80222					Sam	ii	604 N Verbana Dr	Town B	CO	80222				
201	431317031	Rafelita	h	319 Beech St	Town	CO	80222	•	1					319 Beech St	Town	CO	80222				
202	431317001	Current Resident	i	302 S Bradford Ave	Town	CO	80222					Miguel	jj	2834 Lake Ave	Town	CO	80222				
203	431239008	Charles and Angela	j	224 S Bradford Ave	Town	CO	80222					Caroline	kk	4036 Hillside Dr	Town	CO	80222				
204	431239007	Phillip and Billy	k	222 S Bradford Ave	Town	CO	80222	•		2		•	•	222 S Bradford Ave	Town	CO	80222				
205	431239006	Current Resident	l	220 S Bradford Ave	Town	CO	80222					Jessica Lynn	ll	219 S Bradford Ave	Town	CO	80222				
206	431239005	Tony	m	218 S Bradford Ave	Town	CO	80222	•	2			•	•	218 S Bradford Ave	Town	CO	80222				
207	431239004	Benito	n	312 E River St	Town	CO	80222					•	•	312 E River St	Town	CO	80222				
208	431239003	Crito	o	314 E River St	Town	CO	80222	•		2		•	•	314 E River St	Town	CO	80222				
209	431235006	Current Resident	p	305 E River St	Town	CO	80222	•			1	Virginia	mm	16 E Caldwell St - Un	City A	AZ	80222	•	1		
210	431235005	Angela	q	303 E River St	Town	CO	80222	•	1			Michael and Diane	nn	2705 Columbine Av	Town	CO	80222	•		1	
305	431317002	Current Resident	r	217 E Ash St	Town	CO	80222					Retirement LLC		PO Box 43	City B	CO	99999				
308	431239009	Current Resident	s	216 E Ash St	Town	CO	80222					Earl	oo	218 S Chester Ave	Town	CO	80222				
309	431239011	Current Resident	t	218 E Ash St	Town	CO	80222					Earl	oo	218 S Chester Ave	Town	CO	80222				
310	431239012	Teresa	u	216 S Chester Ave	Town	CO	80222					•	•	216 S Chester Ave	Town	CO	80222				
311	431239001	Ana	v	317 E River St	Town	CO	80222	•		2		•	•	317 E River St	Town	CO	80222				
312	431239002	Current Resident	w	316 E River St	Town	CO	80222					Eleanor	pp	903 Currie Ave	Town	CO	80222	•	1		
313	431235008	Current Resident	x	311 E River St	Town	CO	80222					Reed and Melinda	qq	4637 Goodnight Ave	Town	CO	80222				
314	431235009	Robert and Melissa	y	313 E River St	Town	CO	80222					•	•	313 E River St	Town	CO	80222				
315	431235010	Donna	z	329 E River St	Town	CO	80222					•	•	329 E River St	Town	CO	80222				
		Ben and Jim	a	234 E River St	Town	CO	80222	•		2		•	•	•	•	•	•				
101	431230001	Current Resident		302 E 2nd St	Pueblo	CO	80222	•			1	Kevin	aa	3 Dover Ln	Town	CO	80222	•	3		
102	431230001	Current Resident		302 E 2nd St Apt A	Pueblo	CO	80222	•			1										
103	431230001	Current Resident		302 E 2nd St Apt B	Pueblo	CO	80222	•			1										
104	431225010	Current Resident		202 N Bradford Ave	Pueblo	CO	80222	•			1	Holdings LLC		7245 S Havana St Ste	City C	CO	80222	•	1		
105	431225009	Current Resident		204 N Bradford Ave Ap	Pueblo	CO	80222					Matthew	bb	3000 Saint Charles R	Town	CO	80222				
105	431225009	Current Resident		204 N Bradford Ave Ap	Pueblo	CO	80222														
105	431225009	Kirk	b	4 N Bradford Ave Ap	Pueblo	CO	80222	•	1												
105	431225009	Patsy	c	4 N Bradford Ave Ap	Pueblo	CO	80222	•	1												
106	431225008	Current Resident		206 N Bradford Ave	Pueblo	CO	80222	•			1	Crapatola LLC		PO Box 704	City B	CO	99999				
106	431225007	Current Resident		208 N Bradford Ave	Pueblo	CO	80222										80222				
106	431225006	Current Resident		216 N Bradford Ave	Pueblo	CO	80222					Julie	cc	335 Corral Ranch R	Town	CO	80222	•	1		
107	431225005	Current Resident		220 N Bradford Ave	Pueblo	CO	80222					Le Roy and Elizabeth	dd	PO Box 11572	Town	CO	80222				
108	431230018	Kevin	d	313 E 1st St	Pueblo	CO	80222										80222				
109	431230013	Lucille	e	315 E 1st St	Pueblo	CO	80222					Nelson and Alice	ee	2 White Dove Ct	Town	CO	80222				
201	431230002	Current Resident		306 E 2nd St	Pueblo	CO	80222	•			2	•	•	313 E 1st St	Town	CO	80222				
202	431230003	Jay Dee	f	312 E 2nd St	Pueblo	CO	80222	•	1			Properties LLC		PO Box 1424	Town	CO	80222	•	1		
203	431225011	Current Resident		311 E 2nd St	Pueblo	CO	80222	•			1	Crapolla LLC		PO Box 11160	Town	CO	80222	•			1
204	431230004	Patricia	g	314 E 2nd St	Pueblo	CO	80222					•	•	312 E 2nd St	Town	CO	80222				
205	431230005	Current Resident		316 E 2nd St	Pueblo	CO	80222					•	•	311 E 2nd St	Town	CO	80222				
301	431230006	Richard	h	320 E 2nd St	Pueblo	CO	80222					•	•	314 E 2nd St	Town	CO	80222				
302												Gary and Jenny	rr	39 S Golfview Dr	City A	CO	80222				
303												•	•	320 E 2nd St	Town	CO	80222				
									12	8	10								11	1	1

• = Owner address and property address are same.

(An owner-resident vote counts as 2 votes)

Total Votes			
Yes		23	53%
No		9	21%
Abstain		11	26%
As of 10-16-2013		43	total votes
		102	possible votes
		42%	votes received

APPENDIX E
TECHNICAL SUPPORT DOCUMENTATION

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CDOT White Paper: Review of General Barrier Cost/Benefit Data for CDOT Noise Guidelines

The purpose of this memorandum is to document TNM Version 2.5 modeling and associated analyses that were performed in support of CDOT staff as the agency updated the traffic noise analysis guidance document to comply with changes made in 2010 by FHWA to 23CFR772. Specifically, this memo addresses evaluations of barrier cost/benefit as it relates to barrier "reasonableness" assessments under the new regulations.

OVERVIEW

The evaluation of noise barriers for highway projects as specified by 23CFR772 consists of two primary considerations—feasibility and reasonableness. One of several criteria under reasonableness is an examination of the cost/benefit ratio of the noise abatement from a proposed barrier (i.e., wall). The new CDOT guidance must set the threshold for this criterion to allow comparisons and decisions during environmental analysis of future CDOT projects.

CDOT's previous guidance (2002) specified that costs of $4,000/receptor/decibel or higher were unreasonable. This assumed a barrier cost of $30/square foot and counted all receptors receiving at least 3 dBA of noise reduction. The numeric values for the new guidance needed to be updated for 2011 and beyond construction costs while also recognizing the regulatory change that benefiting receptors must now receive at least 5 dBA of noise reduction. The consensus among the CDOT staff participating in the guidance update was that the 2002 cost/benefit threshold had worked well and that a comparable threshold under the new guidelines was appropriate.

To facilitate setting the new cost/benefit threshold, several real-world situations were examined through TNM modeling to evaluate several cost and benefit situations. The examination focused on residential receptors (Land Use Category B) because this is by far the most common situation involving noise barrier evaluations that CDOT has faced. Varying densities of receptors (i.e., neighborhoods) with similarly-performing barriers were combined with updated construction costs to build comparative data (Table 1) to support the selection by CDOT of a new cost/benefit threshold.

TNM MODELING REVIEW

Three example situations were selected from recent past professional experience for examination. The situations are illustrated in Figures 1 through 3. The situations were selected to represent a range of common receptor densities—denser receptor situations would be expected to give better cost/benefit results while lower receptor density would give worse results.

TNM software was used and the modeling processes followed those currently in use for CDOT projects. The actual terrain elevations for the sites were used to ensure realism. The modeling was intended to establish the most compact noise barrier that would provide at least 7 dBA of noise reduction (a simple size optimization of each barrier was included) for the front row receptors so that a matrix of benefits and costs for these neighborhoods could be developed and compared (Table 1).

Separate research for the guidance update, that is not detailed here, reviewed recent CDOT noise barrier construction costs to establish a new barrier cost basis. A new value of $45/square foot was chosen—up from the previous $30/square foot. (Note: earth berms were not examined in this exercise.)

RESULTS

Using the new barrier cost basis along with the "optimized" barrier sizes, the performance of each example barrier was calculated and the results are summarized in Table 1.

Table 1. Example Situation Noise Barrier Cost/Benefit Results

Situation	Benefitting Receptors	Total Noise Reduction (in dBA)	Estimated Cost of Barrier	Cost/Benefit Ratio
Example 1	20	142	$464,000	$3,270
Example 2	57	508	$1,820,000	$3.580
Example 3	21	153	$2,920,000	$19,100

The examples fell into two basic groups: those under $5,000/receptor/dBA and those above. For comparison, the outcomes appeared to be similar to those that would have been expected under the 2002 guidelines, which was viewed favorably by the CDOT panel.

Based on these results, the participating CDOT and FHWA staff felt that an appropriate $/dBA threshold value would be between the $4,000 allowed under the 2002 guidance and the $19,100 exhibited by the poorest-performing example situation (which should not be recommended). A straight escalation of the 2002 threshold value that matched the increased construction cost basis (150%) would give a new threshold value of $6,000. However, this value would not take into account that comparatively fewer receptors would be viewed as benefitting because the minimum noise reduction would increase from 3 dBA to 5 dBA under the new regulations—which affects the final cost/benefit value for a wall. Therefore, it was felt that a (relatively modest) 13% added cost allowance ($800) was appropriate in the new threshold value to offset the loss of some receptors that "benefitted" under the old guidance.

This results in a final recommended cost/benefit threshold value of $6,800/receptor/dBA for the new reasonableness criterion—potential barriers less than or equal to this cost/benefit value are considered to be "reasonable."

SUMMARY

TNM modeling was performed for several example situations to "test drive" ideas regarding a new cost/benefit criterion for potential noise barriers required under the new traffic noise regulations. The results of the modeling fed into the selection by the CDOT panel of a new cost/benefit threshold value that partially determines the "reasonableness" of a potential noise barrier in a CDOT traffic noise abatement evaluation. The new threshold value selected for the CDOT criterion was $6,800/receptor/dBA.

Figure 1. TNM Model Example 1

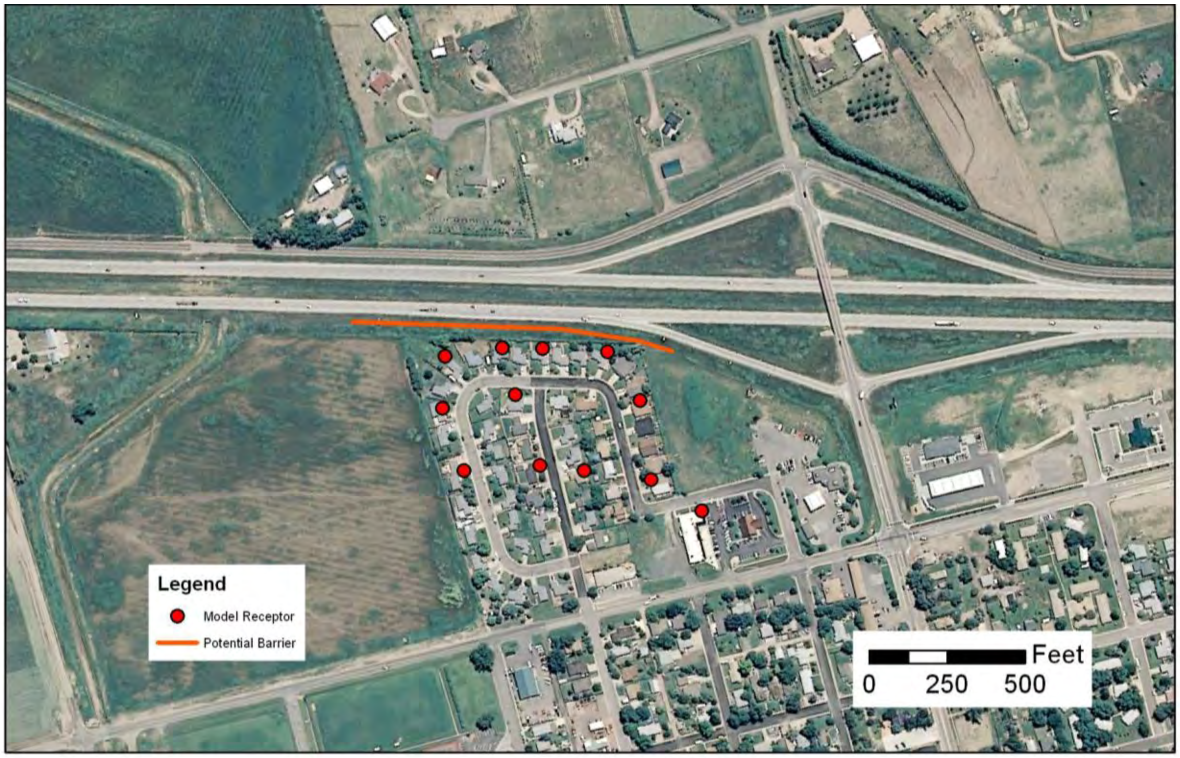
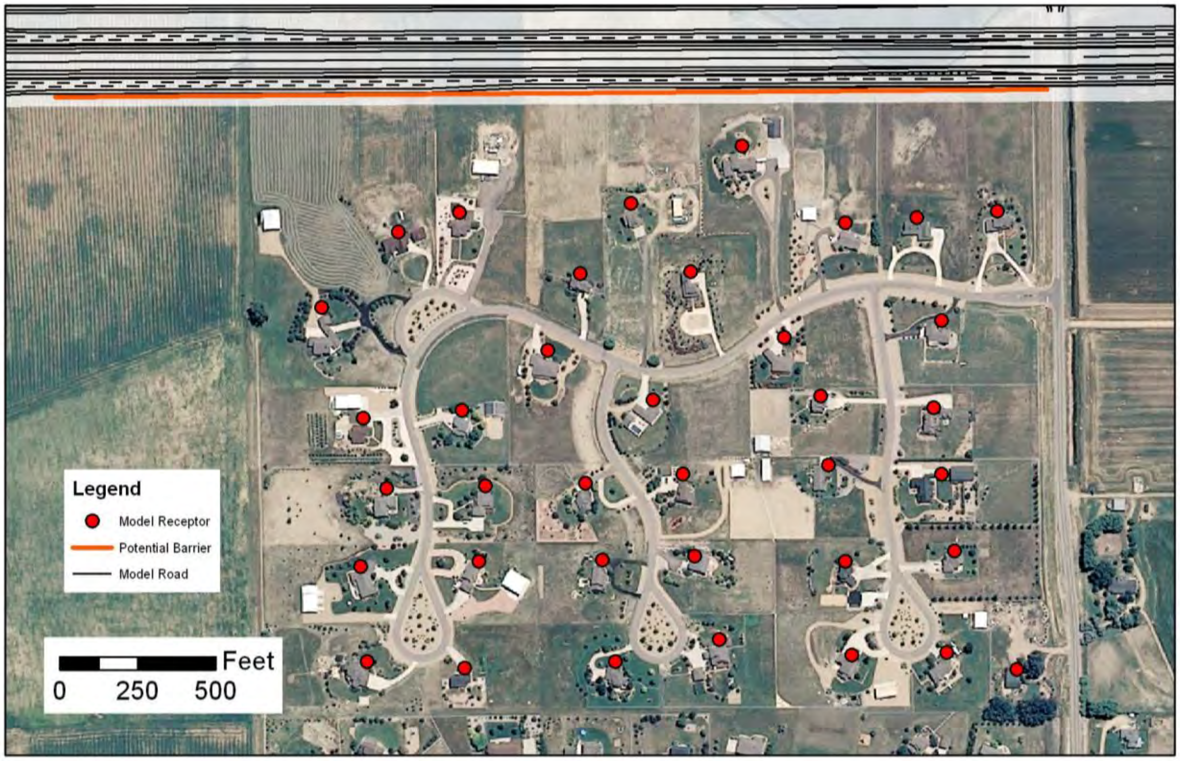


Figure 2. TNM Model Example 2

Figure 3. TNM Model Example 3



<u>CDOT White Paper:</u> General Methodology for Determining Proper Traffic Volumes for use in Noise Analyses

One of the requirements for predicting noise levels in highway traffic noise studies is to capture what is usually referred to as the “worst noise hour,” or the point in time where the traffic noise from a given system is at its highest (in the new 23CFR772.9 (d) the term used to describe this is officially “the worst traffic noise impact”). This will be when the highest volume of traffic is traveling at the highest possible speed, or typically just before or after the corresponding “rush” hour, when traffic on some facilities begins to slow with increasing volumes.

When attempting to predict noise under future conditions for highway projects, traffic volumes are either provided by a separate traffic study or derived from existing information. These volumes, however, are usually given as “peak-hour” volumes, which only represent the highest traffic throughput and represent in many cases a congested situation. As such, it is not appropriate to use peak hour volumes in the noise analysis unless it can be shown that those volumes are below the threshold in which noise levels begin to decrease. Additionally, it is not valid to take congestion-level peak hour volumes and model them at the peak speed limit.

For simplicity, many State Highway Agencies have defined the worst noise hour as the point in time where traffic Levels of Service (LOS), as described in the Highway Capacity Manual (HCM), are at a rating of between “C” and “D”. While this has been a functional approach, it does have limitations as the parameters that are used may not be something that can be universally used over all facilities. Based on this question, the Colorado DOT performed a general evaluation of highway traffic and corresponding noise levels.

The first task undertaken was to determine at what speeds different volumes (which will be based on vehicles per lane per hour) of traffic will be able to travel. The 2000 version of the HCM was used to investigate this question. Initially, freeway facilities were investigated, as it was the simplest methodology provided (Chapter 23 of the HCM) but also because most of the major noise impacts are associated with these facilities. Chapter 23 of the HCM shows the criteria for freeway facilities and is not included in its entirety here, but the basics of the methodology involve identifying a free-flow speed (FFS) for a facility and the traffic characteristics for that facility. The main calculation that is performed determines the actual vehicle speed based on the volume of traffic per lane per hour. Also determined is the LOS of a facility, which is based on traffic density (calculated by dividing the traffic per lane by the speed).

Based on the equations shown in the HCM, there are inflection points with traffic volumes where traffic will begin to slow. These range from 1150 vehicles/lane/hr. for a FFS=75 mph facility to 1750 vehicles/lane/hr. for a facility with a FFS=55 mph. It is interesting to note that based on the LOS definitions in the HCM, the LOS levels for these inflection points (as shown on Figure 23-3 in the HCM) range from B to D. As such, this would indicate that a blanket LOS C or D approach may not result in the highest noise levels for all facilities.

Exhibit 1 illustrates the speeds by volume for different FFS facilities.

Exhibit 1.

VOLUME (vehicles/ln/hr)	Traffic Speed (mph)				
	FFS=75	FFS=70	FFS=65	FFS=60	FFS=55
1500	74.21	69.80	64.99	60.00	55.00
1600	73.48	69.43	64.88	60.00	55.00
1700	72.44	68.80	64.54	59.94	55.00
1800	71.04	67.85	63.90	59.66	54.99
1900	69.26	66.55	62.89	59.02	54.78
2000	67.05	64.85	61.45	57.93	54.18

These numbers illustrate that adding volume to a facility affects the speeds with higher FFS values to a greater extent than facilities with a lower FFS. Thus, it is possible to continue to increase volumes on some facilities more and still increase noise levels up to a certain point.

Exhibit 2 illustrates the approximate traffic volumes and corresponding speeds for the high end of the LOS C condition (defined as a facility density of 26 vehicles/hour/lane).

Exhibit 2.

FFS (mph)	Volume (vehicles/ln/hr)	Actual Speed (mph)
75	1832	70.52
70	1771	68.16
65	1680	64.63
60	1600*	60.00*
55	1750*	55.00*

*Represents LOS D conditions, traffic will begin to slow with higher volumes

This table, when reviewed along with the volume/speed table, illustrates that a blanket consideration of LOS traffic volumes may not result in a true representation of the actual worst-noise hour conditions.

To determine the vehicle traffic/speed combination that would result in the worst-noise hour condition, the FHWA Traffic Noise Model (TNM) was used. For this analysis, a very basic model was constructed, which simulates the physical conditions of a rural interstate (2-lanes per direction with a median; receptors placed 50 feet from the nearest centerline). Traffic was input as all passenger vehicles, as the interest is not the actual noise levels but the combination of traffic/speed values that would result in the highest levels. By using TNM for this analysis the worst noise hour can be determined directly rather than anecdotally.

To perform the TNM analysis, the major assumption that was made was to treat the FFS of a particular segment as being equivalent to the posted speed limit. There are some drawbacks to performing the analysis in this manner, as for some facilities the FFS can be higher than the posted speed, especially if the engineered facility design speed is greater. This can result in potentially underestimating noise levels. However, for the purposes of this analysis it was felt that as volumes increase to the point of congestion, the overall speeds of the vehicles will tend to congregate around the posted speed limit. Traffic/speed combinations were input into TNM based on the HCM calculations.

Many model iterations were performed in TNM to determine the worst-noise hour levels; those values are shown in Exhibit 3.

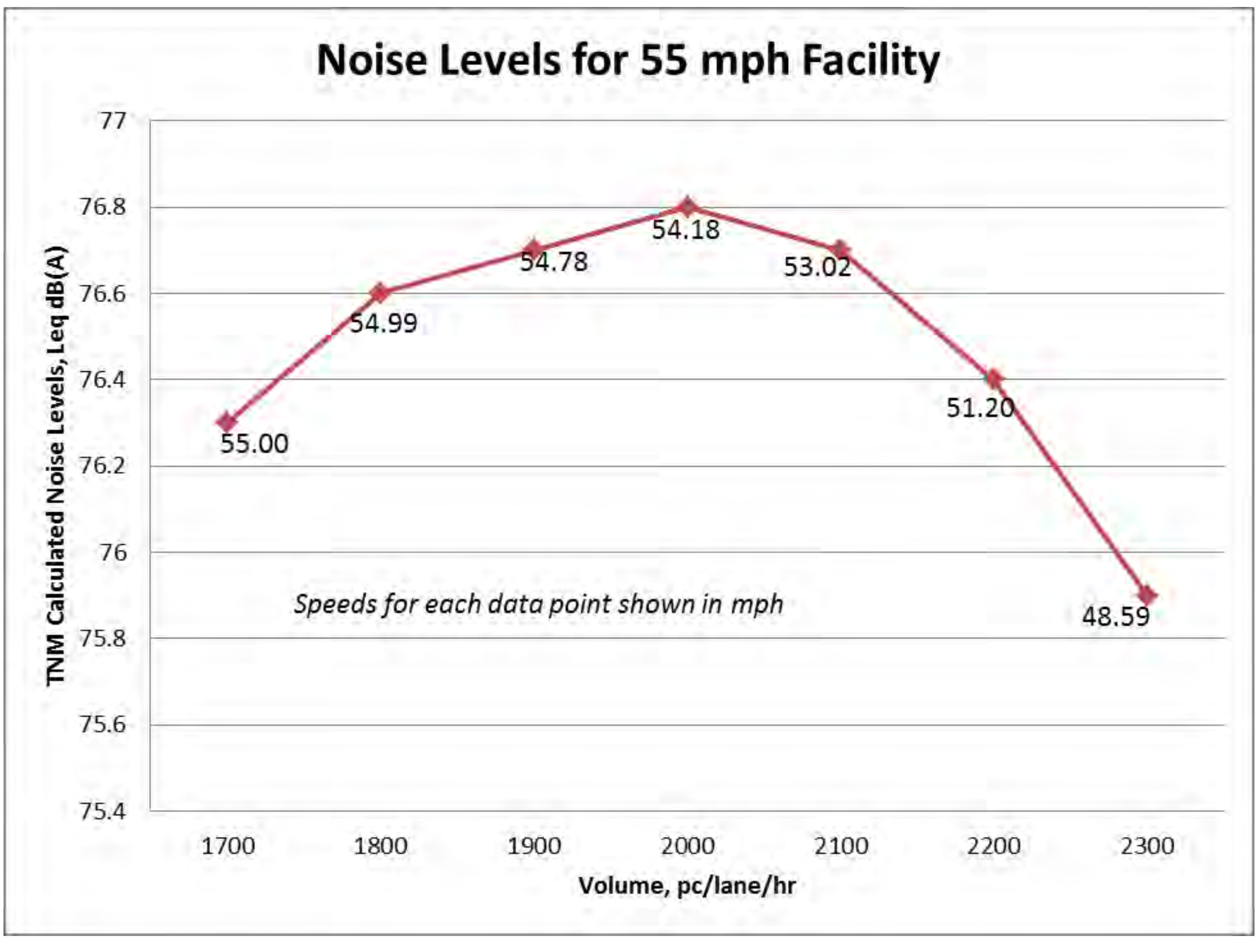
Exhibit 3.

FFS (mph)	Volume (vehicles/ln/hr)	Actual Speed (mph)	TNM Leq Value (dBA)*	LOS
75	1600	73.48	80.6	C
70	1700	68.8	79.8	C
65	1800	63.9	79.0	D
60	1900	59.02	78.0	D
55	2000	54.18	77.0	E

* These values were obtained using the FFS, not the actual speed

For ease of use, CDOT recommends that, for freeway facilities, these volumes be used to represent the worst-noise hour for different facilities based on the posted speed limit. Additionally, although the worst-noise hour was calculated based on the actual speeds, for simplicity CDOT recommends using the posted speed and not the actual speed as calculated. This will increase the noise level that will be predicted by TNM, but this over-prediction ranges from only 0.2 dBA for FFS=55 to 0.3 dBA for FFS=75, which is not felt to be significant.

Exhibit 4. Volume/Speed vs. Noise Level Chart, Example illustrates FFS=55 mph



This detailed analysis was shown for freeway facilities. Additional analysis was also performed for multi-lane facilities (non-freeway) and 2-lane facilities. The methodology for multi-lane facilities is almost identical than that for freeways, and the base results were very similar. However, the impact of other factors with these facilities, for example at-grade intersections, resulted in lower recommended maximum volumes for the worst-noise hour. Two lane facilities utilize an entirely different approach for determining speed and LOS based on an overall capacity of 1600 vehicles/ln/hr. This methodology was combined with the freeway methodology to arrive at the recommended maximum volumes for those facilities.

Admittedly, this approach does not result in a major change in TNM calculated noise levels over the basic LOS approach and may appear to over-simplify some of these variables. Having performed this analysis, however, has provided the data that supports the overall approach. Having this data allows for an expansion on the LOS concept which identifies discrete values that can be easily used for the analysis so that the worse noise hour levels will be reasonably identified. This also allows noise analysts to concentrate on building their models without having to be experts in traffic analysis.

Appendix B

CDOT Noise Abatement Determination Worksheets

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ____________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA, Chatfield Bluffs

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:
Wall inside CDOT ROW has a CBI of $12,553. This is over the $6,800 threshold for reasonableness

Completed by: [illegible signature] Date: 6/19/15

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Meadowbrook western

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $21,248, over the reasonableness criteria.

Completed by: ________________ Date: June 19, 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ______________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Meadowbrook Central

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $12,624

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Meadowbrook Eastern

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Filling in gaps in existing walls within CDOT ROW has a CBI of $30,960

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Chatfield Ave

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall within CDOT ROW has a CBI of $6,579

Completed by: ____________________ Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Columbine Hills

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

20' Wall in CDOT ROW does not achieve 7 dB(A) design goal and has a CBI of $192,857.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised 15A Littleton Commons

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☐ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $3,057.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Villas at Verona

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $2,210.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Bluffs

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ❐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ❐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ❐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❐ YES ❐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ❐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ❐ YES ❐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ❐ YES ❐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ❐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ❐ NO
3. Is insulation of buildings both feasible and reasonable?
   ❐ YES ❐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ❐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $6,317.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: CU70 Revised EA Township

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☐ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☐ YES ☒ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☐ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 1,700 feet long x 20 feet tall wall does not provide even 5 dB(A) insertion loss. Noise from County Line Road minimizes the benefits from a wall for CU70

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Highlands Ranch Dad Clark western

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

While a wall in CDOT's ROW does provide design goal insertion losses, the CBI is $9,265, which is above the $6,800 reasonableness criterion.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Highlands Ranch Dad Clark Eastern

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ❐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ❐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❐ YES ❐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ❐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ❐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ❐ YES ❐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ❐ NO
2. Are noise mitigation measures reasonable?
   ❐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❐ YES ❐ NO
4. Shall noise abatement measures be provided?
   ❐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

While a wall in CDOT's ROW does provide design goal insertion losses, the CBI is $9,674, which is above the $6,800 reasonableness criteria.

Completed by: [signature] Date: June 19, 2015

Noise Analysis and Abatement Guidelines

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Highlands Ranch Venneford

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ❒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❒ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ❒ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❒ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ❒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ❒ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ❒ NO
2. Are noise mitigation measures reasonable?
   ❒ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ❒ YES ❒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 3,330 feet long x 20 feet tall wall in CDOT ROW does not provide the design goal of 7 dB(A) insertion loss and the CBI is $25,101. This CBI is over the $6,800 reasonableness criteria.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA ACC

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW achieves design goals for insertion loss and has a CBI of $4,236.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Shadow Canyon

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☐ YES ☒ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☐ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☒ YES ☐ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW achieves insertion loss design goals and has a CBI of $5,684.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Gleneagle Village

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $15,321 which is over CDOT's reasonableness criteria of $6,800.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Palomino

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
☒ YES ☐ NO
If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
☐ YES ☒ NO
b. If yes, is it reasonable and feasible to provide insulation for these buildings?
☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
☐ YES ☐ NO
4. Shall noise abatement measures be provided?
☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:
Wall in CDOT ROW has a CBI of $15,000 which is over CDOT's reasonbleness criteria of $6,800.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Crest

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ❒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❒ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ❒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☒ YES ❒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ❒ YES ☒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ❒ YES ❒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ❒ NO
2. Are noise mitigation measures reasonable?
   ☒ YES ❒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ☒ YES ❒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW achieves insertion loss design goals and has a CBI of $3,821.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ____________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised 5A Deer Creek Golf

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

The CBI for a wall within CDOT ROW that provides the 7.0 dBA design goal is $145,568. This is over CDOT criteria

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: CU20 Revised EA Deer Creek Pool

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $93,214

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Trail Stop near Wadsworth

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:
Depending on the final location of the wall that is recommend for Chatfield Ave this area may be addressed. Review in final design.

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:
On its own this location has a CBI of $9,000 which is unreasonable. However, Chatfield Ave has been recommended for a wall and this area could come in behind that wall.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Rec 10 Park Trail

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet CBI criteria for reasonableness.

Completed by: [signature] Date: June 19, 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Rec 11 Trail North

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet CBI criteria for reasonableness

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Johnny's Pond

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ❒ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❒ NO

B. REASONABLENESS:
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ❒ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❒ YES ❒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ❒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ❒ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   ❒ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ❒ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ❒ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 20 feet tall wall x 1,550 feet long does not meet CDOT design goal.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA University Area Ball Field

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $157,564. This is over the $6,800 threshold for reasonableness.

Completed by: [signature] Date: June 19 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: CU70 Revised EA Lorenz

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☐ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☐ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☐ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet design goal for insertion loss with a 20 feet tall wall.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Frisbee

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has a CBI of $136,800

Completed by: [signature] Date: June 19, 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Gleneagles Golf

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has CBI of $43,902 which is over CDOT's criteria for reasonableness.

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Skyview Soccer

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☒ YES ☐ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Wall in CDOT ROW has CBI of $89,196 which is over CDOT's criteria for reasonableness

Completed by: [signature] Date: June 19 2015

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19 2015

Project Name & Location: C470 Revised EA Willow Creek South

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ❒ YES ☒ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ❒ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ❒ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ❒ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ❒ YES ❒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ❒ YES ❒ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ❒ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ❒ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ❒ YES ❒ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ❒ YES ☒ NO
2. Are noise mitigation measures reasonable?
   ❒ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ❒ YES ❒ NO
4. Shall noise abatement measures be provided?
   ❒ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

A 1,620 feet long x 20 feet tall wall does not provide design goal insertion loss.

Completed by: [signature] Date: June 19 2015

Noise Analysis and Abatement Guidelines

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: June 19, 2015

Project Name & Location: C470 Revised EA Red Robin

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet design goal for insertion loss

Completed by: ________________ Date: June 19 2015

DEPARTMENT OF TRANSPORTATION

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ________________ Date of Analysis: ________________

Project Name & Location: C470 Revised EA On the Border, LODO, & Brothers

A. FEASIBILITY:

1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   ☒ YES ☐ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   ☐ YES ☒ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   ☒ YES ☐ NO

B. REASONABLENESS:

1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   ☐ YES ☒ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   ☐ YES ☒ NO
3. Are more than 50% of benefited resident/owners in favor of the recommended noise abatement measure?
   ☐ YES ☐ NO

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   ☒ YES ☐ NO

   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
   ☐ YES ☒ NO

   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
   ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. STATEMENT OF LIKELIHOOD:

1. Are noise mitigation measures feasible?
   ☒ YES ☐ NO
2. Are noise mitigation measures reasonable?
   ☐ YES ☒ NO
3. Is insulation of buildings both feasible and reasonable?
   ☐ YES ☐ NO
4. Shall noise abatement measures be provided?
   ☐ YES ☒ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:

Does not meet design goal for insertion loss.

Completed by: [signature] Date: June 19 2015

Traffic Technical Report

For the C-470 Corridor
Revised Environmental Assessment

July 2015

Submitted to:
CDOT Region 1
2000 S. Holly Street
Denver, CO 80222

Submitted by:
Wilson & Company
1675 Broadway, Suite 200
Denver, CO 80202

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1.0 INTRODUCTION

This Traffic Technical Report examines potential traffic operations impacts that would result from proposed improvements to Colorado State Highway 470 (C-470) in the southwestern part of the Denver metropolitan area. The report documents the traffic operational analysis and crash analysis along the study corridor for current (2013) and future (2035) conditions.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in **Figure 1**. In 2013, the Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) initiated a Revised Environmental Assessment (EA) for the 13.75-mile portion of C 470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the Revised EA differs slightly from the Express Lanes alternative identified in the previous EA that was approved by CDOT and FHWA in 2006.

Figure 1: C-470 Corridor and its Surrounding Vicinity

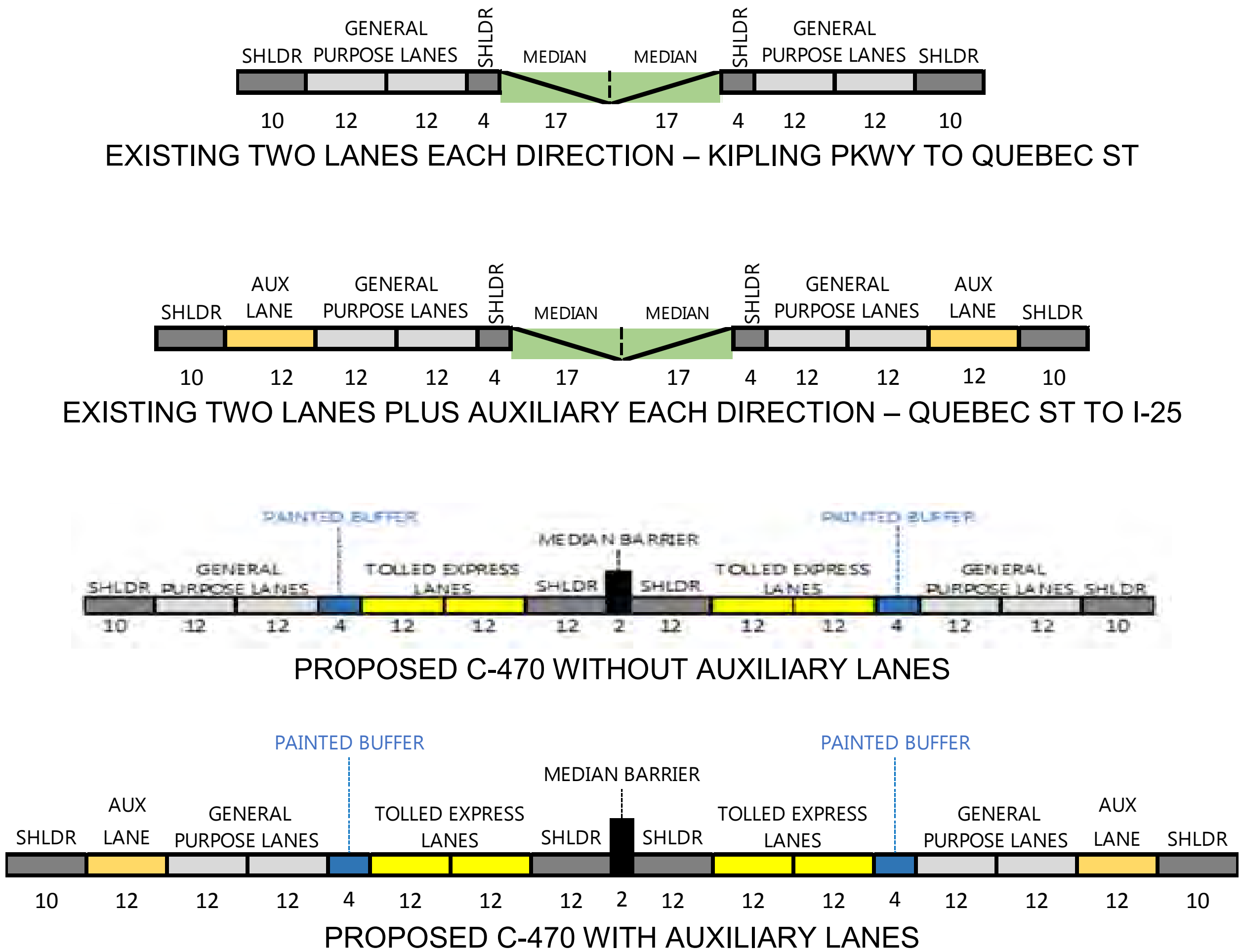
1.1 No-Action Alternative

The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged, but would receive maintenance as needed to ensure the safety and functionality of the existing four-lane freeway.

1.2 Proposed Action

The Proposed Action would add two tolled express lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications. However, at the eastern end of the project area, the Proposed Action also includes direct-connect ramps accommodating movements between I-25 and the C-470 Express Lanes. **Figure 2** shows the existing and proposed typical cross sections.

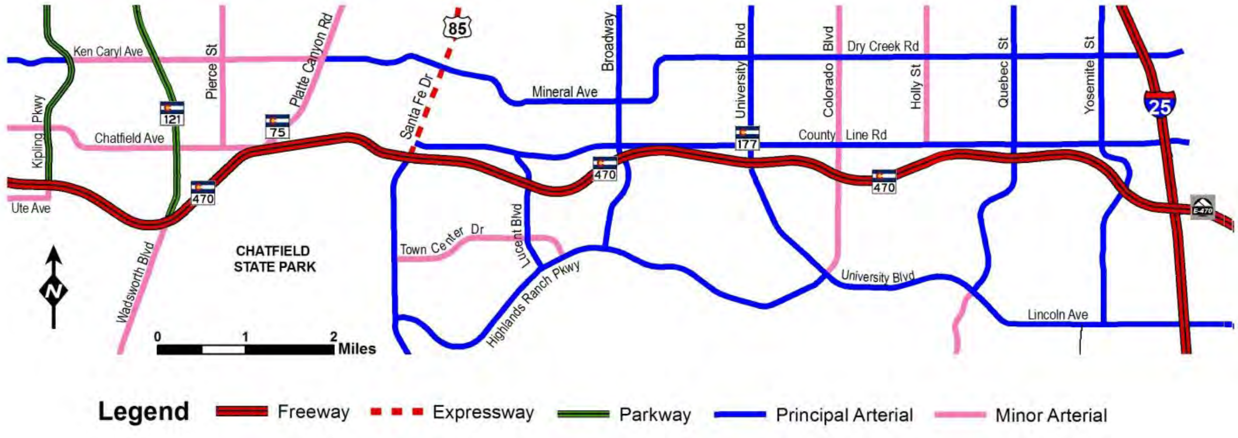
Figure 2: Existing and Proposed C-470 Typical Cross Sections



2.0 EXISTING ROADWAY CONDITIONS

Currently, C-470 has two through-lanes in each direction. From Quebec Street to I-25, the freeway also has auxiliary lanes that connect the on-ramp to the subsequent off-ramp, to provide maximum possible distance for merge and diverge movements to/from the through lanes. There is also a continuous auxiliary lane on eastbound C-470 between Santa Fe and Lucent Boulevard. The posted speed limit on all of C-470 is 65 miles per hour. **Figure 3** shows how C-470 fits in the context of the surrounding arterial roadway system.

Figure 3: C-470 and its Surrounding Roadway Network

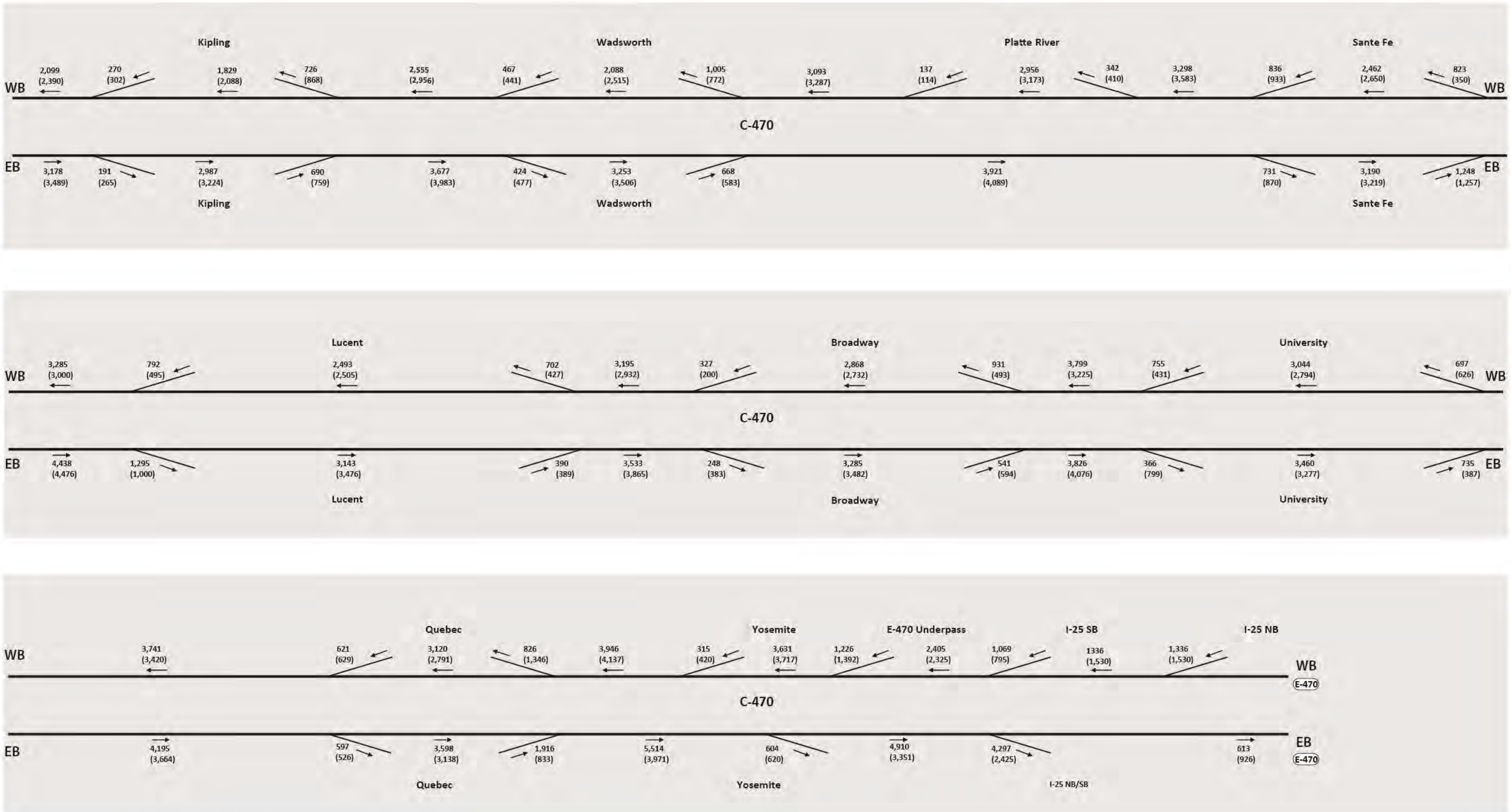


2.1 C-470 Corridor Peak Hour Traffic Volumes

Current C-470 mainline peak hour traffic volumes were obtained from the Colorado Department of Transportation (CDOT). Corridor travel times, intersection turning movement counts and ramp traffic volumes were collected in May 2013. **Figures 4** through **Figure 6** depict the current peak hour traffic volumes along the C-470 corridor.

In general, during the peak hours, traffic on C-470 is balanced in each direction which is not well-suited for capacity improvement strategies that include reversible lanes.

Figure 4



2014 Existing C-470 Freeway Traffic Volumes

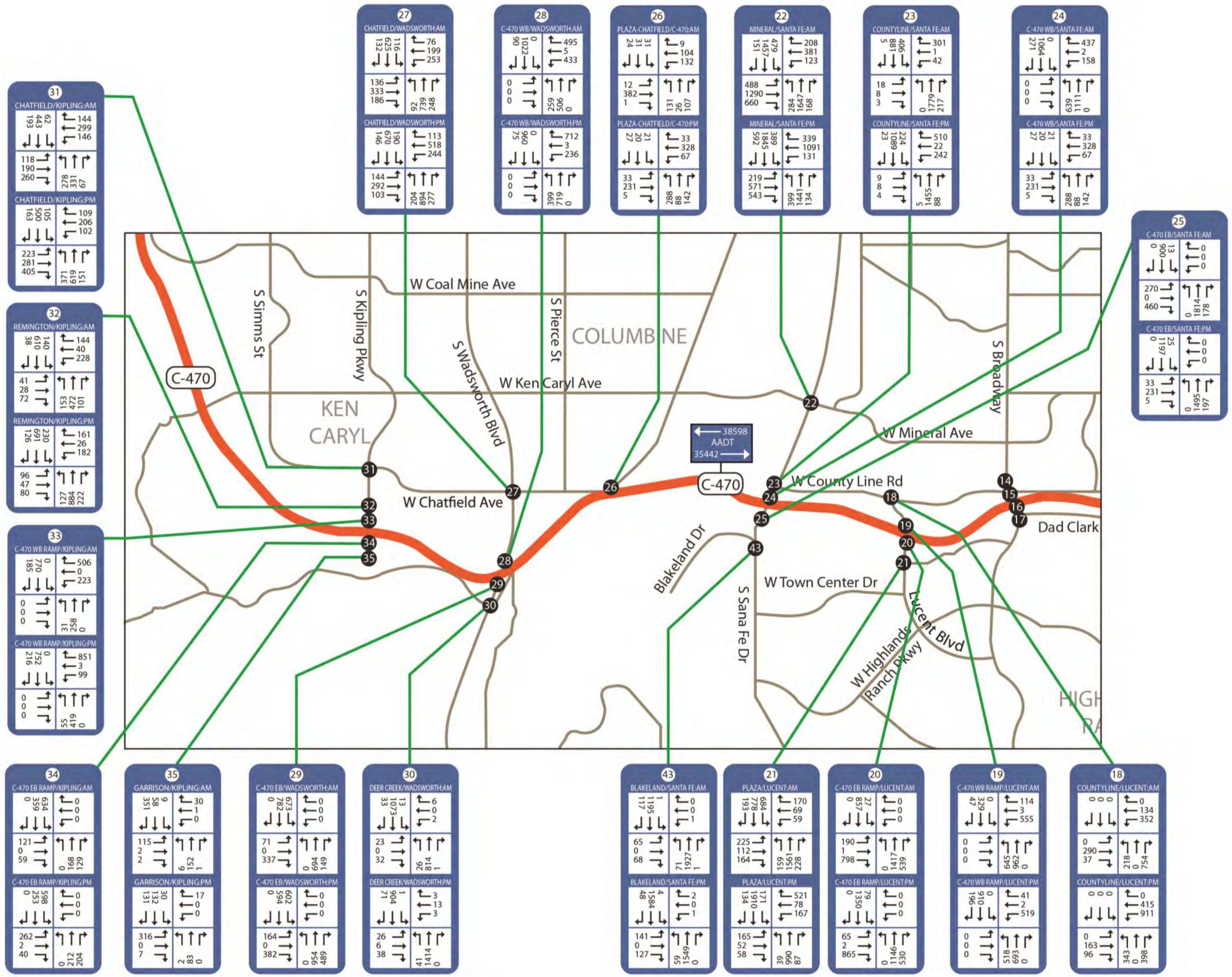
Legend

\# AM Peak Hour
(#) PM Peak Hour

General Purpose Lanes/Ramps

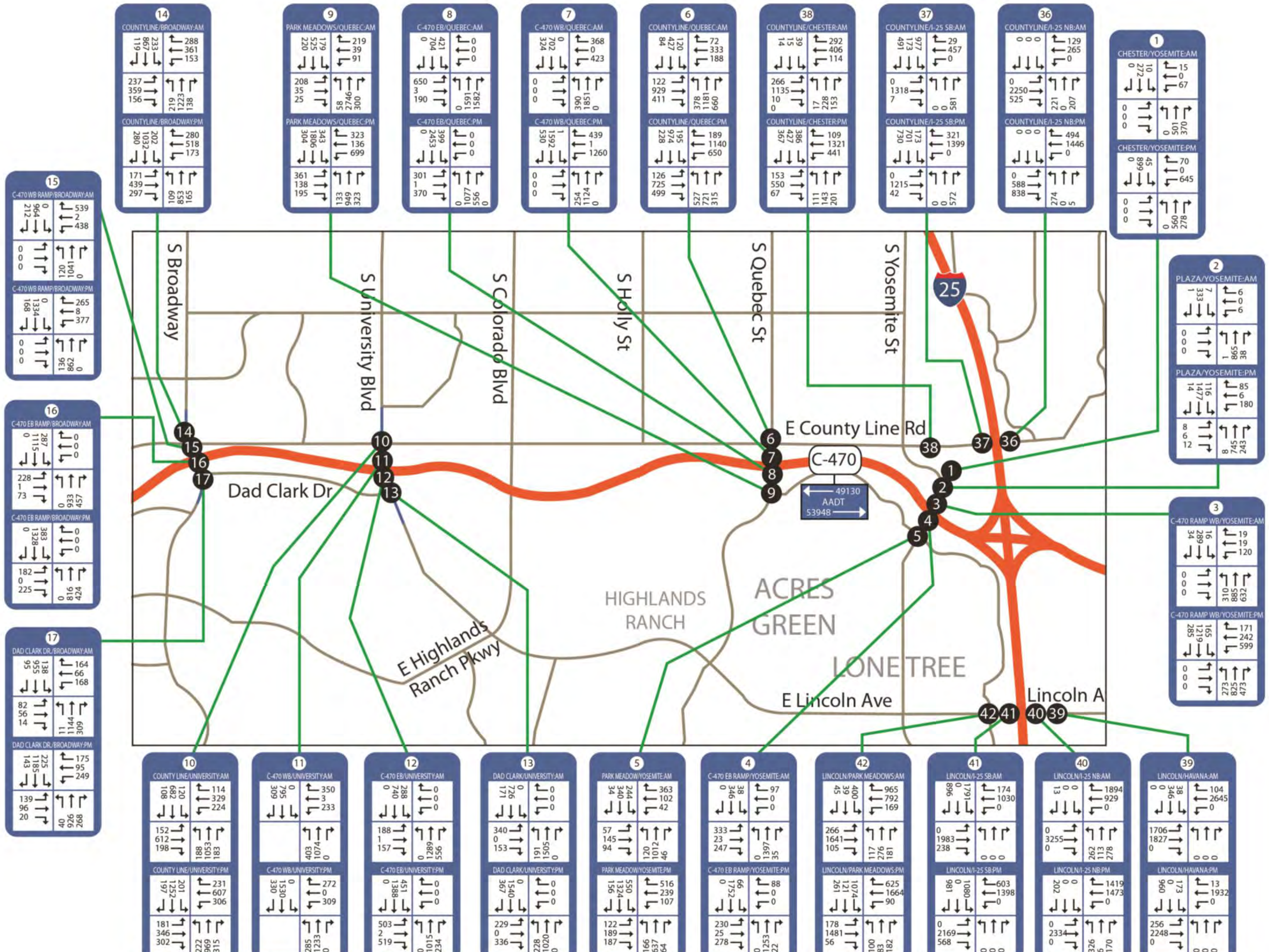
N

Figure 5



C-470 2013 Existing Traffic Volumes: West Segment

Figure 6



C-470 2013 Existing Traffic Volumes: East Segment

2.2 Level of Service Definition

Levels of Service (LOS) for the C-470 Corridor were computed for basic freeway segments, weave sections, and ramp junctions using Highway Capacity Software (HCS) 2010. The LOS thresholds for freeway facilities as taken from the Highway Capacity Manual (HCM) 2010 are summarized in **Table 1**. LOS is determined by vehicle density which is characterized by passenger car per mile per lane (pc/mi/ln).

LOS for the interchange ramp terminal intersections were determined applying the HCM 2010 Chapter 22, Interchange Ramp Terminals methodology. **Table 2** summarizes LOS thresholds for signalized intersections determined by control delay which is characterized by seconds per vehicle (sec/veh).

Table 1: LOS Thresholds for Freeway Facilities

Level of Service	Density (pc/mi/ln)		
	Basic Freeway Segments	Ramp Junctions	Weaving Segments
A	≤ 11	≤ 10	0-10
B	> 11-18	> 10-20	> 10-20
C	> 18-26	> 20-28	> 20-28
D	>26-35	> 28-35	> 28-35
E	>35-45	> 35	>35
F	>45 or v/c > 1.00	Demand exceeds capacity	

Table 2: LOS Thresholds for Signalized Intersections

Level of Service	Control Delay (sec/veh)
A	< 10
B	> 10 and < 20
C	> 20 and < 35
D	> 35 and <55
E	> 55 and < 80
F	> 80

It is important to understand the limitations of the HCM. The reported HCM results do not reflect upstream and downstream conditions. As a result operational and capacity problems downstream may have no impact on upstream analysis results, whereas in reality they would.

2.3 Freeway Operations

This section includes discussion of the following operational characteristics for current C-470 corridor conditions:

- Basic freeway segments
- Ramp junctions
- Weave segments

2.3.1 Basic Freeway Segments

The results of the C-470 basic freeway segments for current conditions are summarized in **Table 3**. The entire section of westbound C-470 between Kipling and I-25 has reported LOS D or better for the AM and PM peak hours. There are several deficiencies in the eastbound direction of C-470 during each of the peak hours that were reported primarily on the western end and middle sections of the C-470 Corridor.

Table 3: 2014 Existing Basic Freeway Segment Operations Summary

	Basic Freeway Segements		AM Peak		PM Peak	
	From	To	Density	LOS	Density	LOS
Westbound C-470	E of C-470	I-25 Off ramp	15.9	B	13.0	B
	E-470	I-25 N/S Ramp Split	17.3	B	10.0	A
	I-25 Off ramp	I-25 On ramp	10.1	A	11.4	B
	I-25 Ramps	C470	19.8	C	19.1	C
	I-25 On ramp	Yosemite On ramp	19.9	C	20.4	C
	Yosemite On ramp	Quebec Off ramp	21.6	C	22.7	C
	Quebec Off ramp	Quebec On ramp	26.1	D	23.0	C
	Quebec On ramp	University On ramp	33.3	D	29.3	D
	University Off ramp	University On ramp	25.3	C	23.0	C
	University On	Broadway Off	34.2	D	27.1	D
	Broadway Off ramp	Broadway On ramp	23.7	C	22.5	C
	Broadway On ramp	Lucent Off ramp	26.8	D	24.2	C
	Lucent Off ramp	Lucent On ramp	20.5	C	20.6	C
	Lucent On ramp	Santa Fe Off ramp	27.8	D	24.9	C
	Santa Fe Off ramp	Santa Fe On ramp	20.2	C	21.8	C
	Santa Fe On ramp	lane drop	27.9	D	31.2	D
	Lane drop	Platte Canyon Off ramp	18.1	C	19.6	C
	Platte Canyon Off ramp	Platte Canyon On ramp	24.5	C	26.6	D
	Platte Canyon On ramp	Wadworth Off ramp	25.8	C	27.8	D
	Wadworth Off ramp	Wadworth On ramp	17.2	B	20.7	C
	Wadworth On ramp	Kipling Off ramp	21.0	C	24.5	C
	Kipling Off ramp	Kipling On ramp	15.0	B	17.2	B
	Kipling On ramp	W of Kipling	17.2	B	19.6	C

Table 3: 2014 Existing Basic Freeway Segment Operations Summary – continued

	Basic Freeway Segements		AM Peak		PM Peak	
	From	To	Density	LOS	Density	LOS
Eastbound C-470	Kipling Off ramp	W of Kipling	26.6	D	30.1	D
	Kipling Off ramp	Kipling On ramp	24.8	C	27.1	D
	Kipling On ramp	Wadworth Off ramp	32.5	D	37.0	E
	Wadworth Off ramp	Wadworth On ramp	27.4	D	30.3	D
	Wadworth On ramp	Santa Fe Off ramp	36.0	E	38.8	E
	Santa Fe Off ramp	Santa Fe On ramp	26.8	D	27.1	D
	Lucent Off ramp	Lucent On ramp	26.3	D	29.9	D
	Lucent On ramp	Broadway Off ramp	30.6	D	35.2	E
	Broadway Off ramp	Broadway On ramp	27.8	D	30.0	D
	Broadway On ramp	University Off ramp	34.6	D	38.6	E
	University Off ramp	University On ramp	29.7	D	27.7	D
	University On ramp	Quebec Off ramp	40.8	E	32.3	D
	Quebec Off ramp	Quebec On ramp	31.4	D	26.2	D
	Quebec On ramp	Yosemite Off ramp	32.5	D	21.8	C
	Yosemite Off ramp	I-25 Off ramp	27.6	D	18.4	C
	I-25 Off ramp	I-25 On Ramp	5.0	A	7.6	A
	C470	I-25 N/S Ramp Split	41.0	E	18.5	C
	I-25 N/S On ramp Merge	E-470	5.2	A	13.3	B
	I-25 On ramp	E of C-470	7.1	A	14.6	B

2.3.2 Ramp Junctions

The results of the C-470 ramp junctions for current conditions are summarized in **Tables 4** and **5**. In the C-470 westbound direction all merge and diverge peak hour traffic operations were reported to be LOS D or better. In the C-470 eastbound direction there are reported congested ramp junction operations for nearly all the ramp junctions on C-470.

Table 4: 2014 Existing Freeway Merge Operations Summary

	On-ramp	AM Peak		PM Peak	
		Density	LOS	Density	LOS
Westbound C-470	Yosemite On	23.4	C	26.1	C
	Quebec On	27.1	C	24.4	C
	University On	33.5	D	28.6	D
	Broadway On	30.2	D	28.0	D
	Lucent On	31.4	D	28.9	D
	Santa Fe On	30.8	D	33.2	D
	Platte Canyon On	21.9	C	23.5	C
	Wadworth On	24.6	C	27.9	C
	Kipling On	20.4	C	22.8	C
Eastbound C-470	Kipling On	32.7	D	35.3	E
	Wadworth On	35.0	E	36.4	E
	Lucent On	32.0	D	34.8	D
	Broadway On	35.0	D	37.0	E
	University On	37.4	E	33.1	D
	Quebec On	41.3	F	28.9	D

Table 5: 2014 Existing Freeway Diverge Operations Summary

	Off- Ramp	AM Peak		PM Peak	
		Density	LOS	Density	LOS
Westbound C-470	I-25 Off	*17.0*	*B*	*13.8*	*B*
	Quebec Off	16.0	B	18.2	B
	University Off	25.1	C	22.2	C
	Broadway Off	25.7	C	20.4	C
	Lucent Off	20.1	C	17.7	B
	Santa Fe Off	20.9	C	18.3	B
	Platte Canyon Off	12.0	B	13.9	B
	Wadworth Off	19.2	B	21.0	C
	Kipling Off	14.2	B	17.9	B
Eastbound C-470	Kipling Off	19.9	B	22.8	C
	Wadworth Off	33.5	D	36.3	E
	Santa Fe Off	26.8	C	28.3	D
	Broadway Off	23.2	C	26.3	C
	University Off	25.9	C	28.2	D
	Quebec Off	29.3	D	24.4	C
	Yosemite Off	22.6	C	15.6	B
	I-25 Off	*28.6*	*D*	*19.5*	*B*
	I-25 N/S Ramp Split	42.8	E	25.6	C

2.3.3 Weave Segments

The results of the C-470 weave segment analysis for current conditions are summarized in **Table 6**. Presently there is one weave section in each direction of C-470, Santa Fe to Lucent in the eastbound direction and Yosemite to Quebec in the westbound direction. The C-470 eastbound weave section was reported to operate at LOS F during both the AM and PM peak hours. The C-470 westbound weave was reported to operate at LOS D or better during the peak hours.

Table 6: 2014 Existing Freeway Weave Operations Summary

	Weave Segment		AM Peak		PM Peak	
	From	To	Density	LOS	Density	LOS
WB C-470	Yosemite On	Quebec Off	26.3	C	28.1	D
EB C-470	Santa Fe On	Lucent Off	*	F	*	F

2.4 Interchange Operations

Each of the interchange signalized intersections were analyzed using the HCM 2010 Chapter 22, Interchange Ramp Terminals methodology, as noted previously and the results are summarized in **Table 7**. Out of the 16 total intersections evaluated, 2 intersections exhibited capacity deficiencies; Quebec/C-470 EB ramp and Quebec/C-470 WB ramp intersections. The intersections with reported deficient operations are highlighted in the table.

Table 7: 2014 Existing Interchange Intersection Operations Summary

	Existing 2014			
	AM		PM	
Intersection	Delay	LOS	Delay	LOS
Kipling & C-470 EB	9.6	A	34.8	C
Kipling & C-470 WB	18.0	B	28.3	C
Wadworth & C-470 EB	12.7	B	12.5	B
Wadworth & C-470 WB	20.9	C	17.8	B
Santa Fe & C-470 EB	14.1	B	15.3	B
Santa Fe & C-470 WB	21.0	C	28.5	C
Lucent & C-470 EB	26.1	C	12.8	B
Lucent & C-470 WB	36.4	D	36.1	D
Broadway & C-470 EB	9.1	A	9.9	A
Broadway & C-470 WB	18.4	B	23.2	C
University & C-470 EB	12.5	B	30.8	C
University & C-470 WB	11.9	B	14.4	B
Quebec & C-470 EB	115.7	F	14.5	B
Quebec & C-470 WB	15.1	B	>120	F
Yosemite & C-470 EB	23.1	C	12.7	B
Yosemite & C-470 WB	7.7	A	30.3	C

2.5 Existing Safety Conditions

The *Roadway Safety Technical Report, November 2013* was completed for the C-470 Corridor Revised EA. The report was a safety analysis conducted for the C-470 Corridor that included a query of CDOT's database identifying all reported accidents for the five years from 2008 to 2012, inclusive, on the C-470 mainline, its ramps, and selected cross-street intersections. The safety report analyzed 1,465 C-470 accidents over the five-year period and the following summarizes the key information contained in the safety technical report. See the full report for additional information.

The predominant category of C-470 mainline accidents was multi-vehicle collisions, which accounted for 62.2% of the total. This category is dominated by rear-end collisions, averaging 142 per year, which comprised nearly half (48%) of all accidents on mainline C-470.

The prevalence of rear-end collisions in 2008-2012 is the same percentage that was found in the 2005 C-470 safety study. The 2005 study stated that "most of these accidents are the direct result of one or more of the involved vehicles either unexpectedly slowing or actually stopping, due to congestion, on a high-speed roadway." With continued growth and development in this portion of the metro area, C-470 traffic volumes and congestion have continued to increase since then.

The second type of accident included in the multi-vehicle collisions category is sideswipe collisions, averaging 40 per year on a corridor-wide basis. This is also the second most prevalent accident type overall on mainline C-470. Sideswipe accidents can occur when motorists attempt a lane change, inadvertently drift from their lane, or attempt to merge without adequate clearance.

Collisions with a fixed object were the second leading accident category, at 26.3%, which is less than half the multi-vehicle collision share. Collisions with cable rail (e.g., in the roadway median, dividing the two directions of traffic), guard rail (preventing drivers from entering areas with no opportunity to recover vehicle control), and other fixed objects all accounted for relatively similar shares of total accidents. CDOT minimizes the inclusion of fixed objects in the vicinity of the roadway in an attempt to avoid crashes of this nature. CDOT has strict criteria for installing cable rail, guard rail, and other structures to ensure that their benefits outweigh their risks. Much of the cable rail installation is fairly recent, preventing a vehicle from veering across the median to hit other vehicles in a more catastrophic head-on collision.

Collisions with a non-fixed object (other than a moving vehicle) accounted for 6.1% of the five-year accident total on C-470. These include collisions with debris (8 accidents per year), wild animals (6 accidents per year) and other unspecified objects (4 accidents per year) which typically cannot be predicted or controlled. Several accidents listed in this category involved crashing with a motor vehicle that was parked along the roadway. Animal crossing warning signs exist in locations near the South Platte River and other areas where crashes with animals have been recorded.

The remainder (5.4%) of the five-year accident total consists of non-collision accidents, including an average of 12 rollover accidents per year, 2 cases of driving off of embankments (i.e., without hitting guardrail), and 2 other miscellaneous cases. Rollover accidents typically indicate traveling at high speed. C-470 has posted speed limits of 65 miles per hour, which obviously some motorists exceed, sometimes even under unfavorable driving conditions.

2.5.1 Mainline Accidents by Location

Traffic volumes on C-470 are highest at the eastern (I-25) end, and gradually diminish for successive segments to the west. This explains why there appear to be fewer accidents per mile in the westernmost parts of the study area.

The average number of yearly accidents for the full-mile segments of the C-470 mainline was approximately 20 and ranged from a low of 8 in mile 13 (Wadsworth Boulevard) to a high of 34 in mile 24 (Quebec Street), as shown in Figure 3. The vicinity of Quebec Street also had the highest number of accidents reported in the 2005 CDOT safety study, based on the data available at that time. The 2008 to 2012 data for mile 24 includes 106 rear-end accidents out of a total of 172, accounting for approximately 62% of the total. This exceeds the 48% average for the corridor overall, and is likely due in large part to traffic congestion.

The locations with the highest average annual accidents during 2008 to 2012 were:

- mile 24 (includes the Quebec interchange) - 34 accidents per year
- mile 19 (includes the Broadway interchange) – 31 accidents per year
- mile 17 (includes the Santa Fe interchange) - 28 accidents per year
- mile 21 (includes the University interchange) - 27 accidents per year
- mile 25 (includes the Yosemite interchange) - 27 accidents per year

2.5.2 Mainline Accidents by Severity

Of the 1,465 C-470 mainline accidents reported during 2008 through 2012, almost 92% resulted in property damage only, almost 8% resulted in one or more injuries, and one half of one percent (8 accidents) resulted in fatalities. Mile-by-mile comparison of injury accidents does not reveal any dense clusters of injury accident locations, and the same is true for the eight accidents that resulted in fatalities.

3.0 FUTURE 2035 ROADWAY CONDITIONS

3.1 No-Action Alternative

The 2035 No-Action Alternative assumed no improvements to the existing C-470 freeway corridor other than performing basic maintenance and/or safety improvements to maintain roadway operations. Improvements to the I-25 and E-470 freeway facilities and other surface street facilities in the vicinity of the C-470 corridor that are included in the Denver Regional Council of Governments *2040 Fiscally Constrained Regional Transportation Plan* and included in the CDOT STIP were included as part of the No-Action Alternative.

3.2 Proposed Action

The development of the Proposed Action was the result of an extensive study and design process that started in late 2012 and was concluded in 2014. The design concept evolved as new information and insights about operations and maximizing the use of the proposed express toll lanes in the corridor were obtained. The Proposed Action (Build Condition) of the 2015 Revised EA for C-470 would add one tolled express lane in each direction between Kipling Parkway and I-25, and a second tolled express lane as follows:

- Westbound, I-25 to Lucent Boulevard
- Eastbound, Broadway to I-25

The tolled express lanes would be open in both directions at all times. Only drivers who choose to use the tolled express lanes would pay a toll. The tolled express lanes would provide users with more choices about how to travel, taking travel time and costs into consideration. The benefits of the tolled express lane are:

- **Travel Time Reliability**
  As travel demand on C-470 continues to grow, congestion, long travel times and uncertain travel time reliability will increase. Congestion, which in 2013 is confined primarily to week day peak periods, will grow over time and extend beyond the weekday peak periods as well. A managed lane provides a mechanism for CDOT to assure a reliable and efficient travel time for 2035 and beyond as travel time reliability degrades in the general purpose lanes. Studies have shown that travelers are willing to pay a toll for travel time reliability.

- **Tolled Express Lanes Provide Options**
  Tolled express lanes that are added in the same corridor as existing general purpose lanes provide options for travelers. Travelers are not required to use the facility, and many will only use them periodically, but travelers are provided the option for a faster, more reliable trip.

- **Tolled Express Lanes are More Consistent with a User Pay Philosophy**
  Nationwide, highway funding and environmental groups have been advocating funding of highway capacity that ties highway travel more closely to a user pay philosophy. Tolled express lanes that clearly match an increasing cost with higher demand is more likely to encourage alterations in travel behavior.

Environmental groups nationwide support this approach because it more clearly passes on transportation costs to the user and serves to encourage transit use or carpooling, which increase person throughput rather than vehicle throughput.

- **Tolled Express Lanes are a More Efficient Use of a Highway**
There is a substantial premium in adding highway capacity in most highway corridors. Providing the long-term ability to maintain a lane of free-flow travel will greatly enhance the capacity of the corridor.

- **Tolled Express Lanes Improve Emergency Response Reliability**
Emergency vehicles will be allowed to use the lanes without paying a toll as long as they have been dispatched to run with lights and sirens for emergency purposes. The tolled express lanes will provide a less congested alternative for emergency vehicles, increasing their reliability and response time.

- **Tolled Express Lanes Improve Economic Viability**
In contrast to congestion gridlock, tolled express lanes provide an option for those willing to pay to travel through the corridor with a reliable travel time. This will improve conditions for commuter travelers as well as other providers of goods and services along the C-470 corridor. This enhances the economic competitiveness of all users of C-470 as well as those communities adjacent to C-470.

These new tolled express lanes, plus new auxiliary lanes where warranted, would supplement the existing (non-tolled) general purpose lanes. In the modeling of the Proposed Action, it was assumed that there would be no designated lanes or toll exemptions for buses or carpools. New direct-connect ramps would be provided to serve some movements at the I-25/C-470/E-470 interchange. The Proposed Action would eliminate the existing two left lane drops on westbound C-470 between E-470 and Yosemite, a design that will operate in a safer manner, also noting that eliminating these left lane drops. This improvement was a key improvement requested by local corridor stakeholders. Improvements to the I-25 and E-470 freeway facilities and other surface street facilities in the vicinity of the C-470 corridor that are included in the *Denver Regional Council of Governments 2040 Fiscally Constrained Regional Transportation Plan* and included in the CDOT STIP were included as part of the Proposed Action. It was recognized early on that the tolled express lane ingress/egress would be a key component of the Proposed Action impacting traffic safety and operations as well as toll revenue. The tolled express lane ingress/egress design and location are discussed below.

3.2.1 Tolled Express Lane Ingress/Egress Design and Location

Ingress/Egress Design Types

The design detail of the different types of ingress and egress for C 470 Express Toll lanes are illustrated in **Figure 7**. In all the pictured cases, these designs include a weave lane for vehicles to enter and exit the express lanes. This merge/diverge/weave lane will provide refuge for transitioning vehicles which will be a safer transition than having vehicles cross directly between the general purpose lanes and express lanes.

The design criteria are based in part on the April 2011 Policy Memo from Caltrans. The design criteria in the Caltrans Policy Memo was based on current Caltrans design criteria and on the evaluation of safety and mobility performance issues, over the last several years, associated with HOT lane access points that resulted in substantial changes to access opening location, spacing and geometry. Some of the findings of the evaluation included:

- General collision studies in California support increasing the weaving length at and between access openings beyond the current practices found in the HOV Guidelines.
- Nationally recognized research findings and products recommend longer openings and longer distances for the weaving along and between successive access openings. Prior and current national practice allows for a 1,000 foot minimum access opening, and (two-sided) weaving lengths that are based on providing 500-800 ft per lane change.

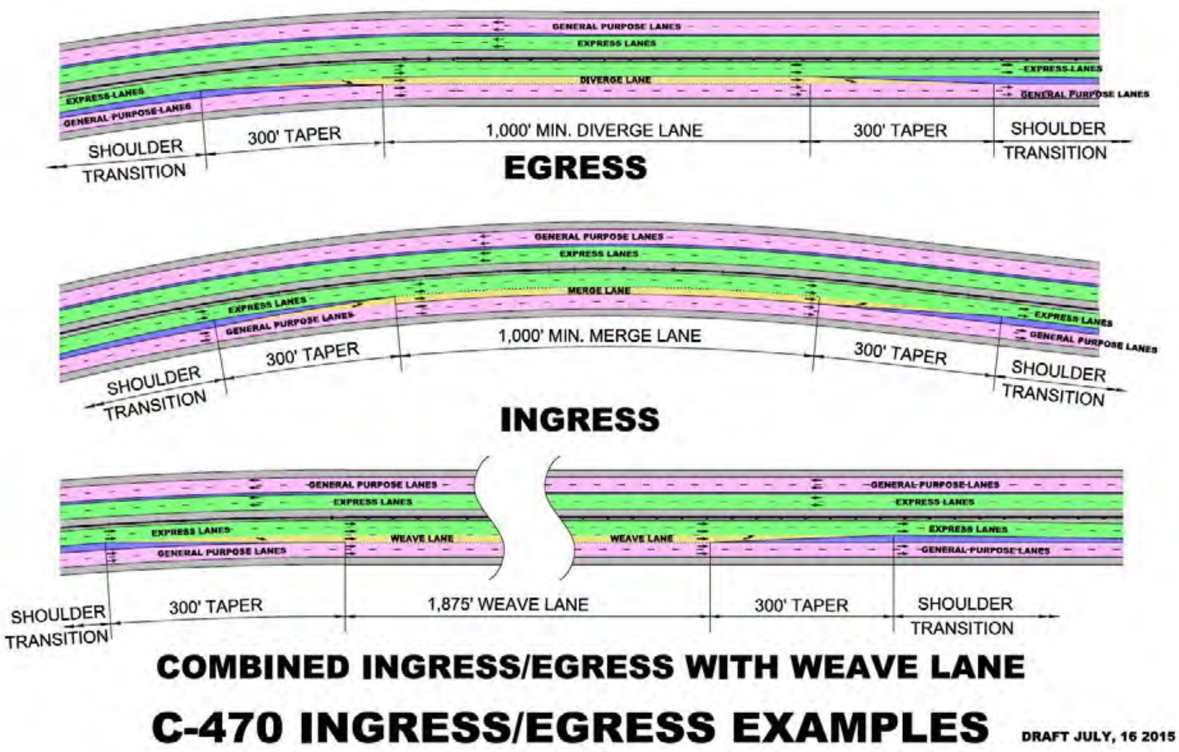
Based on the above research findings, and years of experience managing location-specific operational and safety problems, the Department's freeway operations and traffic safely engineering practitioners recommend the following changes to their standard practices:

  - Increase the minimum access opening length from 1,300 ft to 2,000 ft, and
  - Increase the per-lane change- distance from 650 ft to 800 ft in order to avoid pushing drivers to make consecutive lane change maneuvers across the entire freeway

The design criteria outlined in the April 2011 Policy Memo from Caltrans was discussed in detail with the C-470 Coalition Technical Working and approved and incorporated into the design of the C-470 tolled express lanes.

The design team also considered a different ingress/egress design. This type was a combined ingress/egress opening with **no additional** weave lane. Based on the curvilinear alignment of C-470, the ability for weaving vehicles to safely navigate and a desire to provide a reliable trip this basic concept was rejected. The recommended ingress/egress design also addresses safety concerns by some reviewers that provided public comment on the original C-470 EA in 2006.

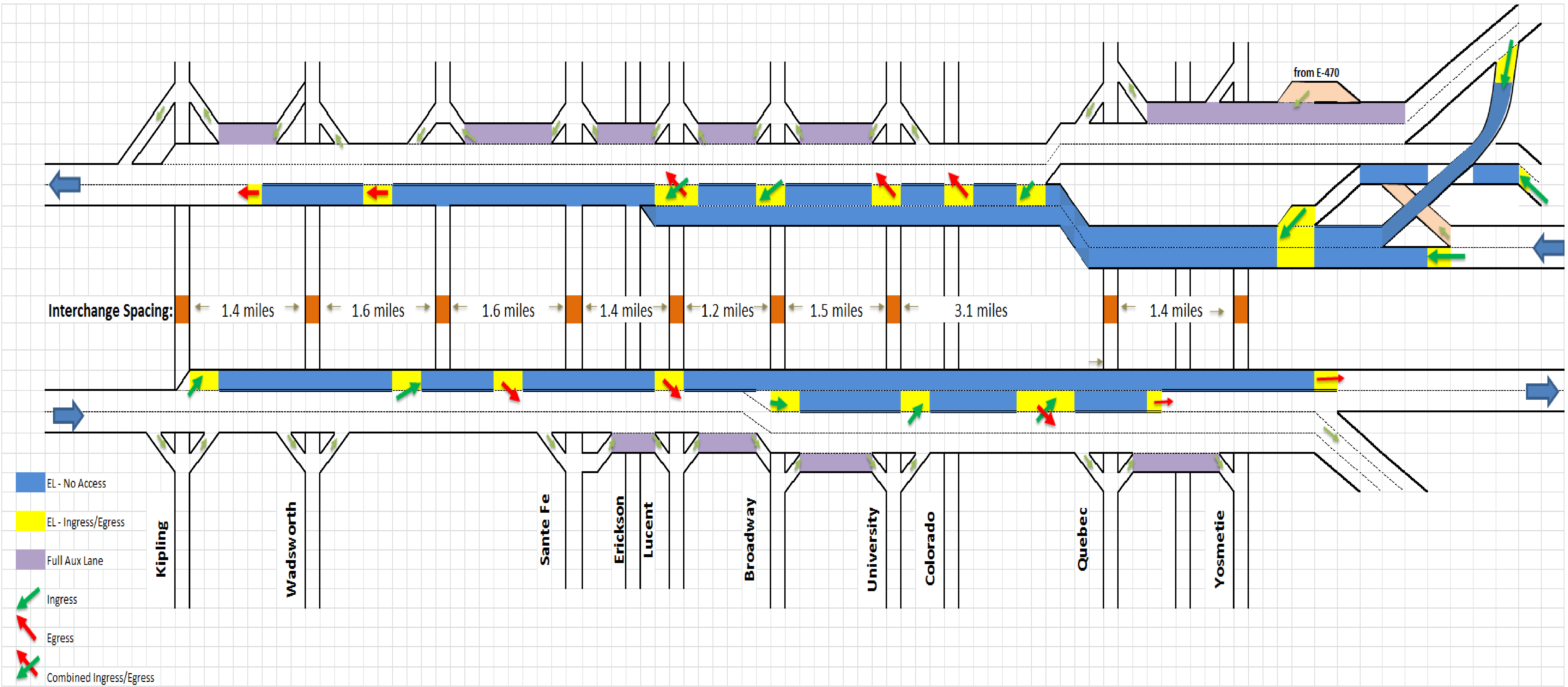
Figure 7: Typical Design for Ingress, Egress and Combined Ingress/Egress



Ingress/Egress Locations

Defining the tolled express lane ingress/egress locations of the Proposed Action was part of the design process that started in late 2012 and also included iterative public process as the Proposed Action was being developed. It is understood that the tolled express lane ingress/egress will create additional turbulence in the C-470 general purpose lanes especially since they would occur on the left hand side of these lanes. The locations of the tolled express lane ingress/egress are shown in **Figure 8**.

Figure 8: Tolled Express Lane Ingress/Egress Locations



4.0 TRAFFIC FORECASTING AND OPERATIONS

4.1 Future Year Peak Hour Traffic Volumes

Forecasting of the 2035 traffic volumes for the C-470 corridor was conducted by Cambridge Systematics and is documented in the *C-470 Express Toll Lanes Traffic Operations Analysis Report*, *May 15, 2015.* The following is taken from that report.

Future patterns and projected increases in volume is an important step within the traffic analysis, and the Denver Regional Council of Governments 2035 Focus model was used to update the regional patterns for the 2035 No Action and Proposed Action scenarios. The Focus model was updated to reflect all of the changes associated with the future alternatives and applied utilizing the entire model process. This included any changes associated with Highway and Transit network projects, as well as any changes to the demographic data.

After all of the changes to the model inputs associated with the future year scenarios were incorporated into the regional model dataset, the regional model was used to forecast future year traffic flows in a manner consistent with the base year traffic forecasting. Incremental growth for every OD pair was added to the base year calibrated trips. The process is described below:

1. Perform standard Focus model forecast to produce estimates of traffic demands;

2. Extract future year subarea OD demands for the regional study area corridor;

3. Adjust future year demands based on the base year validation. The final scenario-specific future year matrices were calculated using the following formula for each vehicle type/class:

Adj. Future Year Matrix = (Raw Future Year Matrix –

Raw Base Year Matrix) +

Calibrated Base Year Matrix

4. Extract C-470 Corridor-level ODs used as input into the simulation models. Multiple iterations of regional travel demand model and simulation model runs were completed to generate reliable future forecasts.

In addition to the major considerations of the future traffic forecast, the Focus model also had to take in to consideration the use of dynamic tolling models in the managed lanes in order to properly assign traffic and determine the correct impact of the addition of the express lanes. The remainder of the section discusses how the express lanes were modeled in the Focus model.

Modeling Express Lanes in the Focus Model

The C-470 Express Lanes that are the focus of this study use a dynamic pricing component that is based on the levels of congestion experienced within the express lanes at very small time increments. It is expected that the express lanes will have some minimum toll at all times they are in operation. Also, some travelers may be averse to paying a toll regardless of the time savings. Therefore, including express lanes without some consideration of the additional cost might result in an over-prediction of demand.

The behavioral response to the pricing component can be divided into pre-trip decisions and en-route decisions. Pre-trip decisions include the activity location, mode, travel time, and toll receptivity. En-route, the traveler is choosing a path and deciding if the time savings in the express lanes justify the cost. The CS team's approach to capture these sensitivities is described below.

Pre-Trip Decisions

Regional travel demand models assume that decision-makers are aware of the equilibrium level of service and cost for each trip. Models also assume that travelers make pre-trip decisions regarding activity location and mode based on the average price for the time period of travel in addition to transportation network level of service (LOS). Some regional travel models address this issue with the inclusion of toll acceptance models that sort travelers into groups of those that will pay a toll and those that will not. Although there is no explicit toll acceptance choice model within the Focus model system, all of the activity-based model elements are sensitive to roadway pricing and have been calibrated and validated across the region with existing toll facilities. To introduce a new element at this time would be inconsistent and would require the models to be recalibrated. Therefore, the current regional model was not modified for this study.

In terms of incorporating the cost of the proposed managed lanes, a pricing scheme such as "fixed variable" that matches the assignment time periods would require no changes to the Focus model. To test dynamic pricing, an average price for each time period was estimated. This was done by applying the micro-simulation model with dynamic pricing to determine an "average" price for each time period that matches the Focus model.

En-Route Decisions

Similar to pre-trip decisions, if the pricing scheme for the express lanes is "fixed variable" where the price is constant for a set period of time but changes based on a predetermined schedule, it is possible to incorporate the effects of price on route choice into the existing Focus model assignment procedure. For instance, if the toll for using the express lane is a fixed amount from 7:00 a.m. to 8:00 a.m., the current generalized cost assignment methodology could be used with the corresponding hourly AM trip table by setting a fixed price for the express lane use for that hourly assignment. The price could then be changed for the next time increment as planned, etc. There would be no need to alter the current assignment methodology of the Focus model.

In the case where the pricing level is dynamic at time periods less than the Focus model and is related to congestion levels, the decision to use the express lanes would be made depending on the actual dynamic price level. As mentioned above, the Focus model utilizes a static assignment procedure to assign demands to the highway network. Static assignment cannot represent moment-to-moment fluctuations in volume; instead the average volume over the time period is calculated. Static assignment, however, can be used to find the equilibrium between the delay on the mainline and the toll on the express lanes. The dynamic price is determined by traffic volume so an iterative process is necessary to determine the price demand equilibrium.

Two different potential approaches were examined to estimate the average dynamic price for a time period. The static assignment of volume between the two facilities was used to estimate the average toll rate for each time segment with some modification to the current Focus model volume delay functions. Alternatively, the average toll rate from the micro-simulation model, which represented the short-term decisions, was fed back into the Focus model network. The implementation of the two approaches is described below.

Develop a Volume Delay Function (VDF) that contains a cost or pricing component that is sensitive to the level of congestion; or

1) Utilize the existing VDF (BPR curve) within the Focus model in a more manual, iterative fashion as follows:

    a) First estimate maximum demand for the express lanes in the static assignment subarea model by allowing all eligible vehicles to use the express lanes at the minimum toll rate;

    b) Run these demands through the micro-simulation model that has a variable pricing component to determine an average cost per time slice;

    c) Re-estimate the demands with the static assignment subarea model using the average price information from the micro-simulation model above; and

    d) Continue this process until equilibrium is reached.

VISSIM Managed Lane Module

The VISSIM managed lane module was utilized to assign traffic within the simulation model to the managed express toll lane(s). The module consists of physical paths in parallel between the general purpose (GP) lanes and the managed express toll lanes, a decision model, and a pricing model. The paths were coded to reflect the ingress/egress of the design concept (design of facilities is discussed in more detail in Chapter 4.0) and the pricing zone structure. The toll pricing and willingness to pay are discussed in more detail below.

Toll Price Setting

The pricing strategy deployed in the VISSIM model is a combination of the logic used in the VISSIM Managed Lane Module and custom scripts written and implemented by the CS Team. The current pricing schemes in the Denver region is time-of-day pricing. In order to develop toll pricing rates for C-470, the CS team ran VISSIM with dynamic pricing and deployed a dynamic congestion pricing algorithm to help determine the time-of-day pricing rates and schedule. Tolls were charged by either a transponder or, if there is not a transponder, through license plate recognition. There is a surcharge on the tolls for vehicles using the express lane with only vehicle recognition, and this will need to be reflected in the pricing.

The parameters and objectives of the toll price setting have been established by High-Performance Transportation Enterprise (HPTE) staff and the TWG. The parameters and objectives are as follows:

- Facility Length – ~13 miles;
- Pricing Basis – Zone based. Three zones westbound; one or two zones eastbound (Interim/Ultimate);
- Minimum Toll – $0.50;
- Maximum Toll – Determined by VISSIM dynamic conditions;
- Toll change time interval – 60 minutes;
- License plate charge – $0.75;
- Operational Capacity – 1,900 vphpl;
- Performance measure – Travel Speed; and,
- Performance target – 55 mph exceeded 90 percent of the time (LOS D).

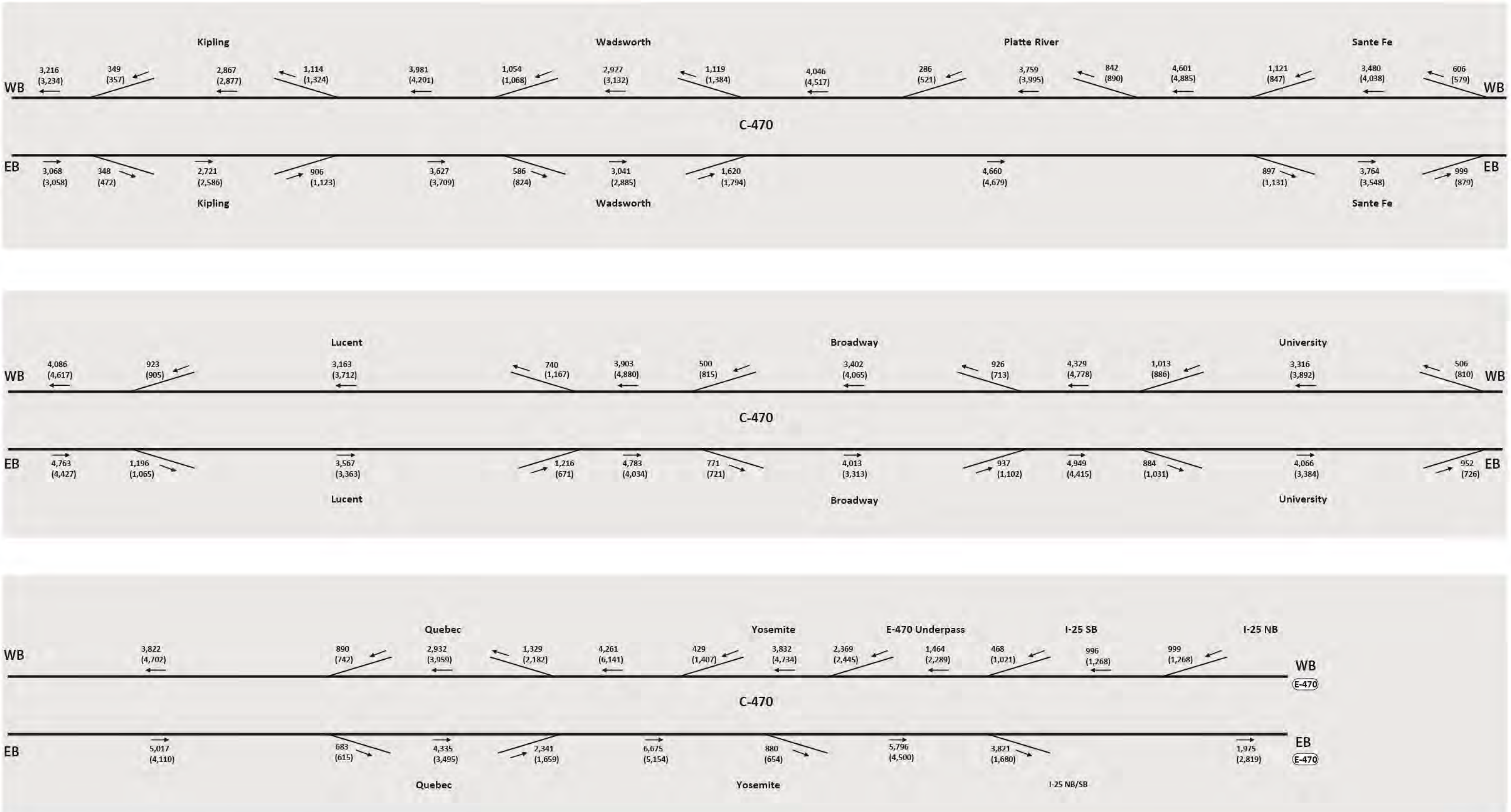
During the scenario analyses, it was determined to provide a slight change in the toll price structure for Zone 1 Westbound traffic entering from E-470. Instead of paying the established rate for the managed lanes as is done by traffic entering from I-25, a smaller minimal toll ($0.50) is charged for vehicles continuing from the E-470 toll facility onto the managed lane facilities. This was to better mitigate congestion along the C-470 corridor and to better balance traffic between the managed lanes and the general purpose lanes.

Willingness to Pay

Willingness to pay is represented in the VISSIM model with a logit model. The logit model has coefficients that are developed based on stated-preference surveys. CS utilized the recent U.S. 36 stated-preference survey that was conducted for the proposed managed lanes between Denver and Boulder in order to set these model coefficients in the model. The survey was adjusted according to prevailing socioeconomic differences between the U.S. 36 corridor and the C-470 Corridor.

The above iterative process that involved refining the demands in the static equilibrium assignment procedure within the FOCUS model and then testing the operations of these demands within the VISSIM simulation models resulted in the 2035 No-Action Alternative and Proposed Action AM and PM peak hour volumes along the C-470 corridor that are shown in **Figure 9** through **Figure 14**.

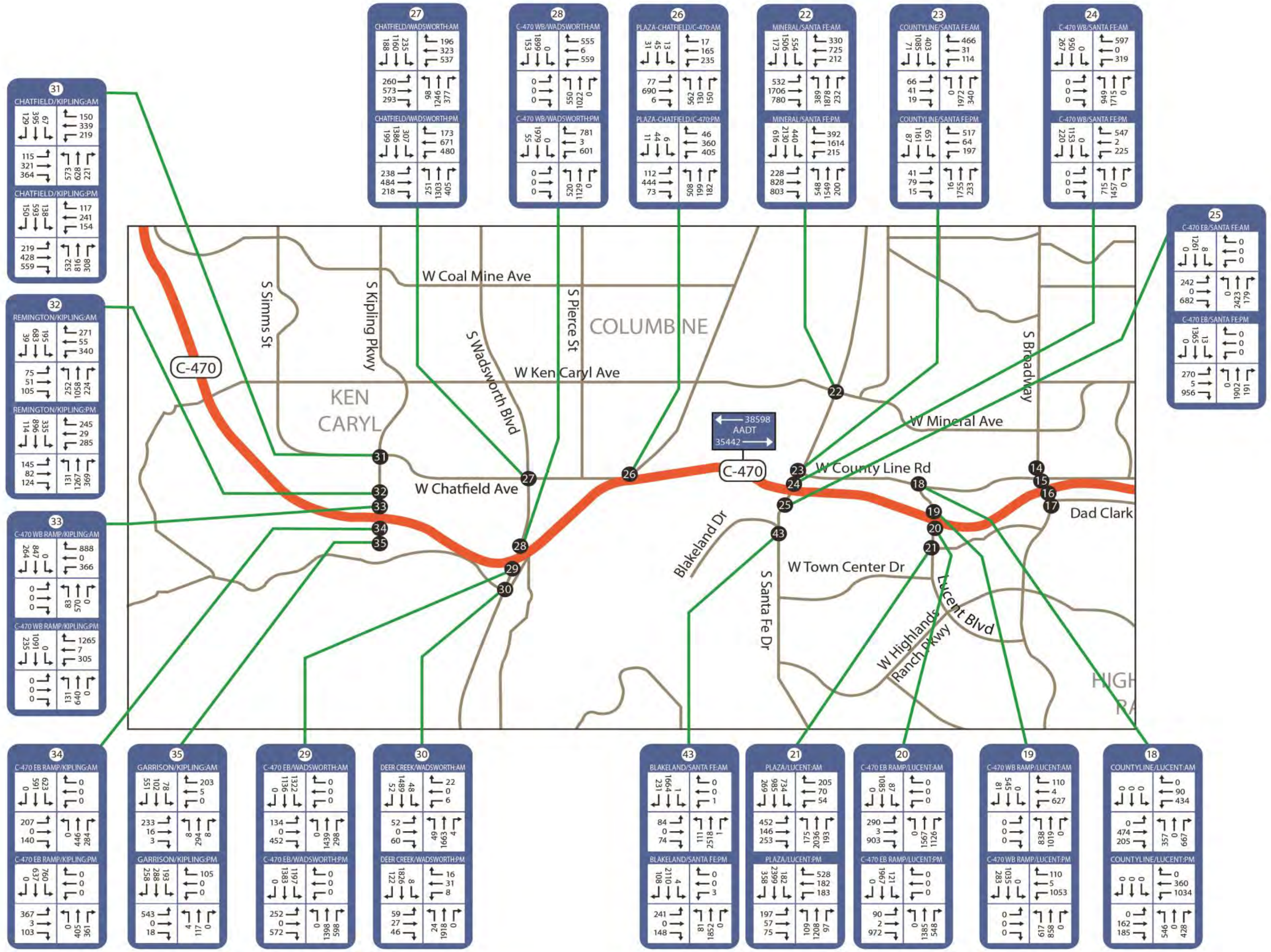
Figure 9



2035 No Action C-470 Freeway Traffic Volumes

Legend
AM Peak Hour
(#) PM Peak Hour
General Purpose Lanes/Ramps
N

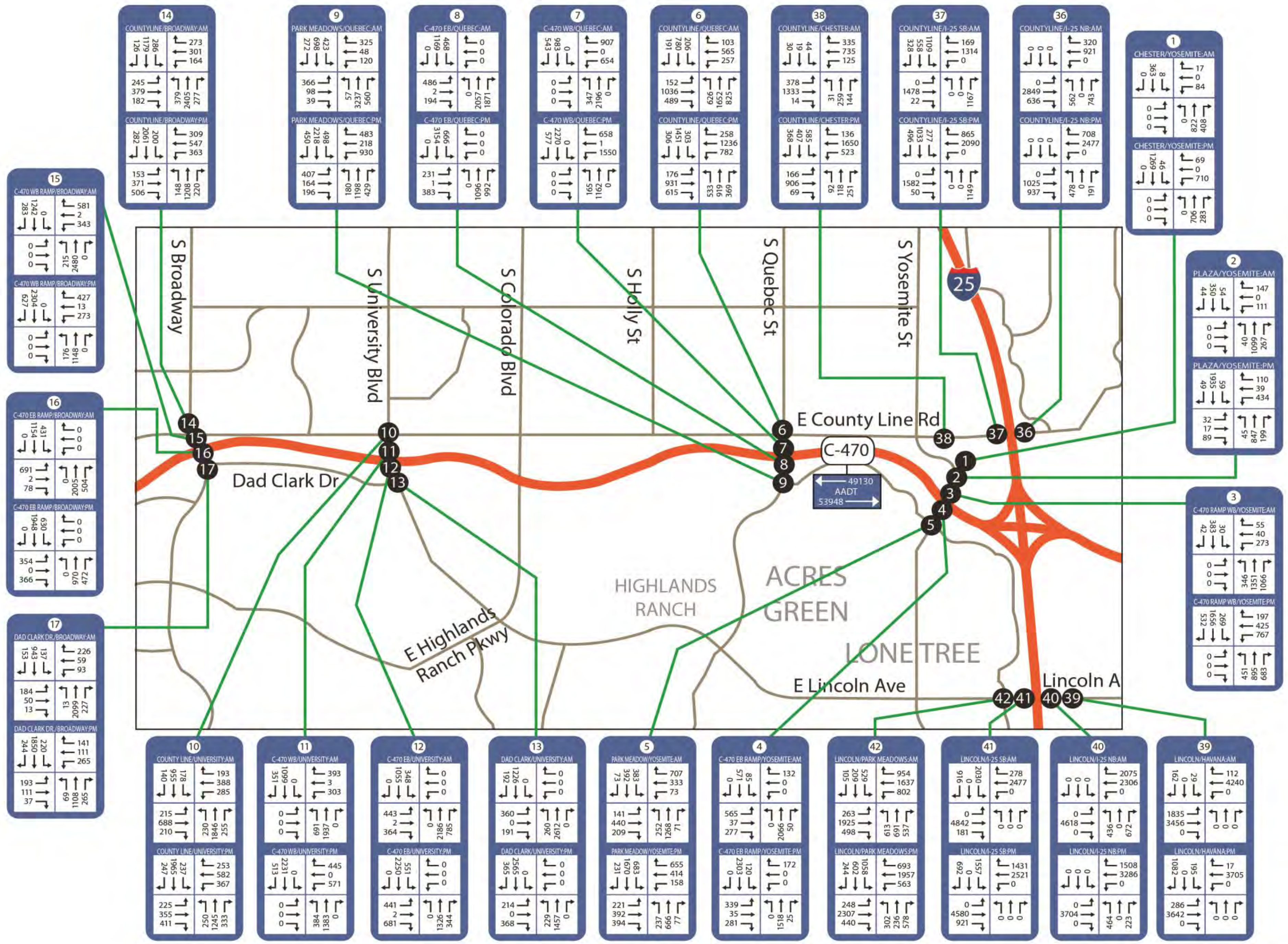
Figure 10



C-470 2035 No-Action Traffic Volumes: West Segment

N

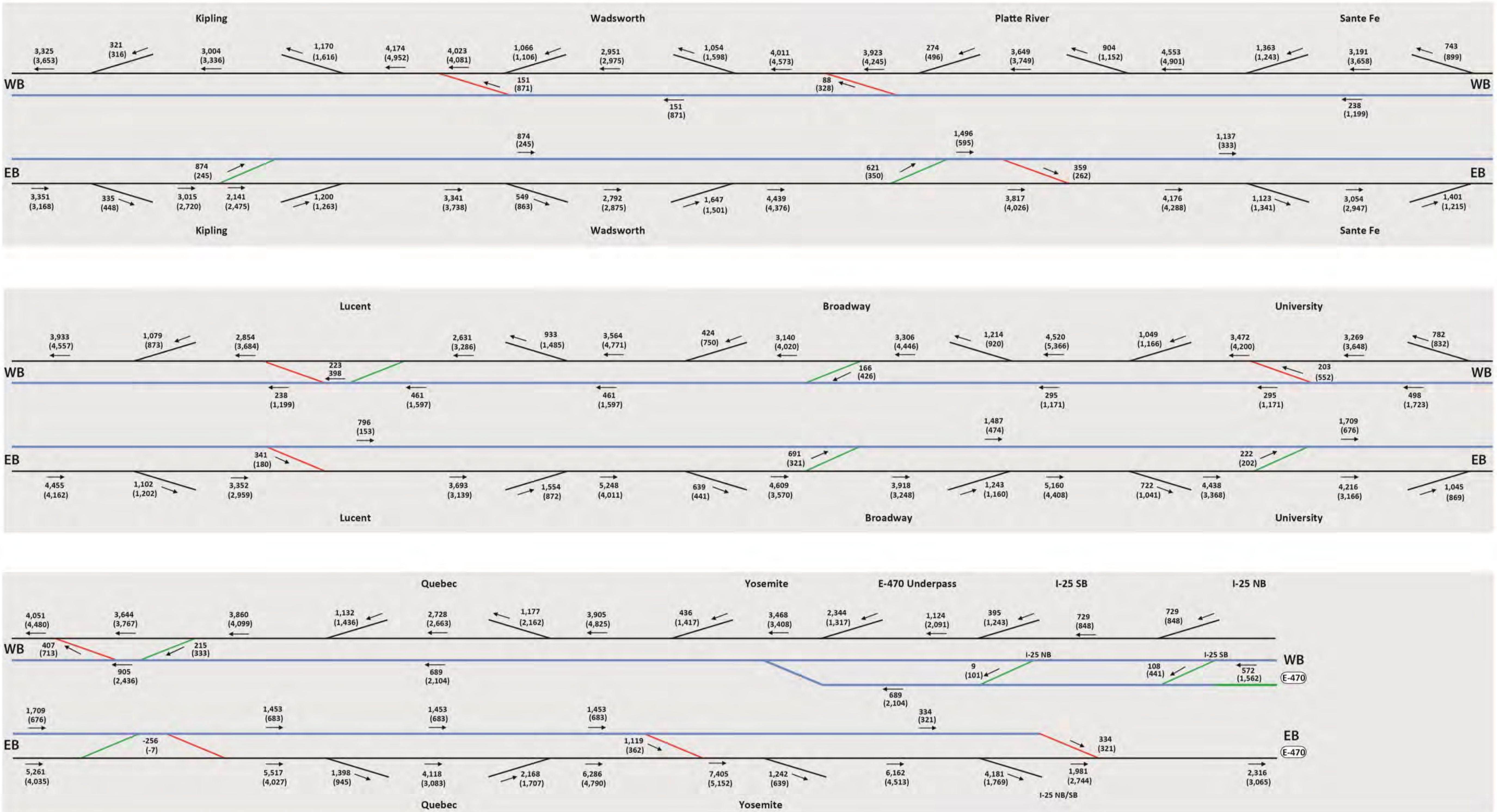
Figure 11



C-470 2035 No-Action Traffic Volumes: East Segment

N

Figure 12



C-470 Proposed Action Freeway Traffic Volumes

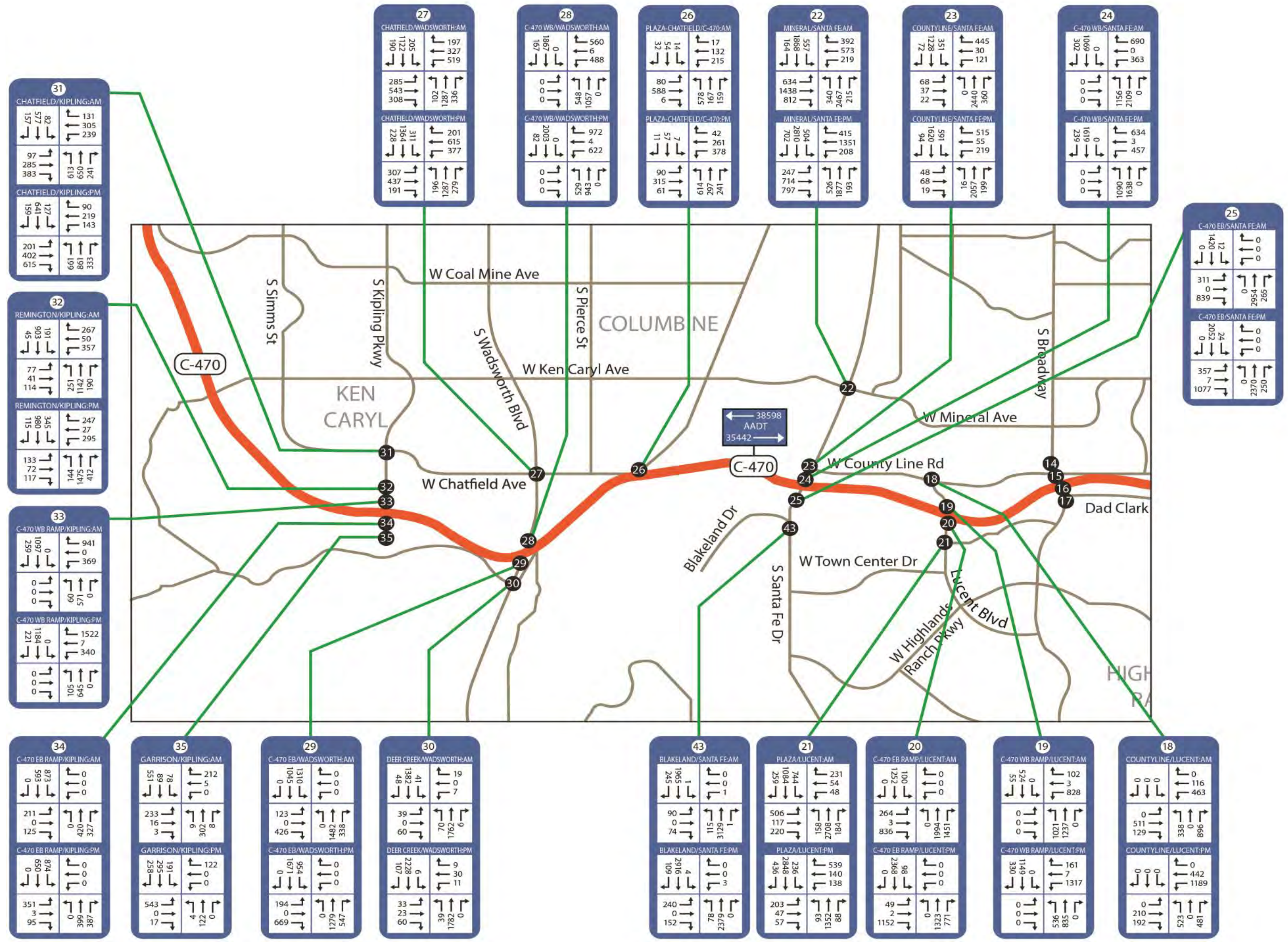
Legend

\# AM Peak Hour — General Purpose Lanes/Ramps — Tolled Managed Lane Egress

(#) PM Peak Hour — Toll Managed Lanes — Tolled Manged Lane Ingress

N

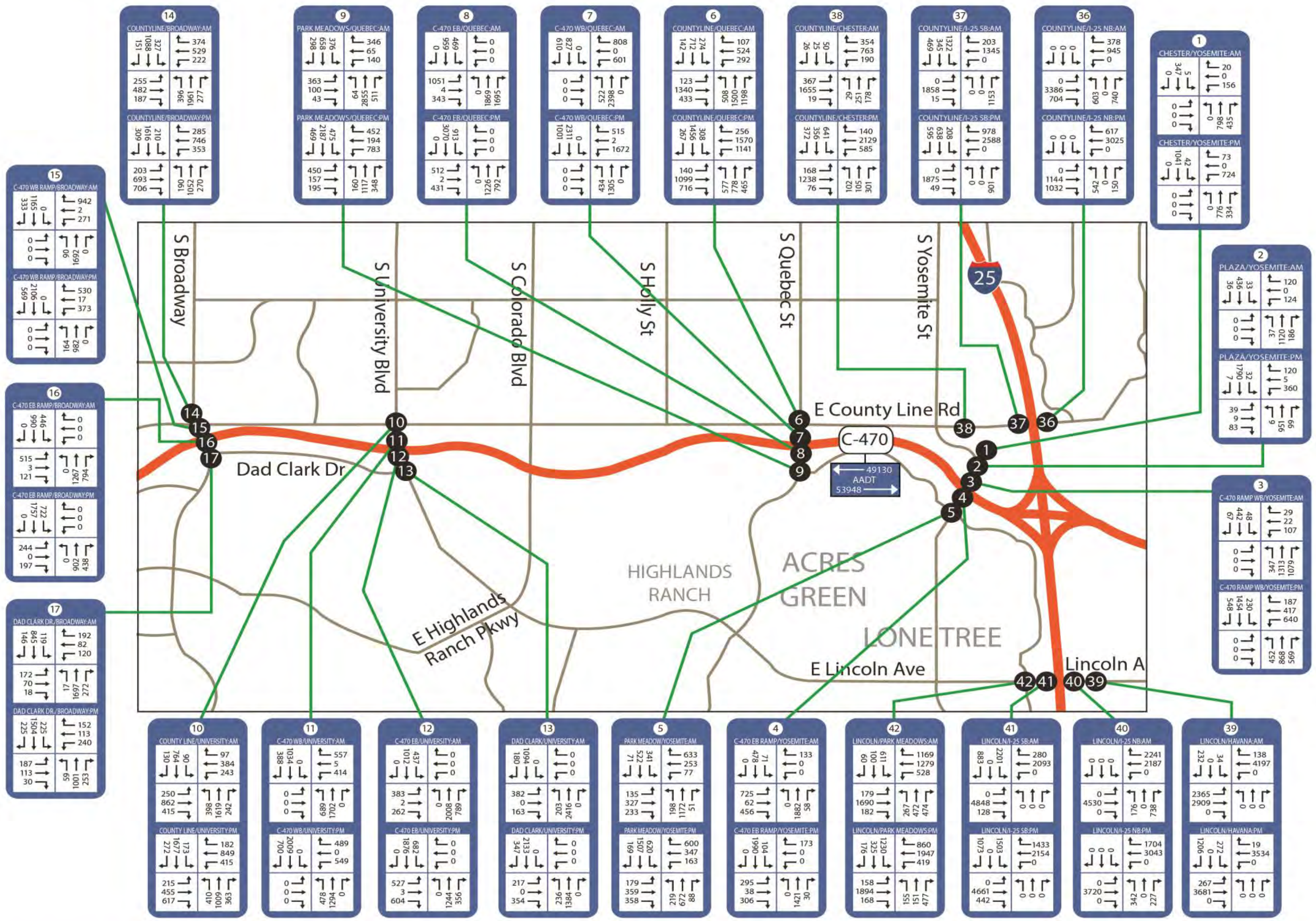
Figure 13



C-470 2035 Proposed Action Traffic Volumes: West Segment

N

Figure 14



C-470 2035 Proposed Action Traffic Volumes: East Segment

4.2 Future Year Truck Percentages for Operations Analysis

In order to establish the current level of truck activity in the C-470 Corridor, additional classification counts were collected along C-470 in July 2014, east of Quebec and east of Broadway to assess the existing heavy truck percentages on the C-470 Corridor. The average current observed truck percentages are summarized in the following **Table 8** for each of the peak hours. These truck percentages were used to conduct the 2035 traffic operation analyses.

Table 8: Current/Future Year Truck Percentages

AM Peak	PM Peak
2.3%	1.9%

Source: Average of observed classification counts conducted in the C-470 corridor in July 2014

4.3 Future Year Freeway Operations

Future No-Build and Build traffic analyses were performed the same way as described in the existing traffic conditions. Level of Service (LOS) for C-470 were computed for basic freeway segments, weave sections, ramp junctions and signalized intersections using Highway Capacity Software (HCS) 2010. It should be noted that the LOS in the tolled express lanes is measured the same way as the general purpose lanes but there is not an explicit standard or currently defined HCM methodology. However it is recognized that CDOT intend to manage these lanes such that traffic flows freely and to keep the express toll lanes flowing at 45 MPH or faster along the C-470 corridor. To accomplish these goals CDOT will continuously monitor traffic volumes along the corridor in both the general purpose and tolled express lanes and adjust the time of day toll rates, increasing or decreasing depending on the levels of congestion to meet the operational goals. LOS C can be considered a reasonable maximum LOS for the tolled express lanes.

As noted for existing conditions LOS for the interchange ramp terminal intersections were determined applying the HCM 2010 Chapter 22, Interchange Ramp Terminals methodology.

4.3.1 Basic Freeway Segments

The results of the C-470 basic freeway segments for the 2035 No Action and the 2035 Proposed Action are summarized in **Table 9**. The results indicate that for the No-Action Alternative nearly all freeway sections in each direction, between interchanges, are projected to operate at a deficient LOS E or F during one or both peak hours, as shown in yellow. Under the Proposed Action basic freeway LOS and/or freeway density is expected to improve relative to the No-Action Alternative for nearly all C-470 segments.

Table 9: 2035 Basic Freeway Segment Operations Summary

	Basic Freeway Segements		No Action				Proposed Action			
			AM Peak		PM Peak		AM Peak		PM Peak	
	From	To	Density	LOS	Density	LOS	Density	LOS	Density	LOS
Westbound C-470	E-470	I-25 Off ramp	23.4	C	24.7	C	23.2	C	25.0	C
	I-25 Off ramp	I-25 N/S Off ramp Split	19.4	C	20.9	C	11.7	B	14.6	B
	I-25 Off ramp	I-25 On ramp	19.5	C	20.1	C	24.1	C	23.8	C
	I-25 Ramps	C470	12.0	B	18.8	C				
	I-25 SB On Ramp	I-25 N/S On ramp Merge					3.5	A	11.1	B
	I-25 N/S Ramp Merge	C470					10.0	A	18.6	C
	I-25 On ramp	Yosemite On ramp	21.0	C	26.4	D	19.0	C	18.7	C
	Yosemite On ramp	Quebec Off ramp	23.4	C	38.9	E	21.4	C	27.0	D
	Quebec Off ramp	Quebec On ramp	24.2	C	36.6	E	22.4	C	21.9	C
	Quebec On ramp	University On ramp	34.5	D	52.9	F				
	Quebec On ramp	ML ingress					35.1	E	39.0	E
	ML ingress	ML egress					32.0	D	33.7	D
	ML egress	University Off ramp					38.2	E	46.9	F
	University Off ramp	University On ramp	28.1	D	35.6	E				
	University Off ramp	ML egress					27.6	D	32.1	D
	ML egress	University On ramp					29.9	D	40.9	E
	University On	Broadway Off	43.5	E	55.3	F				
	Broadway Off ramp	Broadway On ramp	29.1	D	38.4	E				
	Broadway Off ramp	ML ingress					28.0	D	46.1	F
	ML ingress	Broadway On ramp					26.2	D	37.6	E
	Broadway On ramp	Lucent Off ramp	35.7	E	58.8	F				
	Lucent Off ramp	Lucent On ramp	26.5	D	33.0	D				
	Lucent Off ramp	ML combo					21.6	C	27.8	D
	ML combo	Lucent On ramp					11.7	B	15.1	B
	Lucent On ramp	Santa Fe Off ramp	38.8	E	50.4	F	21.6	C	25.2	C
	Santa Fe Off ramp	Santa Fe On ramp	30.0	D	37.9	E	26.8	D	32.2	D
	Santa Fe On ramp	lane drop	50.0	F	59.0	F				
	Lane drop	Platte Canyon Off ramp	25.5	C	27.5	D				
	Platte Canyon Off ramp	Platte Canyon On ramp	33.6	D	37.2	E	32.1	D	33.5	D
	Platte Canyon On ramp	Wadworth Off ramp	38.1	E	47.8	F				
	Platte Canyon Off ramp	ML egress					36.1	E	41.8	E
	ML egress	Wadworth Off ramp					22.0	C	25.4	C
	Wadworth Off ramp	Wadworth On ramp	24.2	C	26.2	D	24.5	C	24.6	C
	Wadworth On ramp	ML egress					22.1	C	22.4	C
	Wadworth On ramp	Kipling Off ramp	37.0	E	40.9	E				
	Kipling Off ramp	Kipling On ramp	23.7	C	23.7	C	24.9	C	28.3	D
	Kipling On ramp	W of C-470	27.0	D	27.2	D	28.2	D	32.1	D

Table 9: 2035 Basic Freeway Segment Operations Summary, continued

	Basic Freeway Segements		No Action				Proposed Action			
			AM Peak		PM Peak		AM Peak		PM Peak	
	From	To	Density	LOS	Density	LOS	Density	LOS	Density	LOS
Eastbound C-470	Kipling Off ramp	W of C-470	25.5	C	25.4	C	28.5	D	26.5	D
	Kipling Off ramp	Kipling On ramp	22.4	C	21.2	C				
	Kipling Off ramp	ML ingress					25.0	C	22.4	C
	ML ingress	Kipling on Ramp					11.7	B	13.6	B
	Kipling On ramp	Wadworth Off ramp	31.8	D	32.9	D				
	Wadworth Off ramp	Wadworth On ramp	25.3	C	23.8	C	23.0	C	23.7	C
	Wadworth On ramp	Santa Fe Off ramp	51.7	F	52.3	F				
	Wadworth On ramp	ML ingress					45.9	F	44.5	E
	ML ingress	ML egress					34.4	D	37.7	E
	ML egress	Santa Fe Off ramp					40.4	E	42.6	E
	Santa Fe Off ramp	Santa Fe On ramp	33.7	D	30.8	D	25.4	C	24.4	C
	Lucent Off ramp	Lucent On ramp	31.1	D	28.6	D				
	Lucent Off ramp	ML egress					28.5	D	24.5	C
	ML egress	Lucent On ramp					32.7	D	26.2	D
	Lucent On ramp	Broadway Off ramp	55.4	F	37.9	E				
	Broadway Off ramp	Broadway On ramp	37.5	E	28.1	D				
	Broadway Off ramp	ML ingress					50.2	F	31.1	D
	ML ingress	Broadway On ramp					36.0	E	27.4	D
	Broadway On ramp	University Off ramp	61.4	F	45.4	F				
	University Off ramp	University On ramp	38.4	E	28.9	D				
	University Off ramp	ML ingress					45.9	F	28.7	D
	ML ingress	University On ramp					41.2	E	26.5	D
	University On ramp	Quebec Off ramp	64.2	F	39.2	E				
	University On ramp	ML Combo					76.3	F	37.9	E
	ML Combo	Quebec Off ramp					32.5	D	22.1	C
	Quebec Off ramp	Quebec On ramp	43.6	E	30.2	D	39.3	E	25.7	C
	Quebec On ramp	Yosemite Off ramp	46.2	F	29.5	D				
	Quebec On ramp	ML egress					40.7	E	26.8	D
	Yosemite Off ramp	I-25 Off ramp	35.1	E	24.9	C	39.2	E	25.0	C
	C470	I-25 N/S Split					22.9	C	9.7	A
	I-25 Off ramp	I-25 On Ramp	16.2	B	23.2	C				
	ML egress	I-25 On ramp					19.0	C	25.5	C
	C470	I-25 N/S Ramp Split	33.0	D	12.8	B				
	I-25 N/S Ramp Merge	I-25 On ramp					10.4	A	18.5	C
	I-25 N/S On ramp Merge	E-470	9.3	A	17.0	B				
	I-25 On ramp	E of I-25	17.5	B	28.7	D	19.0	C	29.3	D

4.3.2 Freeway Merge

The results of the C-470 freeway merge analysis for the 2035 No-Action Alternative and the 2035 Proposed Action are summarized in **Table 10.** The Proposed Action includes a continuous auxiliary lane on C-470 in each direction between many of the interchanges along the corridor. Locations with auxiliary lanes were analyzed as weave sections instead of separate merge and diverge conditions, as appropriate. As shown, nearly all merge operations for the No-Action Alternative were predicted to operate at congested levels LOSE/F during one or both peak hours. Under the Proposed Action interchange merge conditions were reported to improve compared to the No-Action Alternative with the exception in the Kipling westbound on ramp where degradation in LOS was reported. Under the Proposed Action, additional traffic is being served by this ramp creating the congested merge operations. As noted previously, the tolled express lane egress creates turbulence in the general purpose lanes as reported in the westbound direction of C-470 during the PM peak hour.

Table 10: 2035 Freeway Merge Operations Summary

	On-ramp	No Action				Proposed Action			
		AM Peak		PM Peak		AM Peak		PM Peak	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
Westbound C-470	I-25 On from C-470					27.6	C	26.4	C
	I-25 On from I-25 NB					4.3	A	12.9	B
	Yosemite On	26.8	C	42.9	F	22.0	C	31.6	D
	Quebec On	27.7	C	35.1	F	29.1	D	31.0	D
	Que - Colo ML egress					32.2	D	35.6	F
	Univ - Broad ML egress					31.2	D	37.1	E
	University On	38.0	F	41.7	F				
	Broadway On	36.0	E	44.0	F				
	Lucent On	38.1	E	42.6	F				
	Santa Fe On	41.7	F	44.0	F	25.8	C	27.2	C
	Platte Canyon On	29.8	D	33.6	F	35.0	D	37.6	E
	Wadworth On	36.6	E	38.4	F				
	Kipling On	29.7	D	29.8	D	40.3	F	46.8	F
Eastbound C-470	Kipling On	32.3	D	33.0	D				
	Wadworth On	40.8	F	40.9	F	34.6	F	34.1	D
	Wads - SF ML egress					30.7	D	31.7	D
	Luc - Broad ML egress					34.8	D	30.3	D
	Lucent On	42.4	F	36.2	E				
	Broadway On	44.3	F	39.8	F				
	University On	44.2	F	36.7	E	41.5	F	31.3	D
	Quebec On	50.8	F	38.4	F	47.6	F	35.3	F
	ML egress					15.2	B	21.5	C

4.3.3 Freeway Diverge

The results of the C-470 freeway diverge analysis for the 2035 No-Action Alternative and the 2035 Proposed Action are summarized in **Table 11**. As discussed in the Merge Analysis, the Proposed Action includes a continuous auxiliary lane on C-470 in each direction between many of the interchanges along the corridor. Locations with auxiliary lanes were analyzed as weave sections instead of separate merge and diverge conditions, as appropriate. As shown, the majority of diverge operations for the No-Action Alternative were predicted to operate at congested levels LOSE/F during at least one of the peak hours. Under the Proposed Action, interchange diverge conditions were reported to be consistent and or improved compared to the No-Action Alternative. As noted previously, the tolled express lane ingress creates turbulence in the general purpose lanes at some of the ingress locations.

Table 11: 2035 Freeway Diverge Operations Summary

	Off- Ramp	No Action				Proposed Action			
		AM Peak		PM Peak		AM Peak		PM Peak	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
Westbound C-470	I-25 Off	*24.8*	*C*	*26.1*	*C*	*24.7*	*C*	*26.3*	*C*
	Quebec Off	*24.9*	*C*	*35.8*	*F*	*22.8*	*C*	*4.0*	*A*
	ML ingress					37.2	E	39.3	E
	University Off	25.9	C	34.0	F	28.0	C	31.9	F
	Broadway Off	30.5	D	34.7	F				
	ML ingress					32.5	D	42.9	F
	Lucent Off	26.6	C	35.6	F				
	Santa Fe Off	28.3	D	33.2	F				
	Platte Canyon Off	20.8	C	21.2	C	19.5	B	24.5	C
	Wadworth Off	27.9	C	32.2	F	23.4	C	26.7	C
	Kipling Off	27.3	C	29.3	D				
Eastbound C-470	Kipling Off	19.0	B	18.8	B	21.5	C	19.9	B
	ML ingress					18.5	B	15.7	B
	Wadworth Off	33.0	D	33.7	D				
	ML ingress					33.8	E	33.2	D
	Santa Fe Off	33.6	F	33.7	F	11.1	B	12.1	B
	Broadway Off	34.7	F	27.8	C				
	ML ingress					44.1	F	34.6	D
	University Off	36.2	F	31.3	F				
	ML ingress					42.8	F	32.9	D
	Quebec Off	36.9	F	28.5	D	23.4	F	9.8	A
	Yosemite Off	34.1	F	21.2	C				
	I-25 Off	*33.8*	*D*	*26.2*	*C*				
	E-470 Off (left exit)					42.6	E	38.4	F
	I-25 N/S Ramp Split	38.5	E	18.8	B	*24.4*	*C*	*10.3*	*B*

4.3.4 Freeway Weave

The results of the C-470 freeway weave analysis for the 2035 No-Action Alternative and the 2035 Proposed Action are summarized in **Table 12**. As shown, there are only two weave sections, one in each direction, along C-470 and the reported weave LOS indicate congested operations during one or both peak hours. Under the Proposed Action, the current weave operations were reported to be better under this alternative compared to the No Action alternative. However as noted previously the tolled express lane ingress/egress create additional turbulence on C-470 creating congested weave operations at several of these locations. These locations are highlighted in the table and summarized below including the weave lengths:

Westbound C-470

- Quebec on ramp to ML ingress – 4,260'
- ML egress to University off ramp – 4,500'

Eastbound C-470

- Wadsworth on ramp to ML ingress – 2,000'
- ML egress to Santa Fe off ramp – 4,200'
- ML egress to Yosemite off ramp – 2,800'

Nearly all weave sections are over ¾ mile long with the exception of C-470 eastbound ML egress to Yosemite off ramp weave that has a weave length over ½ mile and the C-470 eastbound Wadsworth to ML egress weave that has a weave length over one third mile. These weave locations are along sections of C-470 that do not have any auxiliary lanes. Therefore, traffic volumes in the general purpose lanes are concentrated in only two lanes contributing to the reported congested weave traffic operations.

Table 12: 2035 Freeway Weave Operations Summary

	Weave Segment		No Action				Proposed Action			
			AM Peak		PM Peak		AM Peak		PM Peak	
	From	To	Density	LOS	Density	LOS	Density	LOS	Density	LOS
WB C-470	Yosemite On	Quebec Off	29.1	D	*	F	26.5	C	*	F
	Quebec On	ML ingress					37.7	E	40.6	E
	ML egress	University Off					40.4	E	44.3	F
	University On	Broadway Off					28.7	D	34.6	D
	Broadway On	Lucent Off					22.5	C	30.9	D
	Lucent combo						10.7	B	17.5	B
	ML egress	Wadworth Off					24.9	C	29.0	D
	ML egress	Kipling Off					18.9	B	22.8	C
EB C-470	Kipling On	Wadworth Off					23.3	C	26.3	C
	Wadworth On	ML ingress					41.7	E	41.0	E
	ML egress	Santa Fe Off					41.9	E	42.4	E
	Santa Fe On	Lucent Off	*	F	35.3	E	28.4	D	26.4	C
	Lucent On	Broadway Off					33.7	D	25.1	C
	Broadway On	University Off					32.9	D	27.6	C
	Combo						26.0	C	16.8	B
	ML egress	Yosemite Off					35.7	E	23.6	C

*V/C > 1

4.4 Interchange Operations

As for existing conditions each of the interchange signalized intersections were analyzed using the HCM 2010 Chapter 22, Interchange Ramp Terminals methodology and the results are summarized in **Table 13**. Even with additional traffic being drawn to the C-470 Corridor due to the increased capacity of the Proposed Action alternative LOS at the interchange intersections were reported to be relatively consistent between the No-Action Alternative and the Proposed Action.

Table 13: 2035 Interchange Operations Summary

	No Action				Proposed Action			
	AM		PM		AM		PM	
Intersection	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Kipling & C-470 EB	13.3	B	19.5	B	15.0	B	21.7	C
Kipling & C-470 WB	28.1	C	81.1	F	25.7	C	110.2	F
Wadworth & C-470 EB	73.8	E	74.5	E	79.6	E	42.0	D
Wadworth & C-470 WB	33.8	C	42.0	D	27.0	C	53.3	D
Santa Fe & C-470 EB	52.7	D	>120	F	95.7	F	72.3	E
Santa Fe & C-470 WB	23.5	C	22.8	C	30.6	C	63.2	E
Lucent & C-470 EB	24.0	C	26.0	C	31.7	C	39.1	D
Lucent & C-470 WB	36.7	D	108.2	F	62.1	E	>120	F
Broadway & C-470 EB	51.5	D	15.6	B	>120	F	11.6	B
Broadway & C-470 WB	16.0	B	20.4	C	23.9	C	25.8	C
University & C-470 EB	43.4	D	28.5	C	49.0	D	51.7	D
University & C-470 WB	29.0	C	68.5	E	39.3	D	64.3	E
Quebec & C-470 EB	79.9	E	14.1	B	>120	F	35.1	D
Quebec & C-470 WB	26.2	C	>120	F	26.3	C	>120	F
Yosemite & C-470 EB	39.1	D	14.6	B	54.1	D	12.9	B
Yosemite & C-470 WB	14.7	B	47.4	D	7.0	A	38.2	D

4.4 2035 C-470 Corridor System Analysis

The corridor system evaluation consists of corridor travel times/travel reliability, vehicles miles traveled (VMT) and vehicle hours traveled (VHT). Peak hour corridor travel times were estimated from a macro-level evaluation using reported HCS travel speeds from the basic freeway segment, merge/diverge weave analyses and current corridor travel times. Peak period corridor travel times were determined from a micro-level traffic analysis using traffic simulation model results prepared as part of the *C-470 Express Toll Lanes Traffic Operations Analysis Report*, June 2015, by Cambridge Systematics for Douglas County. Reported VMT and VHT results from the traffic micro-simulation model are presented in this report also.

4.4.1 Peak Hour Corridor Travel Time/Travel Reliability – Macro-level

C-470 corridor peak hour, peak direction travel times from I-25 to Kipling were estimated for the No-Action Alternatives and the Proposed Action for the AM and PM peak hours. During the morning the peak direction of travel is in the eastbound direction and during the evening the westbound direction is the peak travel direction. Travel times for the general purpose lanes and tolled express lanes associated with each alternative were estimated. For the general purpose lanes the peak hour, peak direction travel times were estimated based on current C-470 peak hour, peak direction corridor travel times and travel speed results reported from the HCS analyses for each of the alternatives. As discussed previously, CDOT will manage the tolled express lanes such that traffic flows freely. LOS C can be considered a reasonable maximum LOS for the tolled express lanes which would reflect a corridor travel speed of approximately 55 MPH. The estimated C-470 peak hour, peak direction corridor travel times are summarized in **Table 14**.

Table 14: 2035 Peak Hour Peak Direction C-470 Travel Times (minutes)

Alt.	Lanes	Time Period	Eastbound	Westbound
No-Action	Existing	AM Peak Hour	23-25	
		PM Peak Hour		32-33
Proposed Action	GP lanes	AM Peak Hour	22-24	
		PM Peak Hour		29-30
	Express Lanes	AM Peak Hour	14-15	
		PM Peak Hour		14-15

As shown, travel time in the express lanes for the C-470 section from Kipling Parkway to I-25 would be approximately 14-15 minutes during of each of the peak hours. Peak direction travel times in the general purpose lanes of the Proposed Action would be 1 to 3 minutes shorter than for the No-Action Alternative.

The reliability of travel with the No-Action Alternative would continue to worsen, resulting in substantial effects to corridor mobility, affecting economic viability of businesses in the corridor area and quality of life for corridor residents.

The Proposed Action would provide reliable travel times in the tolled express lanes while maintaining consistent and/or better travel times in the general purpose lanes compared to the No-Action Alternative.

4.4.2 Vehicle Miles of Travel /Vehicle Hours Traveled

The following is contained in the *C-470 Express Toll Lanes Traffic Operations Analysis Report*, June 2015 prepared by Cambridge Systematics for Douglas County.

The two major MOEs for understanding the overall changes in network-wide performance that were used are the Vehicle Miles Traveled (VMT) and the Vehicle Hours Traveled (VHT). The VMT can show increases in vehicle throughput or be used to analyze changes in routing, where the VHT can be used as an overall statistic to show increases or decreases in congestion and/or delay along the roadway. The future VMT and VHT for both the AM and PM peak periods can be seen below in **Table 15**.

Table 15: 2035 Forecast WMT and VHT

6:00 am to 1:00 pm and 1:00 pm to 8:00 pm

	VMT (Millions)		VHT (Thousands)	
	AM	**PM**	**AM**	**PM**
No Action	1.67	1.62	53.4	69.1
Proposed Action	1.77	1.90	49.1	52.3
Percent Change	6%	17%	-8%	-24%

Source: Cambridge Systematics, Inc.

It can be seen above in **Table 15** that the Proposed Action design has an impact on the entire corridor. In the 2035 design year, a slight reduction (8%) in VHT can be seen in the AM peak period, but a more significant impact is seen in the PM peak period, with a 24% reduction in VHT for all vehicles in the network. Another interesting impact that can be seen in the network-wide statistics is that an increase in VMT is achieved with the Proposed Action. This VMT is the result of increase of vehicle throughput along the C-470 mainline as a result of the reduction of congestion and addition of toll lanes to avoid the congestion. Given that the total VMT increased and the total VHT is still decreased is clear indication that the Proposed Action is improving the operational conditions of the entire network, which includes the general purpose lanes, auxiliary lanes, express lanes, ramps, and the arterials up to the nearest adjacent intersections.

4.4.3 Peak Period Corridor Travel Time/Travel Reliability – Micro-level

The average travel times from one end of the study area corridor to the other along C-470 is a good measure of the impact of the express lanes. This helps to show the expected travel time savings that the average user can expect if they choose to pay to use the express lanes. The average travel times in the AM peak period (6AM-1PM) eastbound direction and PM peak period (1PM-8PM) westbound direction of travel on C-470 are shown below in **Table 16**.

Table 16: 2035 Peak Period Peak Direction C-470 Travel Times (minutes)

<table>
<tr><th>Alt.</th><th>Lanes</th><th>Time Period</th><th>Eastbound</th><th>Westbound</th></tr>
<tr><td rowspan="2">No-Action</td><td rowspan="2">Existing</td><td>AM Peak Hour</td><td>37-38</td><td></td></tr>
<tr><td>PM Peak Hour</td><td></td><td>48-49</td></tr>
<tr><td rowspan="4">Proposed Action</td><td rowspan="2">GP lanes</td><td>AM Peak Hour</td><td>32-33</td><td></td></tr>
<tr><td>PM Peak Hour</td><td></td><td>42-43</td></tr>
<tr><td rowspan="2">Express Lanes</td><td>AM Peak Hour</td><td>15-16</td><td></td></tr>
<tr><td>PM Peak Hour</td><td></td><td>19-20</td></tr>
</table>

Source: Cambridge Systematics, Inc.

It should be noted that the C-470 Corridor limits for the reported peak period travel times are eastbound C-470 (Kipling to I-25) and westbound C-470, an average of travel times that end at Kipling and start at the following locations:

- E-470 WB approximately ¼ mile east of I-25
- I-25 NB approximately ¼ mile south of Lincoln Avenue
- I-25 SB approximately ¼ mile north of County Line Road

These starting westbound travel time limits were selected in order to capture all the delays on I-25 and E-470 associated with delays and queuing of traffic from westbound C-470 that spillback onto these facilities and associated ramps, especially under the No-Action Alternative. For the Proposed Action, the reported travel times also begin at the locations noted above, and the 19-20 minute travel time for the tolled express lanes include time spent on E-470 or I-25 before the vehicles physically enter the tolled express lanes (the average speeds in the tolled express lanes exceed 45 miles per hour).

It is acknowledged that the reported corridor peak period travel times from the micro-simulation model are greater than the peak hour travel times which were determined at a macro-level that were estimated based on current corridor travel times and HCS reported travel speeds. The HCM methodologies have limitations with regard to upstream and downstream congested conditions as well as the accounting for the interaction of vehicles traveling along the corridor. The micro-simulation model better captures traffic operating conditions affecting the corridor. Each of the corridor travel time evaluations, macro-level and micro-level, confirm that the Proposed Action alternative would provide reliable travel times in the tolled express lanes in addition to maintaining and or improving travel times in the general purpose lanes, relative to the No Action alternative.

4.5 Future Safety Conditions

Capacity improvements and/or some type of demand management, on the C-470 corridor is needed to accommodate the additional travel demand, and address congestion and delay both now and in the future years. If the existing conditions were perpetuated, maintaining the existing freeway would expose motorists to increased traffic congestion above what currently exists. Because the No-Action Alternative would keep the facility "as is" no substantial improvements to safety would occur to reduce the crash rates. Because the rate at which the crashes occur remains the same as existing, but the amount of traffic using the facility increases, the total number of crashes would be expected to increase over time for the No-Action Alternative.

The Proposed Action would improve safety conditions along the C-470 corridor by providing additional capacity on C-470 with the tolled express lanes, eliminating the two left lane drops on westbound C-470 between E-470 and Yosemite, a design that will operate in a safer manner. Eliminating these left lane drops was identified as an important improvement for local corridor stakeholders. In addition corridor safety and traffic flow also would benefit from the continuous auxiliary lanes between many of the interchanges along the corridor. All C-470 corridor improvements would meet current design standards. The combination of increased capacity, the elimination of left lane drops and applying current design standards along the C-470 corridor would improve highway operations and provide higher levels of safety. CDOT studies of multi-lane roadways show that additional lanes result in lower crash rate for a given volume. It is recognized that the tolled express lane ingress/egress will create additional turbulence in the C-470 general purpose lanes especially since they would occur on the left hand side of these lanes which may offset some of the Proposed Action safety and operational benefits.

5.0 TRANSPORTATION IMPACTS AND IMPROVEMENTS

Intersection delay was used to measure transportation impacts of adding capacity to C-470 associated with the Proposed Action. The following methodology was used to determine if the Proposed Action would create an impact at an intersection:

1. Overall intersection peak hour delay was calculated for the No Action
2. Overall intersection peak hour delay was calculated for the Proposed Action
3. If the overall intersection peak hour delay increased 20 seconds or more as a result of the Proposed Action over the No Action then opportunities to improve overall peak intersection delay were identified.

The focus of the evaluation was on the immediately adjacent major intersections along the C-470 corridor. **Table 17** summarizes the 2035 overall intersection peak hour delay evaluation. As shown seven intersections were identified where the Proposed Action overall peak hour intersection delay increased by 20 seconds or more over the No Action.

Table 17: 2035 Overall Intersection Peak Period Hour Delay Summary

Intersection	Intersection Delay (seconds)			
	AM Peak Hour		PM Peak Hour	
	No Action	Proposed Action	No Action	Proposed Action
Yosemite St & Chester St	2.8	3.2	13.5	12.7
Yosemite & Plaza Dr	10.6	10.5	29.8	17.7
Yosemite & C 470 WB on ramp	17.6	14.3	31.2	28.6
Yosemite & C 470 EB Off ramp	18.3	20.5	13.2	13.6
Yosemite & Park Meadows	62.3	48.1	48.7	44.2
Chester & County Line	27.1	28.6	28.9	32
County Line & Quebec	55.7	125.7	130.3	192.2
Quebec & C 470 WB on ramp	26.8	36.1	113.7	146.5
Quebec & C 470 EB on ramp	134.8	151.5	31	50.7
Quebec & Park Meadows Dr	222.1	171.7	59.7	44.1
University & County Line	48.8	41.2	98.4	133.9
University & C 470 WB on ramp	33.3	45.9	52.6	54.6
University & C 470 EB on ramp	45.6	44.9	55.3	54.9
University & Dad Clark	22.2	20.5	26.2	16.6
Broadway & County Line	65.2	67.6	68.2	82.9
Broadway & C 470 WB on ramp	21.6	23.2	27	40.1
Broadway & C 470 EB on ramp	31.8	23	22.4	19.5
Broadway & Dad Clark	23.9	21.2	21.9	22.4
Lucent & County Line	42.2	73.8	110.5	139.4
Lucent & C 470 WB on ramp	25.7	28.7	52.9	72
Lucent & C 470 EB on ramp	25.6	50.1	37.2	76.5
Lucent & Plaza	166.3	254	95.9	129.9
Santa Fe & County Line	310.9	459.4	104.8	118.2
Santa Fe & C 470 WB on ramp	18.1	19.4	19.2	36.2
Santa Fe & C 470 EB on ramp	9.4	11.1	8.1	15.5
Santa Fe & Blakeland Dr	14	46.3	17.1	63.7
Wadsworth & Chatfield Ave.	69.3	66.4	67.4	56.1
Wadsworth & C 470 WB on ramp	16.2	14.7	16.6	19.2
Wadsworth & C 470 EB on ramp	129.4	124.2	97.8	83.3
Wadsworth & Deer Creek Canyon	4.3	3.9	6.1	6
Kipling/Kipling Pkwy & Chatfield Ave.	28.1	29	28.3	28.7
Kipling & Remington	27.2	26.7	26.4	25.4
Kipling & C 470 WB on ramp	8.6	8.7	9.3	22.4
Kipling & C 470 EB on ramp	22.5	22.3	27.9	29

Improvements to the identified intersections were examined to reduce overall peak hour intersection delay associated with the Proposed Action. A sensitivity evaluation was conducted to determine at what year improvements to these intersections would be needed. **Table 18** summarizes the intersection improvements and probable year that these improvements would be required.

The off-system intersections are not impacts and mitigation. The off-system intersections are requirements of the 2035 ultimate configuration.

Table 18: Potential Local Intersection Improvements Summary

Intersection	Year			Intersection Improvement
	2018	2025	2035	
Quebec and County Line	X			Provide three southbound thru lanes, one southbound right-turn lane, and eastbound right-turn overlap phasing
Lucent and County Line	X			Add westbound dual left-turn lanes and change eastbound to shared thru/right-turn lane.
Lucent and Plaza	X			Change eastbound/westbound phasing from split phase to protected left. Add westbound right-turn overlap phasing
Santa Fe and County Line	X			Change westbound to separate single left and through lanes. Change phasing to protected eastbound/westbound left turns.
Quebec and C-470 WB on-ramp		X		Change westbound to dual left-turn lanes and shared through/right-turn lane
University and County Line		X		Add eastbound right-turn overlap phasing
Santa Fe and Blakeland			X	Major improvements TBD by Santa Fe Planning and Environmental Linkages Study

These improvements would fit within the existing ROW of the intersection and would not result in substantial reconstruction. Therefore, minimal impacts to the surrounding area would result.

Utilities Technical Report

For the C-470 Corridor Revised Environmental Assessment

May 2015

Submitted to:
CDOT Region 1
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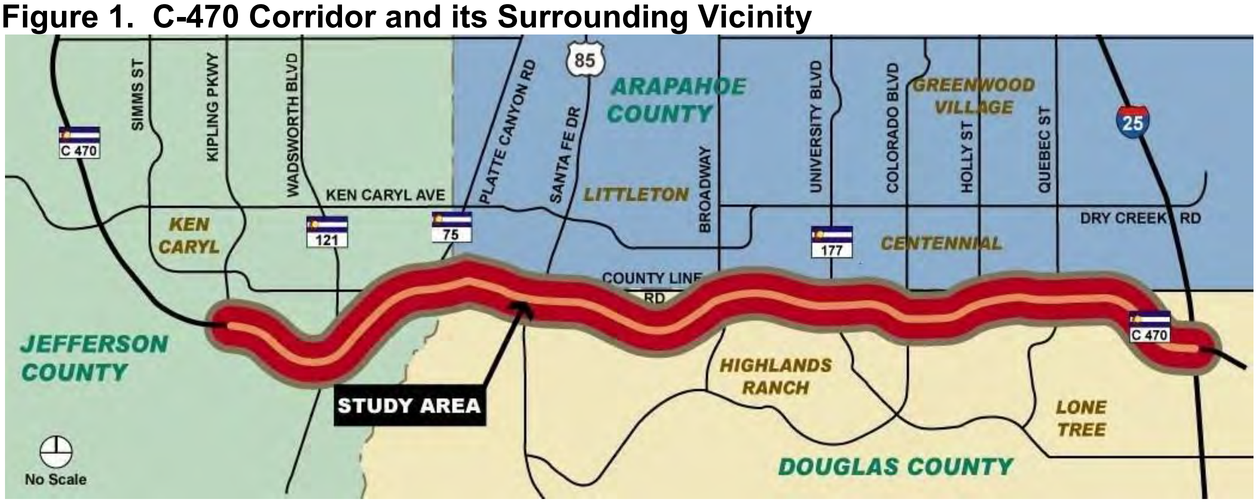
1.0 INTRODUCTION

As the C-470 project is about 13.75 miles long, nearly 400 utility lines closely parallel or cross the highway.
Of these, 34 lines that cross C-470 are considered critical based on the criteria identified in this report.

This Utilities Technical Report examines potential impacts to utilities as the result of proposed improvements to Colorado State Highway 470 (C-470) in the southwestern part of the Denver metropolitan area. Relocation of utility lines can add time and expense to highway construction projects, and so is avoided where possible, but relocation of small and medium sized utility lines is a normal component of highway construction activity. In cases involving certain critical (e.g., very large water supply or sewer) lines, it may be more cost-effective to modify the roadway design than to relocate the utilities. The current conceptual design C-470 Proposed Action has been developed to avoid major utility impacts.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in Figure 1. In 2013, the Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) initiated a Revised Environmental Assessment (EA) for the 13.75-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the Revised EA differs slightly from the Express Lanes alternative identified in the previous EA that was approved by CDOT and FHWA in 2006.

Figure 1. C-470 Corridor and its Surrounding Vicinity



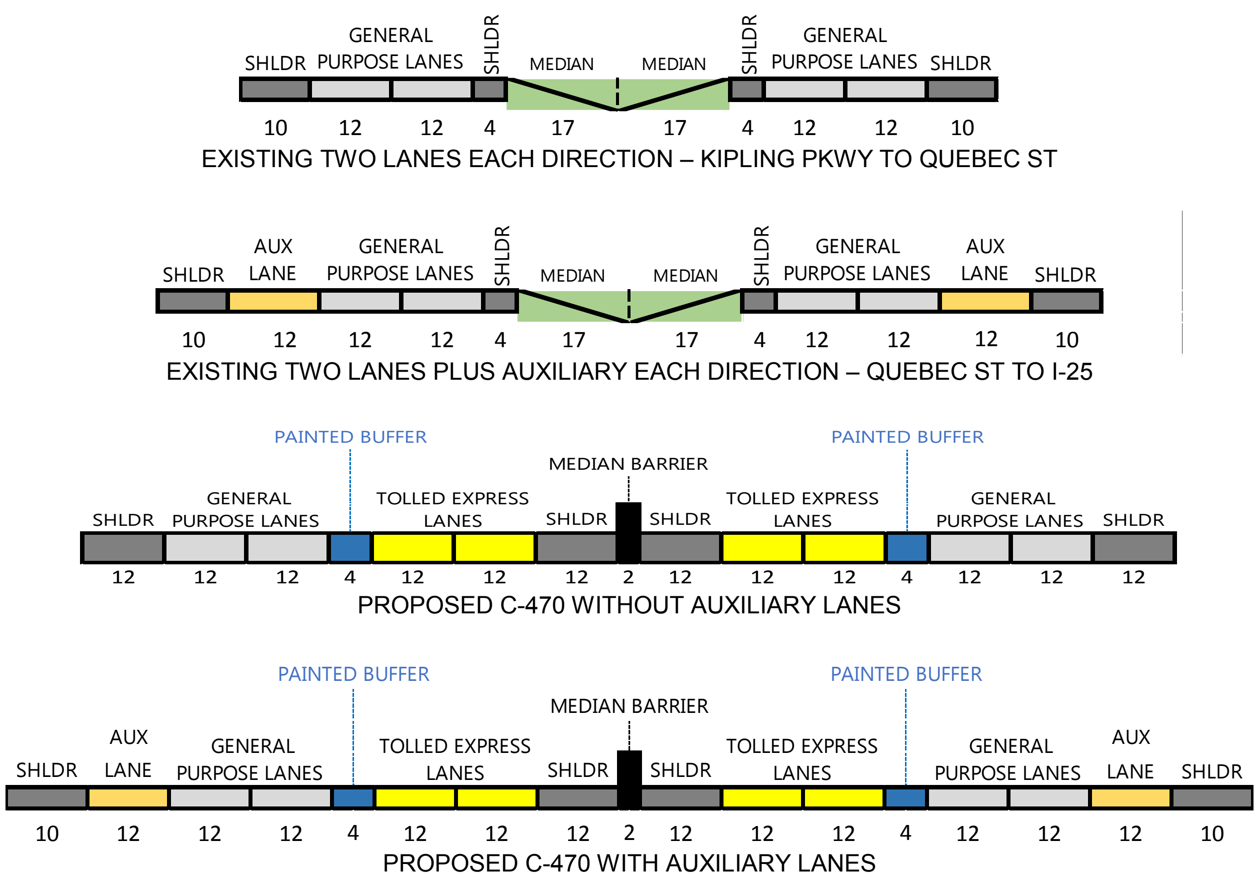
1.1 No-Action Alternative

The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged, but would receive maintenance as needed to ensure the safety and functionality of the existing four-lane freeway.

1.2 Proposed Action

The Proposed Action would add two tolled Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications. However, at the eastern end of the project area, the Proposed Action also includes direct-connect ramps accommodating movements between I-25 and the C-470 Express Lanes. The existing and proposed typical cross sections are shown below in Figure 2.

Figure 2
Existing and Proposed C-470 Typical Cross Sections



2.0 AFFECTED ENVIRONMENT

A complete utility inventory has been prepared for the C-470 corridor and will be included as Table A in at the end of this report. This review identified 184 potential utility resource conflicts used by 18 owner/operators. Many of these utility lines cross C-470, either aerial or underground. A few cross over C-470 along bridges.

Based on discussions with CDOT personnel at the Utility Scoping Meeting held in 2003, only major utilities have been considered for this Environmental Assessment report. Major utilities are defined as follows, per CDOT: water mains and large sanitary sewer lines greater than or equaling 60" in diameter; electrical transmission lines; and fiber optic lines considered critical to national security. Based on these criteria, 34 of the 150 utility lines that cross C-470 are considered critical. These consist of 10 gas lines, 6 water lines, and 18 fiber optic lines.
Table 1 summarizes the potential utility conflicts identified within the Proposed Action.

Table 1
Major Utility Resources Potentially Affected by Proposed Action

Operator	Potential Utility Conflicts		Major	Resource Type
Xcel Energy – Electric	28	15%	3	Electric
CDOT ITS	25	14%	4	Fiber
Denver Water	21	11%	4	Raw and Potable Water
Xcel Energy – Gas	15	8%	7	Gas
Comcast	12	7%	9	Fiber/Cable
Century Link	8	4%	3	Fiber Optic
Zayo	5	3%	3	Fiber Optic
Lockheed Martin	5	3%	5	Fiber Optic
MCI	4	2%	1	Fiber Optic
Irrigation Ditches	4	2%	4	Irrigation
BNSF and UPRR Railroads	2	1%	2	Railroads
Others	55	30%	0	Various
TOTALS	**184**	**(100%)**	**45**	All Types

Figures 3, 4, and 5 depict the locations of the Major utility resources.

Table 2 presents the name and telephone number of for each operator of a utility resource that parallels or crosses C-470. Each person listed was contacted for this project. Many of the fiber optic companies have changed ownership or have changed contacts. The list in Table 2 is current as of 2014.

Table 2
Utility Contact Information

Utility Owner	Contact	Phone
Army Corps of Engineers	Tim Rose	303-979-4120 303-979-0602
AT&T	Guido Aguillard	303-566-6045
CDOT Fiber	Jill Scott	303-512-5805
Centennial WSD	Ryan Edwards	303-791-0430
CenturyLink	Andy Devine	303-792-6298
City of Englewood	Bill McCormick	303-762-2528
City of Littleton	Roger Peterson	303-795-3919
City of Lone Tree	Michael Demmon	303-662-8112
Colorado State Parks - Chatfield	Ryan Eggelton	303-791-7275 303-791-1231
Comcast (South Side)	Patrick Peck	303-603-5441 720-636-3922(cell)
Denver Water	Ray Batts	303-628-6682
Douglas County Governement	Brad Federle	720-346-5783
East Cherry Creek Valley WSD	Glen Bedell	303-693-3800 ext 234
Highlands Ranch Metro District	Forrest Dykstra	303-791-2185 ext 3545
Inverness WSD		303-649-9857
Ken Caryl Ranch WSD	Joe Gallegos	303-979-7424
Level3	Guido Aguillard	303-566-6045
Lockheed Martin Astronautics	Barb Carlsen	303-971-8867 303-971-1259
MCI	David McAllister	800-289-3427
Meadowbrook	Steven Homer	303-913-6514
New Century Energy	Willie Walter	
Northern Douglas County WSD	Sarah Parsley	303-985-3636
Platte Canyon WSD	Scott Morse	303-979-2333
Roxborough WSD	Mike Marcum	303-979-7286
Southgate WSD	Tammi Lantz	303-779-0261
Southwest Metropolitan WSD	Scott Hand	720-726-5025 303-921-1426(cell)
Willows WSD	Joshua Baile	303-770-8625 303-598-9571(cell)
Xcel Energy - Electric Distribution	Karolyn Langley	303-716-2034 303-716-2056
Xcel Energy - Gas	Scott Gomer	303-716-2003
XO Communications	Steve Valdez	801-364-1063
Zayo Group	Richard Benge	303-381-4683

FIGURE 3 – Major Utilities in C-470 Segment between Kipling Parkway and Santa Fe Drive

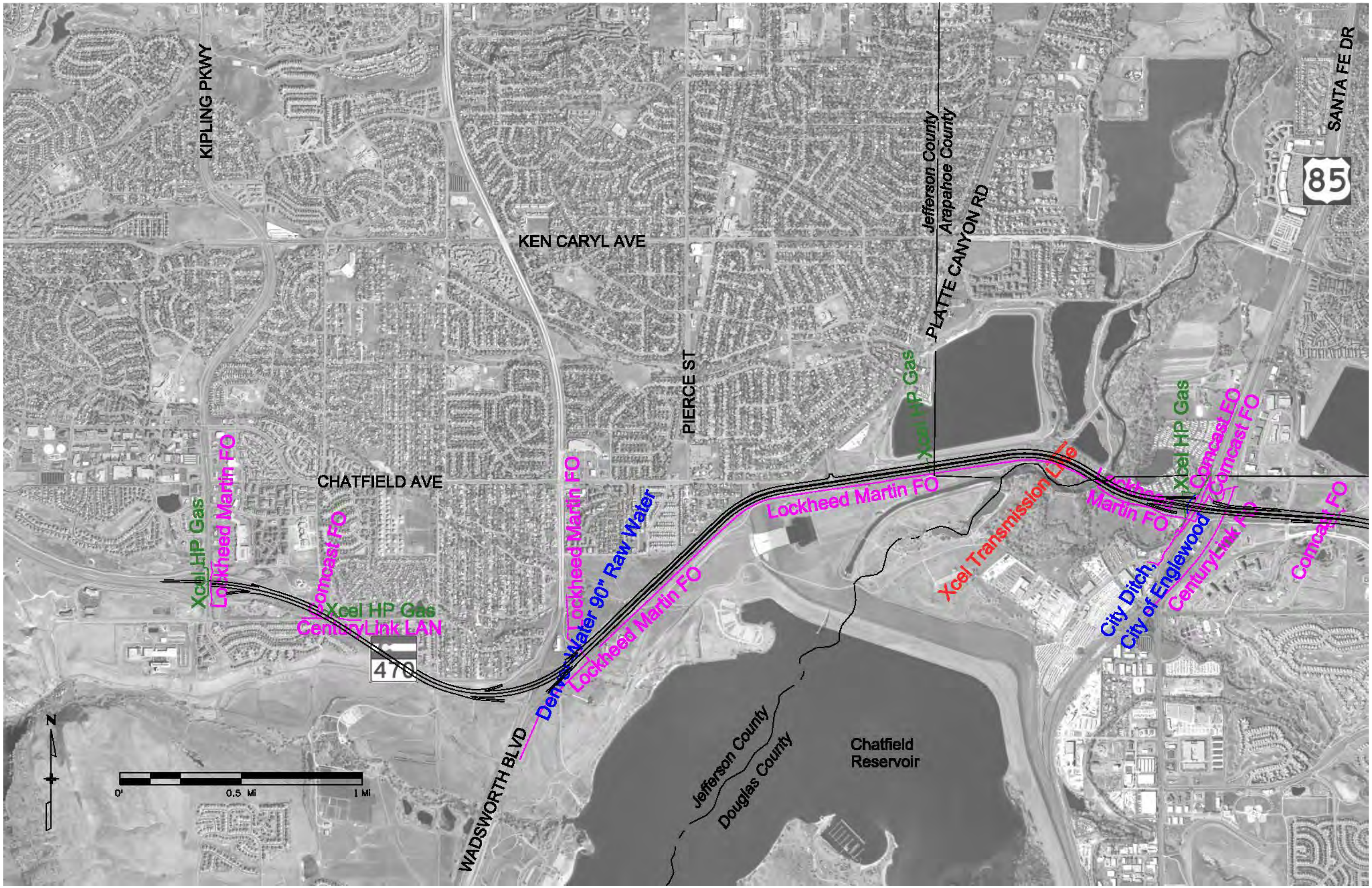


FIGURE 4 – Major Utilities in C-470 Segment between Santa Fe Drive and Colorado Boulevard

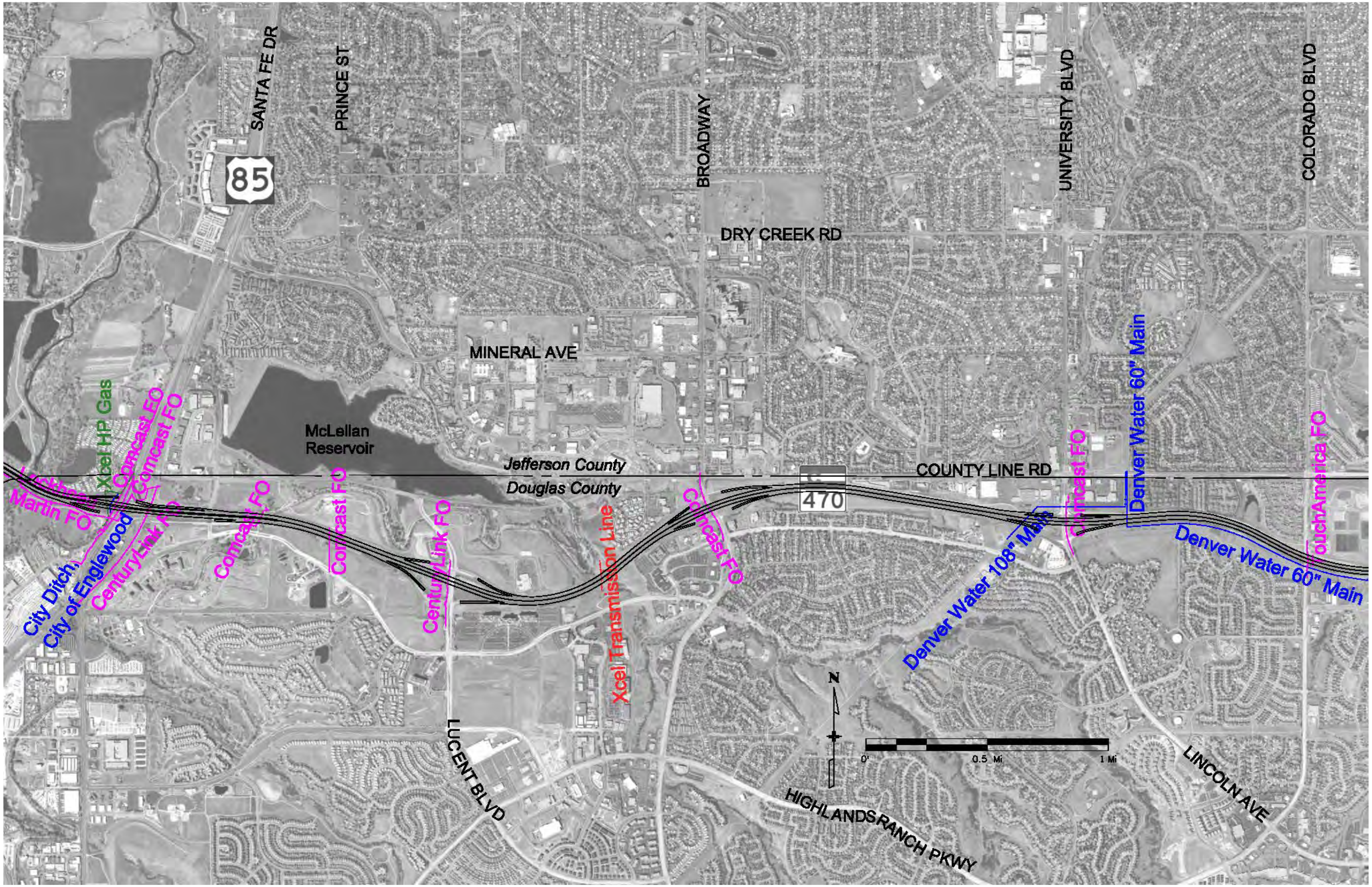
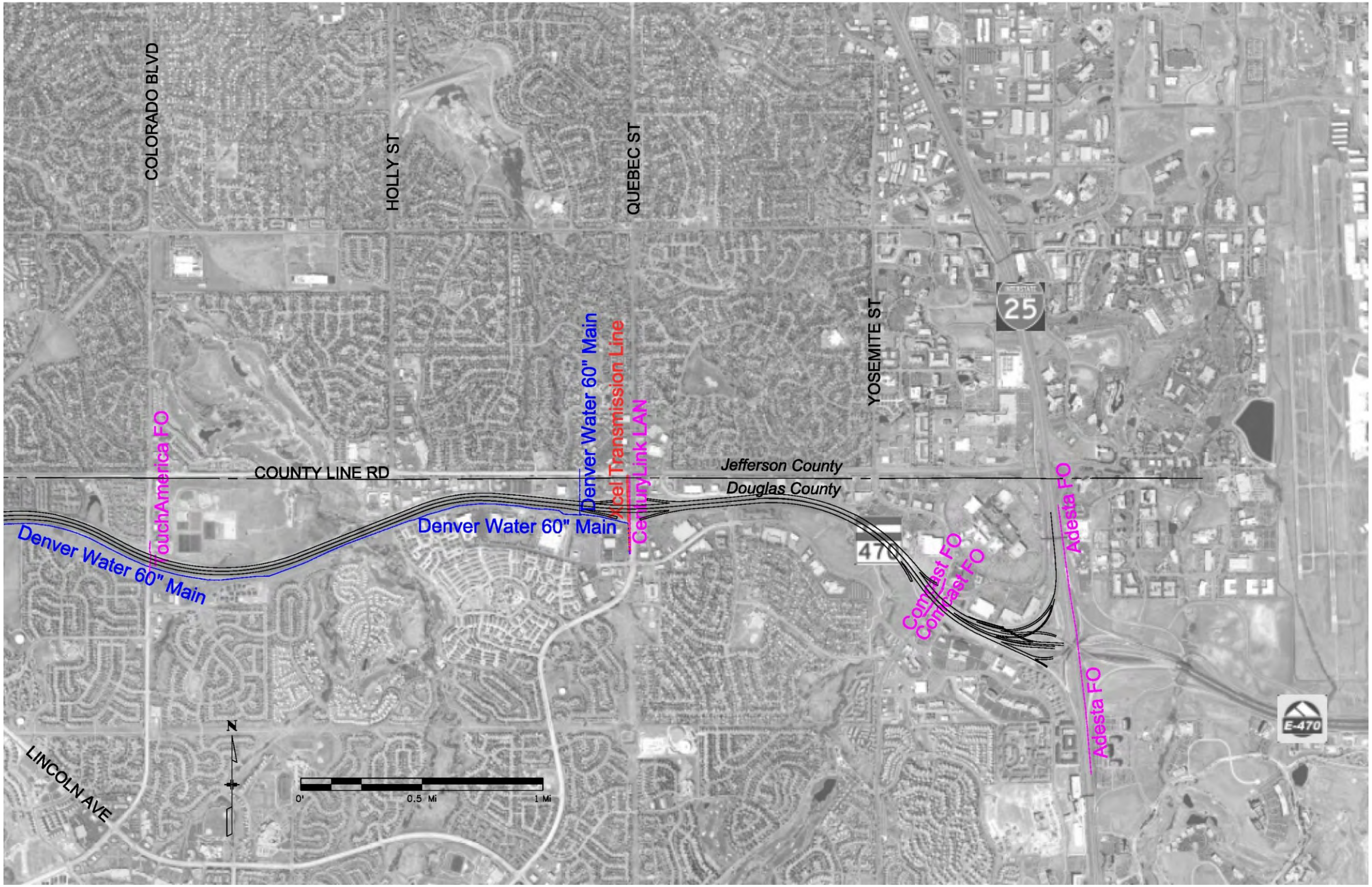


FIGURE 5 – Major Utilities in C-470 Segment between Colorado Boulevard and Interstate 25



For the purpose of this report, utilities have been separated into five subgroups. These subgroups are telephone and communications, electrical and gas, water and sanitary, ditches, and railroads. The major infrastructures are owned mainly by the telephone and communication, electrical and gas, and water and sanitary subgroups. The subgroups describe the type of utility rather than the company that owns the specific facility; for example, the Lockheed Martin fiber optic communication lines in the project corridor are included in the telephone and communications subgroup.

Potential utility impacts were evaluated in segments along the C-470 corridor as follows:

- Between Kipling Parkway and Santa Fe Drive;
- Santa Fe interchange vicinity;
- Between Santa Fe Drive and University Boulevard;
- Between University Boulevard and Interstate 25.

Table 1, presented earlier, indicated that the 34 critical utility resources that cross C-470 consist of 18 fiber optic lines, 10 gas lines, and 6 water resources (notably including the High Line Canal, City Ditch, and a 108-inch diameter water line). Each of these critical lines is described in more detail below. The discussion is organized by project segment and utility type.

2.1 Between Kipling Parkway and Santa Fe Drive

Telephone and Communications: Comcast owns a fiber optic line that crosses C-470 from north to south at Garrison Street, east of Kipling Parkway. This an aerial line using Xcel-owned poles on either side of the C-470 right-of-way. This fiber line provides cable television and internet services and is considered by Comcast to be a trunk line.

In this corridor segment, Lockheed Martin owns three fiber optic lines that are considered critical to national security, as they provide direct communications from Lockheed Martin's Littleton offices to other Lockheed Martin sites and NASA facilities. These fiber lines are buried and have stringent security requirements associated with any potential construction impacts. Any direct impacts to these fiber lines must be approved by Lockheed Martin prior to start of work, and if any fiber line will be exposed overnight, an armed guard must be hired to protect the line. Lines currently existing on the eastern edge of Kipling and Wadsworth, crossing C-470 and running north/south. The line then runs along the southern edge of C-470 all the way to the eastern edge of Santa Fe Drive where it crosses C-470.

Century Link owns one buried fiber optic line that crosses C-470 from west to east near Ute Avenue and Garrison Street.

CDOT ITS maintains a fiber optic backbone along the northern edge of C-470.

Electrical and Gas: Xcel owns one electric transmission line in this segment. Transmission lines provide high voltage power from power plants to large transformers for distribution to local areas. This particular transmission line crosses C-470, north to south, at the Platte River greenway, just west of Santa Fe with existing poles located outside of the easement that C-470 exists within. This line is aerial and primarily supported by large, wooden, column-style towers. The remainder of Xcel electric lines in the area are either distribution lines or lines that feed highway lighting.

Xcel also owns several buried high pressure gas transmission lines in this segment. In Kipling, a single line running north/south is an 8 inch HP gas line. East of Kipling, a 16-inch HP gas line crosses C-470. East of Wadsworth a 10-inch HP gas line crosses C-470. The two most critical gas mains in this segment parallel C-470 north of the highway near the Platte Canyon off-ramp and continuing to the east where they cross C-470 to the south near the county line. Just west of Santa Fe, a 3-inch gas line crosses C-470 to serve the Wolhurst Community. High pressure gas transmission lines are similar in function to electrical transmission lines, in that they provide large volumes of gas for distribution to local areas.

<u>Water and Sanitary</u>: Denver Water owns a 90" raw water main that crosses C-470 beneath the east ramps at Wadsworth Boulevard.

<u>Ditches</u>: The Last Chance Ditch crosses in a conduit under C-470 just east of the Platte Canyon off-ramp. The Nevada Ditch crosses C-470 west of the South Platte River.

2.2 Santa Fe Interchange Vicinity

The Santa Fe interchange vicinity has been considered as a separate segment, as it includes many utilities along Santa Fe (US Highway 85), as well as the corridor's only railroad crossing. Impacts will be refined as design progresses. Some of the utilities along Santa Fe have already been relocated as part of the flyover ramp construction project that was completed in December 2011.

<u>Telephone and Communications</u>: Comcast owns two buried fiber optic conduits in this segment that provide cable television and internet services to businesses and residents. These are considered trunk lines. The first Comcast fiber line crosses C-470 beneath the west ramps at Santa Fe, and is outside of the project footprint to the north and south. The second fiber line crosses C-470 attached to the Santa Fe overpass and continues to the north and south in the southbound lanes of Santa Fe.

Lockheed Martin owns one critical fiber optic communication conduit in this segment. It is part of the same network mentioned earlier and the same security measures apply. The fiber line is buried and crosses C-470 attached to the Santa Fe overpass.

MCI owns one fiber optic communication conduit in this segment that is considered a backbone line. It crosses C-470 on the railroad bridge owned by Burlington Northern and Santa Fe Rail Company (BNSF). The BNSF bridge is the eastern-most of two rail overpass bridges just east of Santa Fe. This fiber line is buried to the north and south of this overpass bridge.

Century Link owns one fiber optic communication conduit that is considered a backbone line. This fiber conduit crosses C-470 on the BNSF bridge, and is buried to the north and south of this overpass bridge.

Zayo owns one fiber optic communication conduit in this segment that is considered a backbone line. It crosses C-470 attached to the railroad bridge owned by Union Pacific Railroad Company (UPRR). The UPRR bridge is the western-most of two rail overpass bridges just east of Santa Fe. This fiber line is buried to the north and south of the overpass bridge.

CDOT ITS maintains a fiber optic backbone along the northern edge of C-470. There is also a north/south fiber optic along the western edge of Santa Fe Drive.

<u>Electrical and Gas</u>: Xcel owns one high pressure gas transmission line in this segment. This gas transmission line is buried and crosses C-470 beneath the west ramps at Santa Fe. Based on information gathered to date, there are no electrical transmission lines in this segment that would be affected by proposed C-470 improvements.

<u>Water and Sanitary</u>: Based on information gathered to date, no major water or sanitary sewer mains in this segment would be impacted by the C-470 Proposed Action.

<u>Ditches</u>: The City of Englewood owns the City Ditch that provides water to Englewood from the South Platte River. This portion of the City Ditch is a buried 58”x36” reinforced concrete pipe that crosses C-470 beneath the west ramps of Santa Fe.

<u>Railroads</u>: The Burlington Northern and Santa Fe Railroad (BNSF) Company owns the easternmost of two rail overpass bridges that crosses C-470 on the east side of Santa Fe. The Union Pacific Railroad Company (UPRR) owns the western-most of the two. Rail companies often attach their own utilities to their rail and structures.

2.3 Between Santa Fe Drive and University Boulevard

<u>Telephone and Communications</u>: Comcast owns four buried and one overhead fiber optic cable conduits in this segment that could potentially be impacted by this project. These fiber lines provide cable television and internet services to residents and businesses and are considered trunk lines by Comcast. The first buried fiber line in this segment crosses beneath C-470, north to south, at the High Line Canal crossing between Santa Fe and Lucent. The second buried fiber line crosses C-470, north to south, east of the High Line Canal crossing, west of Lucent. The third buried fiber line crosses C-470 beneath Broadway, and the fourth crosses C-470 beneath University.

Century Link owns one buried fiber optic communication conduit in this segment that could potentially be impacted by this project. This fiber optic line provides long distance services and is considered a backbone line by Qwest. This critical fiber line crosses C-470 on the west side of the Lucent overpass.

CDOT ITS maintains a fiber optic backbone along the northern edge of C-470. There is also a north/south fiber optic line along the western edge of Santa Fe Drive.

Electrical and Gas: Xcel owns one electric transmission line in this segment that could potentially be impacted by this project. Electric transmission lines are considered critical for maintaining power supply to large areas. This line is aerial and supported in this area by the thin steel-style towers. This transmission line crosses C-470 west of Broadway, with existing poles outside of C-470 right-of-way.

Water and Sanitary: Denver Water owns one major water main in this segment. The 108" inner diameter water main is buried and crosses C-470 beneath the west ramps at University Boulevard. The main parallels the northern right-of-way of C-470 to the eastern ramps of University, where it then extends northward.

Ditches: Denver Water owns one ditch in this segment. It is the High Line Canal, which crosses C-470 between Santa Fe and Lucent. The box culvert that carries the canal under C-470 is not affected by the Proposed Action.

2.4 Between University Boulevard and Interstate 25

Telephone and Communications: Comcast owns two buried, fiber optic cable conduits in this segment. These fiber lines provide cable television and internet services to residents and businesses. Comcast considers both of these to be trunk lines. These lines run parallel crossing C-470 beneath Yosemite.

Century Link owns one buried fiber optic communication conduit in this segment. This fiber line provides local telephone service to residents and businesses and Century Link considers it to be a backbone line. It crosses C-470 at Quebec attached to the overpass.

Zayo owns one buried fiber optic communication line in this segment that was formerly owned by Touch America. This fiber line provides telecommunications services and is considered a backbone line to Zayo. It crosses C-470 attached to the Colorado Boulevard overpass bridge.

Zayo (formerly Adesta fiber optic in this location) owns a fiber optic line that runs along the eastern edge of I-25 through the C-470 interchange.

Electrical and Gas: Xcel owns one electric transmission line in this segment. This aerial line is primarily supported by the thin steel towers. The line crosses C-470 at Quebec Street, just west of the overpass bridge.

Based on information gathered to date, no high pressure gas transmission lines were found to be impacted in this segment.

Water and Sanitary: Denver Water owns two major water mains in this segment. Both mains are buried and are 60" inner diameter conduits. The first main crosses C-470 beneath the east ramps of University Boulevard and parallels the south right-of-way of C-470 to Quebec Street. The second main crosses C-470 beneath the west ramps of Quebec Street.

Based on information gathered to date, no major sanitary sewer lines were found to be impacted by any proposed improvement along the C-470 corridor in this segment.

3.0 IMPACTS TO UTILITIES

3.1 Impacts of the No-Action Alternative

The No-Action Alternative would maintain the existing highway in its existing configuration, with no new construction. No impacts to utilities would result.

3.2 Impacts of the Proposed Action

C-470 highway design will avoid critical utility resources to the degree possible and may require extra efforts to accommodate or relocate those which cannot be avoided. Non-critical utility resources that cross or parallel C-470would be relocated as needed, in accordance with routine practices. Table 3 details what is expected to occur with regard to each of the major utility lines that are potentially affected by C-470. As seen in the table, many of the key utility resources would not be affected by the Proposed Action.

Table 3
Potential Impacts to Major Utility Lines (listed by utility operator)

Owner/Operator		Type	Description/Location	Project Impact
Between Kipling Parkway and Santa Fe Drive				
Xcel	1	Gas	8 Inch In Kipling	No Impact
Xcel	2	Gas	16 Inch Crossing C-470	Potentially Impacted
Xcel	3	Gas	20-Inch North of C-470 east of Platte Canyon – Buried	Potentially Impacted
Xcel	4	Gas	24-Inch North of C-470 east of Platte Canyon – Buried	Potentially Impacted
Xcel	5	Gas	20-Inch Crosses C-470	Potentially Impacted
Xcel	6	Gas	24-Inch Crosses C-470	Potentially Impacted
Comcast	7	Fiber/ Cable	Crossing C-470 aerial at Garrison	Potentially Impacted
Century Link	8	Fiber Optic	Crossing C-470 UG at Garrison	Potentially Impacted
Lockheed Martin	9	Fiber Optic	In Kipling – Bridge Widening	Potentially Impacted – pothole and avoid
Lockheed Martin	10	Fiber Optic	In Wadsworth – bridge widening	Potentially Impacted – pothole and avoid
Lockheed Martin	11	Fiber Optic	Crossing C-470 east of Wadsworth	Potentially Impacted – pothole and avoid
Lockheed Martin	12	Fiber Optic	South of C-470	No Impact
CDOT ITS	13	Fiber Optic	North of C-470	Impacted – relocated with ITS/Tolling design

Table 3 (continued)
Potential Impacts to Major Utility Lines (listed by utility operator)

Owner/Operator		Type	Description/Location	Project Impact
Between Kipling Parkway and Santa Fe Drive				
Denver Water	14	Raw Water	90-Inch east of Wadsworth	No Impact – pothole and avoid
Xcel	15	Electric Trans.	Aerial west of Platte River	No Impact
Last Chance Ditch	16	Irrig.	UG in conduit east of Platte Canyon	No Impact
Nevada Ditch	17	Irrig.	UG in conduit west of Platte River	Potentially Impacted – pothole
Santa Fe Interchange Area				
Comcast	18	Fiber/Cable	Crosses west ramps	Potentially Impacted – pothole
Lockheed Martin	19	Fiber	In Bridge running north/south	Potentially Impacted – pothole
MCI	20	Fiber	In railroad bridge	No Impact
Century Link	21	Fiber	In railroad bridge	No Impact
Zayo	22	Fiber	In railroad bridge	No Impact
CDOT ITS	23	Fiber	North of C-470	Impacted – relocated with ITS/Tolling design
Xcel	24	Gas.	3-Inch	Potentially Impacted – pothole
Englewood – City Ditch	25	Irrig.	In conduit crossing C-470 west of Santa Fe bridge	Potentially Impacted – pothole
UPRR	26	Railroad	Crosses east of Santa Fe	No impact – railroad C&M process
BNSF	27	Railroad	Crosses east of Santa Fe	No impact – railroad C&M process
Between Santa Fe Drive and University Boulevard				
Comcast	28-32	Fiber/Cable	Aerial and UG in 5 locations	Potentially impacted – pothole
CDOT ITS	33	Fiber	North of C-470	Impacted – relocated with ITS/Tolling design
Xcel	34	Electric Trans.	Aerial crossing C-470	Not impacted
Denver Water	35	Water	108-inch west of University	No impact – avoid
Denver Water	36	Irrig.	Highline Canal – box culvert	No impact
Between University Boulevard and I-25				
Comcast	37-38	Fiber/Cable	UG	Potentially impacted – pothole
Century Link	39	Fiber	Quebec bridge	Potentially impacted – pothole
Zayo	40	Fiber	In Colorado Boulevard bridge	No impact
Zayo	41	Fiber	East of I-25	No impact
Xcel	42	Electric Trans.	West of Quebec – protect poles	No impact
Denver Water	43-44	Water	Two 60-inch water mains	Potentially impacted – pothole
CDOT ITS	45	Fiber	North of C-470	Impacted – relocated with ITS/Tolling design

In some locations, the existence of major utility lines parallel to C-470 creates potential design conflicts that would preclude various other project mitigation features, such as creation of a water detention pond or a noise berm. These issues have been considered in the conceptual design of the Proposed Action to identify solutions that best balance any conflicting needs.

4.0 MITIGATION MEASURES

Common, minor utility impacts are relatively simple to mitigate. In general, when a privately owned utility is located within public right-of-way, the owner company is responsible for relocating the utility to accommodate a public improvement project. This usually applies to telephone and communications and electrical and gas subgroups. When a publicly held utility must be relocated to accommodate a public improvement project, it is generally the project's (CDOT's) responsibility to fund the related construction for relocation. Publicly held utilities generally fall under the water and sanitary subgroup.

5.0 NEXT STEPS

Utility assessment for this Revised EA was prepared based on the generally known locations of utility lines for the purpose of identifying impacts and constraints. In the proposed project design/build process, the next stage of utility coordination is the need to develop more detailed design information. Engineering "locates" (location determinations) should be performed and a field survey of the locates should be completed. Any utility company that will be impacted by construction during this project will be notified. A potholing plan will be devised to determine any subsurface utility conflicts and more precisely locate any utility lines that could potentially be impacted. Any remaining conflicts will be resolved by relocation of that utility or additional roadway design modifications.

Visual and Aesthetic Character Technical Report

For the C-470 Corridor
Revised Environmental Assessment

January 2015

Submitted to:
CDOT Region 1
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2015 UPDATE TO 2005 REPORT

This report examines how the proposed roadway improvements would change the look or visual character of Colorado State Highway C-470, between Kipling Parkway and Interstate 25, in the southwestern portion of the Denver metropolitan area. In 2013, CDOT and FHWA began evaluating impacts of a slightly revised Proposed Action in the same location as the alternative that was studied previously in the C-470 Environmental Assessment (EA) that was approved by these same agencies in 2006.

C-470 is located about 13 miles south of downtown Denver. It passes through Arapahoe, Douglas, and Jefferson counties, as shown in Figure 1. CDOT and FHWA have initiated the Revised EA for the 13.75-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users.

Figure 1
C-470 Corridor and its Surrounding Vicinity

The Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes would be provided between closely spaced interchanges (e.g., one mile apart). The typical cross section would vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications.

An extensive previous version of this report was completed in August 2005, and was included in the technical compendium for the approved 2006 C-470 EA. Since that time, two notable changes to the C-470 setting have occurred, and there have been notable changes to the proposed improvements. These changes are as follows:

- The preferred alternative in the 2006 EA included a proposed flyover ramp carrying traffic from southbound Santa Fe drive to eastbound C-470, beginning near the Wolhurst (mobile home) Community north of the Santa Fe interchange. That flyover ramp has been constructed as a separate safety project and is now part of the existing setting. The flyover ramp and its visual impacts are not part of the 2015 Proposed Action.

- The 2005 report noted that a gravel pit located north of C-470 and east of Platte Canyon Road was planned to be converted to a water storage reservoir in the very near future. That conversion has taken place. The gravel pit has been replaced by the 6,480 square-foot South Platte Reservoir.
- The 2015 C-470 Proposed Action now includes a buffer separation (pavement with painted striping) rather than a raised concrete barrier to separate the planned new managed express (toll) lanes from the general purpose (free) lanes, for each direction of traffic. Thus, the 2015 Proposed Action would have a more open feeling than the prior proposal.
- The 2015 Proposed Action does not include any proposed direct access ramps. The 2006 preferred alternative had called for new ramps connecting the inside lanes of C-470 to the middle of the existing Colorado Boulevard bridge that crosses over the freeway.

For clarification, the proposed managed express lanes would use modern toll collection technologies that do not require any tollbooths. The use of tollbooths on toll highway E-470 (which is connected to C-470 at the eastern terminus of the project) was discontinued in July 2009, in favor of all-electronic toll collection methods.

The August 2005 C-470 Visual and Aesthetic Character Technical Report was 241 pages long, because its 13 pages of text were accompanied by exhibits of design features, a copy of CDOT design guidelines, correspondence records and a bibliography. The August 2005 report is incorporated by reference so that those details do not need to be repeated here.

The 2015 Proposed Action is similar to the 2006 preferred alternative, in that it would add two express lanes in each direction, but no longer includes the Santa Fe flyover, Colorado Avenue direct access ramps, or concrete barriers for lane separation. The 2015 Proposed Action thus has notably reduced visual impacts. CDOT has not revisited the prior mitigation details that were identified through extensive interagency and public involvement, but will implement the previously identified mitigation as appropriate.

The 2005 analysis has been updated in 2015 to reflect the changes discussed above, but is otherwise little changed from its original version. The following pages describe the project's setting, anticipated impacts and proposed mitigation.

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1.0 INTRODUCTION

1.1 Resource Definition

During the process of assessing potential changes to the environment, it is important to consider how the proposed C-470 improvements would change the look or visual character of an area. This is typically done by defining view sheds from the highway, both away from the highway as a driver would see the views, and back towards the highway as a resident would perhaps see the highway.

View sheds are defined as being either natural or manmade vistas which are viewed within a given setting or location. Usually outer boundaries for view sheds are apparent, such as the edges of a city's downtown, or the bound limits of a specific park. Outer boundaries can also be expansive, such as the extents to which one can physically see.

For this C-470 visual impacts analysis, five such vistas were identified and defined as important view sheds for the southwest region of Metropolitan Denver. These vistas captured the visual essence of the quality of life people choosing to live in this area value. People are attracted to the natural setting the region offers, with the convenience of being close to the economic vitality of both the Denver Technological Center and Denver's Downtown Central Business District.

> Five distinct view sheds were identified along the 13.75-mile C-470 project area.

Another important consideration in assessing visual changes is the aesthetic treatment of the facility itself. In order to create a unifying identity for the entire C-470 corridor, consistently themed treatments of specific structural elements, engineering features, and landscaping should be maintained throughout.

1.2 Report Overview

This technical memorandum describes the visual and aesthetic impacts and mitigation measures that would be necessary for the C-470 Proposed Action, as described in the C-470 Environmental Assessment document. First, the related plans and policies used to perform the visual analysis are described, and the existing conditions in the C-470 corridor, including any relevant future conditions that are planned. The memorandum then explains the methodology used to perform the visual analysis, and how both the Proposed Action would affect the existing visual qualities or offer unique structural features, compared to the No-Action Alternative. Finally, the memorandum identifies mitigation measures that have been incorporated or would be implemented to mitigate adverse impacts and offer an Aesthetic Treatment Plan to maximize corridor visual consistency.

The visual analysis was conducted using the guidance of *FHWA Technical Advisory Report T6640.8A*; 23 *U.S.C. 101, 109, 138, 319*; *49 U.S.C. 303, 5301, 5312, 5324, 55, Subchapter II*; *Visual Impact Assessment Manual for Highway Projects* (FHWA HI 88-054, 1988); and *Esthetics and Visual Quality Guidance Information*, (FHWA, 1986).

2.0 AFFECTED ENVIRONMENT

2.1 Related Plans and Policies

CDOT's regional office serving the Denver metropolitan area has developed a set of standards for each corridor in their jurisdiction. These standards are contained in the document *Urban Design for Region 6*, July 2003, and were used as a baseline for maximizing visual consistency in the corridor. These standards are part of the Administrative Record for this Environmental Assessment. Due to an internal CDOT reorganization in 2013, Region 6 no longer exists, but the referenced design standards remain in place, now administered by Region 1.

In the 2005 analysis, cities and counties along C-470, as well as the State Historical Preservation Office, were asked if any visual inventory or guidelines have been conducted or used by their entity in the past for the C-470 corridor. No past records could be found, and therefore none were used in this analysis.

2.2 Description of Existing Conditions

2.2.1 General Overview and Aesthetics

Built in the late 1980s, C-470 lies in the southwest quadrant of the Denver metropolitan region, having portions in Jefferson County, Douglas County, and Arapahoe County. This 13-mile stretch of east-west highway from Kipling Parkway to I-25 serves local residents, commercial traffic, tourists, and motorists making longer, regional trips.

C-470 is a visually appealing corridor, both to tourists traveling through the area headed towards the Rocky Mountains and to the local community. Over 80,000 vehicle trips use C-470 every day, with motorists and their passengers taking in the views and character of the highway. The Dakota Hogbacks (foothills to the Rocky Mountains) are a dominant visual feature, seen to the west from many views along C-470, as in Figure 2.

Figure 2
Dakota Hogbacks as Seen from C-470 Project Western Terminus)

The Hogbacks provide a unique visual identity for the Denver Metropolitan Area, different from other cities in Colorado, even along the Front Range of the Rocky Mountains. They contribute to the quality of life for the community and are a draw for the promotion of tourism.

The views of Chatfield State Park, including both the reservoir and the dam, are another striking visual feature as one drives along C-470. This is a 300-acre recreational facility in the area, and also provides flood control for the region. It is maintained by the U.S Army Corps of Engineers (USACE) and provides an attractive expanse of undeveloped land and water, amongst the highly developed housing areas surrounding the park.

In general, over the last few decades, there has been a gradual loss of undeveloped or natural areas in the C-470 corridor due to urban development (see example, Figure 3). As a result, C-470 is becoming visually confined. The foreground in places is becoming highly suburbanized. As residential vegetation grows, it will enhance the character of the landscape from open meadow to urban and suburban development. Large patches of undeveloped land are found along the highway in the Highlands Ranch area.

Figure 3
Residential Development along Westbound C-470, West of Colorado Boulevard

However, there are still some natural areas, like the previously mentioned Chatfield State Park, that can still be viewed from the highway. Other areas include both the South Platte Park and the McClellan Reservoir. Natural features such as creeks, gulches, and smaller open fields can be seen along C-470 as well. The Biological Resources Technical Report for the Revised EA notes that there are 20 active prairie dogs colonies along C-470, and some of these are immediately adjacent to the highway.

The C-470 corridor also has its share of less attractive views, including commercial buildings, car dealerships, and a gravel and sand supply pit. Furthermore, the highway generally has relatively minimal, low-maintenance landscaping.

Noise walls built by CDOT exist in a few locations along C-470. In other locations, privately built walls or fences block views to and from various residential areas. The CDOT noise walls near Santa Fe Drive and Wadsworth Boulevard were constructed with a generic CDOT Region 6 design and treatment, using a color scheme that does not completely match the existing bridges along the corridor. The walls do contain subdued colors that do not detract or distract from the surrounding views beyond. Better aesthetics are displayed on the wall near Platte Canyon Road, shown in Figure 4.

Figure 4
Noise Wall North of C-470 and West of Platte Canyon Road

The Centennial Trail runs the length of the C-470 corridor and can be seen from the highway in numerous locations. It is particularly prominent in undeveloped areas where there is minimal visual clutter behind it (see example, Figure 5). It is paved, well marked, and well used. By having the trail parallel to the highway, a multi-modal functioning facility is brought to the public's attention, creating a user friendly corridor.

Figure 5
Centennial Trail as Seen from Westbound C-470, West of Colorado Boulevard

A few specific issues of concern adjacent to the corridor were recognized while conducting the visual analysis. Both Lone Tree and Douglas County use the Quebec Interchange as gateways to their communities, to the north and to the south, respectively. Community signs and designation features have been placed on Quebec at each gateway, and should be maintained.

A new flyover ramp carrying traffic from southbound Santa Fe Drive to eastbound C-470 was opened to traffic in December 2010. This flyover ramp (see Figure 6) was discussed in the 2006 C-470 EA as part of the preferred alternative but was subsequently constructed as part of safety improvements at that interchange. Therefore, the flyover ramp is not part of the 2015 Proposed Action but instead is now part of the existing visual conditions of the corridor.

Figure 6
Santa Fe Flyover Ramp as Seen from Westbound C-470

Retaining walls, bridges (both overpasses and underpasses), and guardrail were constructed with generic CDOT design and treatment as well. However, no effort was made to maintain a consistent theme to unify these elements throughout the corridor. Most of the bridge, retaining wall, lighting, signage, guardrail and other design elements existing today are the same as the original C-470 design standards. A notable exception is that the structures for overhead signs are the new CDOT standard mono tube sign supports and sign bridges.

2.2.2 View Sheds

For the purposes of this Environmental Assessment, the study area has been defined by five different view sheds including cultural, natural, and recreational areas. Listed in order from the west end of the study area to the eastern end, these are:

- Dakota Hogbacks View Shed
- Chatfield State Park View Shed
- McClellan Reservoir and South Platte Park View Shed
- Downtown Denver Skyline View Shed
- Denver Tech Center View Shed

Dakota Hogbacks View Shed

The Dakota Hogbacks View Shed is located on the western end of C-470, and extends as far as one can see both to the south and to the north. This view shed can be divided into thirds for description purposes: southern, middle, and northern. Both the southern and northern thirds are usually viewed under hazy conditions, with no specific details of the terrain able to be made out. The middle section creates the distinct “Colorado feel” of living close to the Rocky Mountains. Natural drainage ways, ridges, and native vegetation can be seen from C-470. Mountain Range views create a visual dimension to the skyline and add depth and interest to the viewer. A photo of the Dakota Hogbacks formation was presented earlier, in Figure 1.

Chatfield State Park View Shed
The Chatfield State Park View Shed extends from C-470 on the north, to the edges of Chatfield State Park on the south, west, and east, bounded by Wadsworth and Santa Fe. The focal point of this view shed is the Chatfield Reservoir and adjacent dam. The surrounding natural grasslands with low-density forested areas incorporate the remaining stretches of this view shed. The Chatfield State Park View Shed is the only view shed on the southern side of the C-470 corridor, and provides a visual break from the surrounding urban infill (see Figure 7). Views of water are highly coveted by residents of Colorado because of water’s scarcity in a semi-arid ecological zone.

Figure 7
Chatfield State Park as Seen from Eastbound C-470,
East of Wadsworth Boulevard

McClellan Reservoir and South Platte Park View Shed
The McClellan Reservoir and South Platte Park View Shed extends from just west of Santa Fe to just west of Broadway, on the northern side of the C-470 corridor. The primary focal point of this view shed is the McClellan Reservoir, seen in Figure 8. McLellan Reservoir is not immediately adjacent to the highway, while South Platte Park abuts it. The surrounding forest in the South Platte Park provides a rural look amidst the residential populations in the area. Trails can be seen running through the Park and near the Reservoir. Again, views of water are highly coveted by residents of Colorado because of water’s scarcity in a semi-arid ecological zone.

Figure 8
McLellan Reservoir as Seen from Westbound C-470, West of Lucent Boulevard

Downtown Denver Skyline View Shed

The Downtown Denver Skyline View Shed can be viewed as a backdrop to the north, when passing over University while traveling on C-470. The foreground is filled with commercial and residential units, as well as fully developed urban landscaping. Many of the roadways providing a network to get into and out of downtown Denver can also be seen from this view shed. The view to downtown Denver is distant and is only successful on days with good visibility. This view denotes the sense of commerce and activity, leaving the natural mountain and recreational scenes viewed to the west. In Figure 9, looking north, the downtown Denver skyline is highlighted in an oval, at the horizon.

Figure 9
Downtown Denver Skyline
as Seen from Westbound C-470 Bridge over University Boulevard

Denver Tech Center View Shed

The Denver Tech Center View Shed can be seen from C-470 by looking northward when passing over the Broadway and University interchanges. Although less dramatic then the Downtown Denver Skyline, it contains the commercial buildings that make up Denver's southern business community. The foreground of this view shed is also filled with commercial and residential units, as well as fully developed urban landscaping. This view also denotes the sense of commerce and activity. The office buildings that comprise the Denver Tech Center have been highlighted with an oval in Figure 10.

Figure 10
Denver Tech Center as Seen from Eastbound C-470, East of University Boulevard

3.0 ENVIRONMENTAL CONSEQUENCES

3.1 Methodology for Impact Evaluation

Feedback was obtained from CDOT project managers on the desired level of detail to be completed for the visual analysis. This level was determined by expected agency and public interest and sensitivity. An advanced level of detail was desired, which includes two-dimensional treatment examples; development of corridor standards with elements specific to alternatives including forms, textures, and shapes; and detailed corridor animations to illustrate potential visual treatments for the project alternatives.

After discussions with city and county stakeholders, a decision was made to apply corridor wide visual treatment standards to all design elements for overall consistency throughout the corridor. Cities and counties would have the ability to upgrade features of interchange treatments by providing additional funding for design, landscaping, aesthetic treatments, construction, and maintenance.

Relevant data was collected for the C-470 corridor including aerial photographs, corridor photographs, and maps. A field inspection was performed, noting the location of sensitive visual areas, locations of visual issues and view sheds, and unique community architectural features. This information was mapped. For both the General Purpose Lanes and Express Lanes Alternatives, the visual impacts on adjacent areas and view sheds were determined. An assessment of visual quality was made, based on the regulatory guidelines listed previously. Visual qualities and unique structural features of the Alternatives were disclosed, as well as their impact to the host community. An Aesthetic Treatment Plan, mitigation options, and areas for additional community support were then developed. Options for aesthetic treatments of the proposed highway improvements were explored and include landscaping, architectural design elements, and barriers during construction phases.

3.2 Identification of Anticipated Impacts

Potential visual impacts associated with the No-Action Alternative and the Proposed Action are described below.

3.2.1 No-Action Alternative

The No-Action Alternative would result in some visual impacts along the highway. Without additional corridor improvements, further deterioration of existing levels of service along the C-470 corridor would occur as traffic volumes increase. Congestion and delay currently experienced during peak traffic periods would increase and extend through more hours of the day. Increased traffic volumes and congestion would make the existence of C-470 more visually apparent. This visual impact would occur in all view sheds. The C-470 corridor would continue to have an assortment of highway elements and treatments that were built over the past twenty years, prior to the development of the Region's design guidelines. Without a transportation improvement alternative, there would be no implementation of consistent corridor standards, as no one entity would be responsible for overseeing the task.

3.2.2 Proposed Action

The Proposed Action would affect the visual character of the corridor in various ways. Wider pavement sections would be noticeable with the elimination of the existing grassy median. Interchanges would have larger foot prints, as the ramps are pulled back for safe geometric design. The longer ramps will result in the need for more retaining walls and barriers near the intersections. These larger interchanges will also be in need of more overhead lighting for safety reasons.

The managed express lanes would have toll collection gantries at every access point, which will distract from the views at these locations. Additional signage will also be needed, both roadside and overhead, to inform motorists of their options for toll lane ingress and egress. This would include some signage outside of the roadway construction limits, providing advance information to motorists. Advance signage would be needed as follows:

- eastbound on C-470, west of Kipling Parkway
- westbound, on E-470, east of I-25
- northbound on I-25, south of C-470
- southbound on I-25, north of C-470

The three locations listed above for the eastern project terminus are in the vicinity of a freeway-to-freeway interchange, already "busy" with signage.

> The Proposed Action could result in addition of several new noise barriers, ranging from 12 to 20 feet high. This would affect the visual character of the C-470 corridor.

As traffic levels increase on C-470, more noise walls will need to be constructed for adjacent residential communities. These noise walls would block views to and from the corridor, and create a more urban feel along the Corridor. However, walls would be added only where there is existing development needing noise relief, not in scenic, open areas. For the number and size of recommended noise barriers, please see the *Noise Technical Report* which is included as a separate appendix to the Revised EA.

With new water quality regulations in place, numerous water quality ponds would need to be constructed along the corridor. These would be visible from the highway, some positively impacting the corridor by providing breaks from the commercial and residential terrain that currently exists. Others would impact the corridor negatively, adding more concrete in the region to line the ponds. The 2006 EA recommended creation of 53 new water quality ponds, but now a smaller total is expected as the result of interagency cooperative detention solutions pursued for the Revised EA.

The addition of retaining walls in various locations would be necessary to minimize effects to environmentally sensitive areas, prevent the need for excessive ROW acquisition, and to avoid the need to modify CDOT's U.S. Army Corps of Engineers easement along the northern boundary of Chatfield State Park.

The C-470 interchange at Interstate 25 would include wider interchange ramps, but will not be visually distracting, and instead would blend into the interchange that currently exists. This location is already a busy freeway-to-freeway interchange with a very urban character.

Elements of the Proposed Action with visual impacts include: increased traffic, added lanes, toll information signage and collection equipment, noise barriers, water quality ponds, and retaining walls.

The five identified view sheds along the C-470 corridor would not be visually impacted by the Proposed Action. Additional temporary visual impacts would be seen at many locations along the corridor while the construction of the improvements for this Alternative takes place.

4.0 MITIGATION MEASURES

To mitigate adverse visual impacts of the Proposed Action, CDOT is committed to providing and maintaining standard architectural treatments for the C-470 Corridor. After discussions with stakeholders along the corridor, a set of standards was created using existing features and unifying elements. Common themes were sought to be maintained throughout the corridor, in order to provide a uniform suburban corridor look. Color will be added where practical and subtle changes will be made to existing features in order to avoid reconstruction to the many architectural treatments in the existing corridor. The original colors used throughout the original C-470 corridor are to continue to be used on all bridges, lights, sign structures, sound barriers, retaining walls and concrete railings. In addition, an accent pin stripe has been added to the exterior side of the new bridge rails and the top of sound barriers and retaining walls.

The following summarizes the architectural standards to be used throughout the corridor.

- For bridge piers, a standard straight wall pier or a standard step pier with tapered ends will be used. Many of the existing bridge piers are in these shapes, and CDOT will maintain these themes for consistency.
- For any bicycle and pedestrian path overpasses, piers will be tapered in the lower section, and pier caps will be used in the upper sections of the piers.
- Abutments to the bridges will be slope paved at all overpasses and underpasses, as this is the standard method existing today.
- Standard Type 7 concrete bridge rails formed in the safety shape will be used to maintain pleasing proportions throughout the corridor.
- Where noise mitigation walls are deemed feasible and reasonable according to CDOT's noise mitigation policy, masonry block single wye noise walls will be used.
- The many retaining walls that are needed throughout the corridor will contain textures of basic geometric shapes, with caps on every wall.

Toll-related features such as overhead toll collection devices and signage will follow a region-wide standard, consistent with other tolled roadways in the Denver region. The specific design for these elements in the C-470 corridor will remain flexible at present in order for the future addition of these unifying toll road elements.

Architectural upgrades will be allowed, with CDOT's approval, to enable for city and county stakeholders to bring their communities' unifying elements into the C-470 Corridor. For example, upgrades may include textured sound walls, additional landscaping, or bridge identification markings. In some areas, additional community support should be sought by the city and county stakeholders in order to gain public acceptance of the planned visual appearance of the corridor. In order to maintain a consistent appearance for the Corridor, an Aesthetic Treatment Plan, or menu of design features, has been set by CDOT from which stakeholders may select their upgrades. Stakeholders wishing to upgrade architectural elements will be responsible for funding the construction of and maintaining the elements chosen.

The following summarizes the upgrade architectural standards to be used throughout the Corridor by stakeholders, if desired.

- Enhancement of bridge abutments may be made using one of two methods - architectural improvements in the concrete or landscaping design.
- Landscaping could be done using a tiered approach to break up large retaining walls, or by using a free-form design.
- If desired, bridge rail may be upgraded by thickening the rail to enhance the proportions of the rail depth. A colored pin stripe may also be added to the rail for the purpose of defining specific C-470 bridges. The pin stripe color must blend with existing color schemes in the corridor.

- Another option is to include street names cast in the concrete of the bridges.
- Stakeholders are encouraged to avoid using visually thin bridge decks, so as not to disrupt the proportions in the corridor.
- Where noise mitigation walls are abutting residential property, stakeholders may elect to enhance the residential side of the walls. The affected community should be involved in the selection process. Consistent coloring schemes must be used for the noise walls, but stakeholders will have flexibility in textures, materials, and patterns on the walls, within CDOT's standards.
- Retaining walls located along C-470 may be enhanced by using a variety of patterns including both greater textured choices, and choices with smoother finishes. Selection of the retaining wall treatments may involve seeking community input where necessary. In some areas, retaining walls may also tier back or contain landscape, in order to break up larger heights

Generally, retaining walls along C-470 would be constructed in a manner with forms and textures consistent with CDOT design standards and existing features along the entire corridor. However, retaining walls constructed near Chatfield State Park will be textured and colorized to match the native grasses present. The largest retaining wall near the Chatfield Dam will be tiered to provide a visual break in the height of the wall. CDOT will continue to work with Chatfield State Park during the final design stage, on developing the exact details for the retaining walls in this area.

Lone Tree and Douglas County have also expressed interest in maintaining the gateways to their communities from the Quebec interchange. CDOT will work with these stakeholders to compromise on unique architectural upgrades in this area as well, but with financial responsibility falling on the city and county. Public processes may be applicable to enhancing these gateways.

CDOT is also recommending providing visual continuity with the E-470 corridor, but with the opportunity for local diversity. By doing this, CDOT will help preserve and enhance regionally significant natural areas in accordance with goals set from the E-470 corridor. Two of the enhancements mentioned in the standard aesthetic treatment plan for C-470 are used by E-470 currently – both the thickened bridge rail to enhance proportions, and the pin stripe concept, with red being the chosen color.

Throughout the final design and construction phases of this project, CDOT will continue to work with the involved cities and counties as well as the public stakeholders to ensure a desirable visual character for the C-470 corridor is constructed.

5.0 SUMMARY

The conclusions of this report were based on a thorough analysis of the most current visual and aesthetics information available. Visual impacts were refined according to the latest available conceptual design for the Proposed Action, and will be refined further throughout final design. Therefore the impacts identified in this report are also subject to change during the final design stage.

The Proposed Action will affect some of the existing view sheds along C-470, but will provide additional enhancements to the architectural elements that help unify the corridor. Continuous communication with affected communities will be maintained to ensure a proactive process in creating a visually pleasing corridor.

Water Quality Technical Report

For the C-470 Corridor
Revised Environmental Assessment

July 2015

Submitted To:
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FIGURES

TABLES

1.0 INTRODUCTION

The Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA) have identified a need for improvements to the C-470 corridor from Kipling Parkway to Interstate 25 (I-25).

1.1 Location

CDOT right-of-way within this portion of the C-470 corridor, which will be referenced as the “Study Area,” is located in the South Denver Metropolitan area and crosses through portions of Douglas, Arapahoe, and Jefferson Counties and the Cities of Littleton and Lone Tree, as shown in **Figure 1**.

Figure 1. C-470 Corridor and Surrounding Vicinity

1.2 Purpose and Need

The purpose of proposed C-470 improvements is to address congestion and delay and improve travel time reliability for C-470 users. This Water Quality Technical Report is part of the 2015 Revised Environmental Assessment and identifies ultimate project improvements and changes to the Proposed Action described in the approved 2006 C-470 EA. This report also describes existing (No-Action) conditions and proposed mitigation measures to address potential environmental impacts in receiving waters due to stormwater runoff from ultimate (Proposed Action) improvements.

During an interim phase of the Proposed Action, improvements will be completed through a portion of the Study Area, approximately from Wadsworth Boulevard to I-25. Water quality improvements for the interim phase will be designed to be consistent with the Proposed Action ultimate improvements and mitigation measures.

1.3 Alternatives

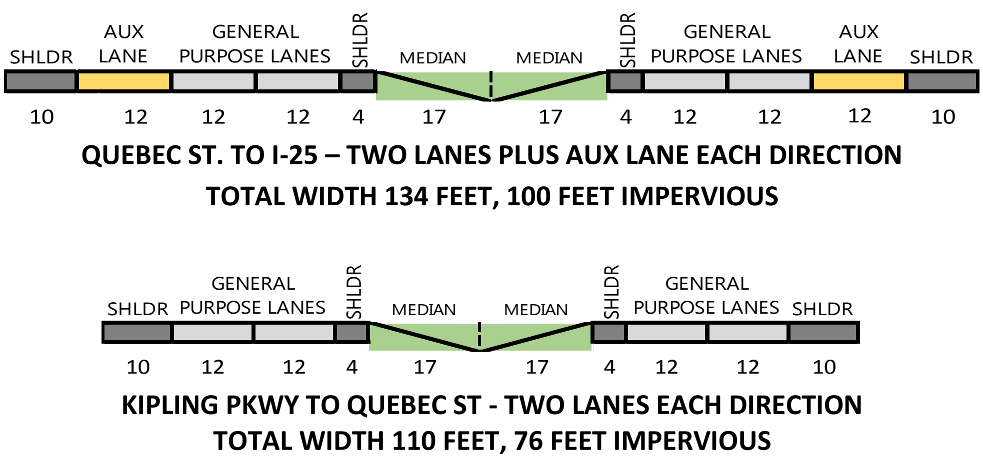
Two alternatives are presented and evaluated in the 2015 Revised Environment Assessment for the project. These alternatives include a No-Action Alternative and the Proposed Action. Aspects of these alternatives that have potential environmental impacts to water quality in receiving waters are described in this report.

C-470 No-Action Alternative

The No-Action Alternative involves taking no action to improve the existing C-470 roadway or its drainageway crossing structures between Kipling Parkway and I-25 other than performing basic maintenance and/or safety improvements to maintain roadway operation.

Within the Study Area, the existing C-470 roadway consists of two general-purpose lanes in each direction. An auxiliary lane in each direction exists between the Quebec Street interchange and the I-25 interchange, serving as continuous acceleration and deceleration lanes. The existing roadway (No-Action Alternative) consists of 12-foot travel lanes, including auxiliary lanes, with inside and outside shoulders, plus a 34-foot un-paved median, as shown in **Figure 2**. Paved shoulder widths vary between four and ten feet.

Figure 2. Typical Sections for No-Action Alternative

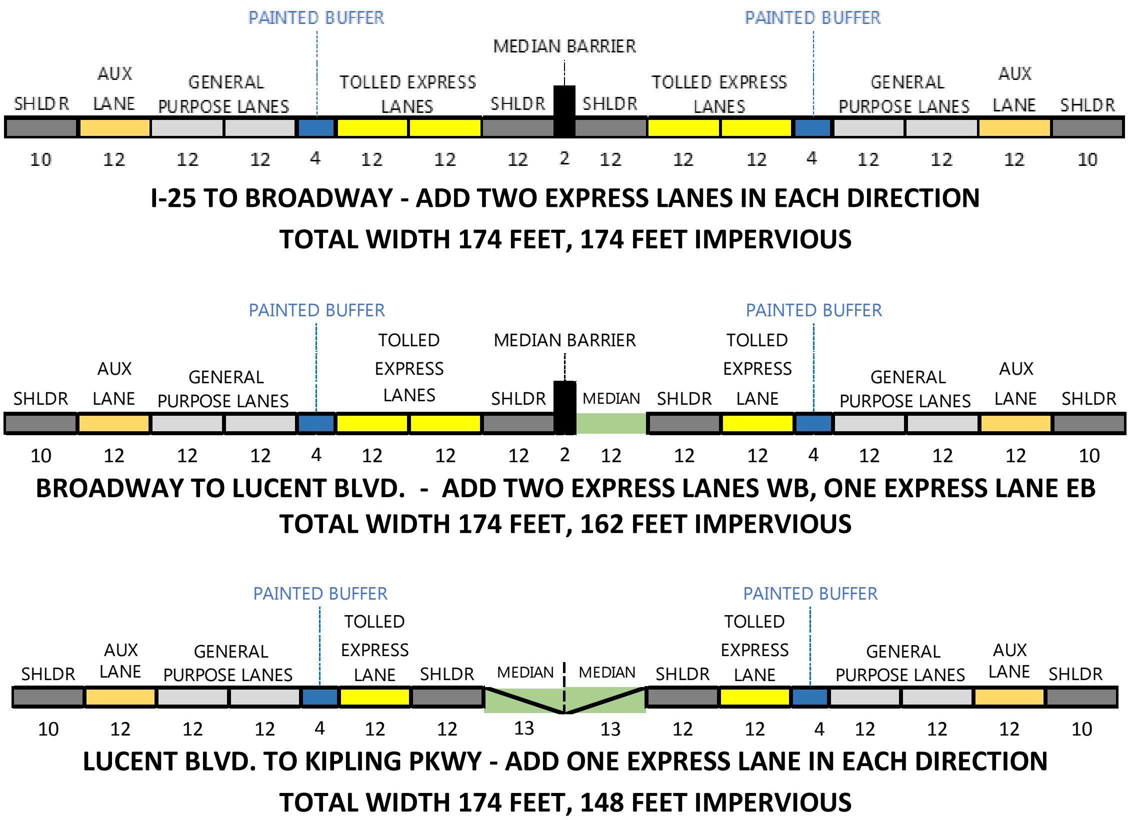


Less than 10 percent of the existing roadway pavement runoff enters water quality treatment facilities that meet current permit requirements. Limited water quality treatment occurs as runoff is conveyed along vegetated roadside ditches.

C-470 Proposed Action

The Proposed Action would add one managed tolled express lane in each direction between I-25 and Kipling Parkway, and a second managed express lane between I-25 and Lucent Boulevard, westbound and Broadway to I-25, eastbound. These new through lanes, plus new auxiliary lanes, where warranted, would supplement the existing (free) general-purpose lanes, which would be reconstructed. The proposed typical sections are shown in **Figure 3**. The project will also add new direct-connect ramps to serve some movements at the C-470/I-25 interchange.

Figure 3. Typical Sections for Proposed Action



1.4 Applicable Statutes and Regulations

Applicable statutes and regulations are noted below:

Federal Water Quality Laws and Regulations

- *The Clean Water Act:* The Clean Water Act (CWA) established the National Pollution Discharge Elimination System (NPDES) program. The U.S. Environmental Protection Agency (EPA) has delegated the authority to implement the regulations of the Clean Water Act and NPDES to the Colorado Department of Public Health and Environment (CDPHE) under Sections 402, 401 and 303(d), as well as the MS4 permit system (see below).
- *CWA Section 404 (permitting for dredge or fill in the nation's waterways, as administered by the U.S. Army Corps of Engineers):* This regulation will apply to any work in "waters of the United States" within the project area such as drainageways and jurisdictional wetlands.

State Regulations

In Colorado, CDPHE's Water Quality Control Division (WQCD) administers regulation sections 402, 401 and 303(d) of the Clean Water Act.

- *CWA Regulation Section 402 (National Pollution Discharge Elimination System, or NPDES, which is administered by Colorado under the Colorado Discharge Permit System, or CDPS)*.
- *Regulation Section 401 (certification by states that federally-permitted activities comply with state water quality standards):* In Colorado, this is administered by CDPHE. In most cases, a Section 401 certification will be obtained automatically when a Section 404 permit is issued for the project.
- *Regulation Section 303(d) (state designation of water bodies that do not meet water quality standards for their designated uses and to develop Total Maximum Daily Loads (TMDLs) to bring the water body up to the required water quality standard):* The State of Colorado is responsible for developing TMDLs for impaired waters.

Regulation 31: the Colorado Water Quality Control Commission (WQCC) establishes the basic standards and methodologies for surface waters throughout Colorado (CDPHE, 2013).

Regulation 38: sets the water quality standards for surface waters within the South Platte Basin (CDPHE, 2014a).

Regulation 61: establishes the regulations that apply to the discharges from any point source to waters of the State, and includes regulations for the General Permit for Stormwater Discharges from Construction Activities and Municipal Separate Storm Sewer System Discharge (MS4) Permits (CDPHE, 2015).

Regulation 85: Establishes requirements for nutrient controls, including more requirements for MS4 permittees (CDPHE, 2012c).

Permits Required:

- 404 Permit: from USACE for any impacts to wetlands or waters of the U.S.
- 401 Certification: from CDPHE (automatic for CDOT unless an Individual Permit is required)
- CDPS Permit from CDPHE for Stormwater Discharges from Construction Activities.
- SB40 Permit: for aquatic life impacts related to construction in and adjacent to Waters of the State.
- USACE permission: needed for C-470 improvements between Wadsworth Boulevard and Santa Fe Drive, a 3-mile stretch of C-470 where the highway is situated not on State-owned right-of-way but instead on an easement from USACE.

Municipal Separate Stormwater Sewer Systems (MS4) Permits

CDPHE most recently issued CDOT a Phase 1 MS4 permit on December 2006 that applies to state and interstate highways and their rights-of-ways within “urbanized areas,” as defined by the CDPHE. The CDOT MS4 permit area covers nearly all of the

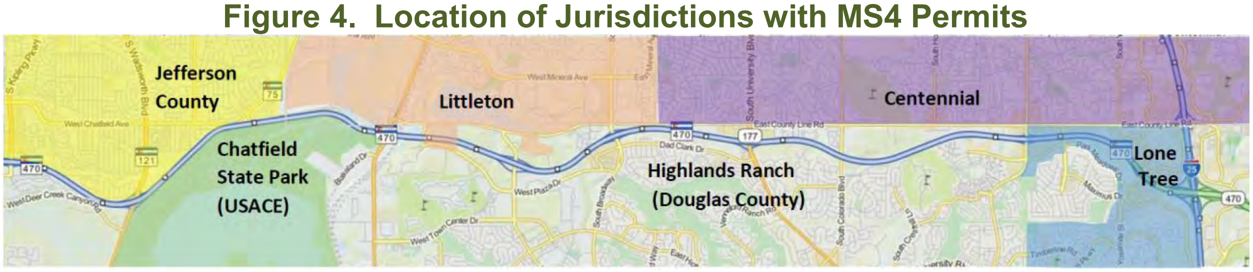
C-470 project area. That permit expired on January 31, 2012, but has remained in effect pending issuance of a new permit. In 2014, CDPHE modified CDOT's New Development & Redevelopment Program significantly, in response to a modification requested by CDOT on April 17, 2014. The request was approved with conditions issued on April 22, 2014 (CDPHE, 2014b) and May 22, 2014 (CDPHE, 2014c). The result is the CDOT NDRD Interim Guidance, dated September 18, 2014 (CDOT, 2014), herein after, referred to as the "2014 Interim NDRD Guidance". The 2014 NDRD was further modified by a CDPHE letter to CDOT dated January 8, 2015 (CDPHE, 2015b), herein after referred to as the "2014 Interim NDRD Program" or "2014 NDRD".
To simplify contracting and administration of the regulations, the requirements of the 2014 Interim NDRD Program will be applied to the entire project area.

The 2014 Interim NDRD Program includes a change of terminology from "Best Management Practices (BMPs) to "Control Measures (CMs)" for Permanent Water Quality facilities. However, since the new MS4 permit has not been received and the terminology could change again at that time, this Technical Report will continue to refer to permanent water quality facilities and activities as "BMPs".

Other MS4 permits are held by counties, municipalities, districts, and other agencies that overlap or are located adjacent to or near the project area. These MS4 permit holders are listed below and their locations along the corridor are indicated in **Figure 4**.

- Jefferson County
- Douglas County
- City of Littleton
- Colorado Parks and Wildlife (Chatfield State Park)
- City of Lone Tree
- Highlands Ranch Metro District
- Arapahoe County
- City of Centennial

Figure 4. Location of Jurisdictions with MS4 Permits



Although it is anticipated that the requirements of the CDOT MS4 permit will be applied throughout the project area, requirements of the adjacent permits may apply if project facilities fall outside of the CDOT ROW.

The two locations where C-470 is located within or adjacent to municipal boundaries are Littleton and Lone Tree. Per Section 43-2-135, C.R.S. and CDOT Policy 1050, maintenance requirements apply within municipal boundaries. **Figure 5** indicates the segments of C-470 that are located in Littleton and Lone Tree. C-470 is in Littleton for about 0.4 mile, from east of Santa Fe Drive to the Highline Canal, mileposts 17.112 to 17.588. C-470 is within Lone Tree for about two miles, from Quebec Street to I-25, mileposts 24.144 to 26.195. Within these areas, the statute requires municipalities to maintain any permanent water quality BMPs built for the project that can be accessed from outside CDOT ROW.

1.5 Comparison with 2006 C-470 Environmental Assessment

The 2006 C-470 EA anticipated that runoff from 100% of impervious surfaces within the project area would be treated for water quality. However, the 2014 Interim NDRD Program modifies this goal.

Figure 5. C-470 Segments within Municipalities - Littleton and Lone Tree

Sources: City of Littleton, 2013; City of Lone Tree, 2013.

The 2014 Interim NDRD Program requires that runoff from impervious surface areas equal to or greater than 90% of the *increase* in impervious surface area be treated for water quality. The increase in impervious surface area is the difference between pre-project (No-Action) and post-project (Proposed Action) conditions over the entire project. **Table 1** compares both the 2006 Preferred Alternative and the 2015 Proposed Action Alternative to the No-Action (existing condition) alternatives for the entire project. The increase in impervious area due to the Proposed Action is 119.8 acres. About 4.4 acres of the new impervious area will be treated by existing facilities at Santa Fe Drive. According to the 2014 Interim NDRD Program, runoff from 90% of this area, or 107.8 acres, must be treated. The Proposed Action would provide water quality treatment for runoff from an additional 185.1 impervious acres, or about 172% of the required area. By treating more than the minimum required area, CDOT is committing, not only to preserve, but to improve stormwater quality in the corridor.

Portions of the project area that discharge directly to waters listed as having a roadway related impairment, based on the CWA Section 303(d) list, must be accounted for separately. Therefore, because the South Platte River is listed for an arsenic impairment (**Table 2**), runoff from at least 90% of the project added impervious surface area that contributes directly to the S. Platte River must be treated by facilities within that drainage basin.

Table 1. Comparison of 2006 Preferred Action and 2015 Proposed Action to No-Action Alternatives

Scenario	Features	Impervious Surface Area[1]	Portion of Project Area Addressed with BMPs[2]
2006 Existing Condition	Four-lane highway built prior to current MS4 requirements.	135 acres	Less than 10 percent
2006 EA Preferred Alternative	Widen to eight-lane highway, with Colorado Blvd. T-ramps, median barriers and Santa Fe interchange improvements	322 acres = 187 acres more than the 2006 existing condition	100%, in accordance with MS4 permit (estimated 53 water quality ponds)
2015 Existing Condition (Future No-Action Alternative)	Same highway as 2006, plus Santa Fe Dr. interchange improvements completed in 2011 (flyover ramp)	204.9 acres	Less than 10 percent including 5.7 acres treated with BMPs in place at Santa Fe Dr.
2015 Revised EA Proposed Action	Widen to eight-lane highway plus auxiliary lanes, ramps and I-25 Interchange improvements	324.7 acres = 119.8 acres more than the 2015 existing condition	185.1 acres, including 65.3 acres of existing impervious area, or 172% of the 107.8 acres required by the 2014 NDRD

1. Differences between pre-project areas are due to the more detailed delineation of subbasin areas available for the 2015 report and differences in project extents such as the inclusion of the Santa Fe Dr. flyover, interchange ramps and the addition of interchange improvements at I-25.
2. Water quality treatment will be provided for at least 90% of new impervious areas within the S. Platte River drainage basin separately and for at least 90% of the new impervious areas outside of the S. Platte River drainage basin.

2.0 RECEIVING WATERS OF INTEREST

The entire Study Area is within the South Platte River basin. Runoff is discharged to six major drainageways and two constructed reservoirs as shown on **Figure 6**. Information describing the general characteristics of these water bodies and their regulatory status is contained in **Table 2.** None of the receiving waters is designated as "Outstanding Waters" (CDPHE, 2012a).

Table 2. Receiving Waters Summary

Figure I.D.	Water Body Name	Water Body Type	CDPHE, WQCD[1] Water Body I.D.	CWA[2] Section 303(d) Impairment	303(d) Priority	Watershed Size[3] (square miles)
1	Massey Draw	Stream	COSPUS07	-	-	1.34
2	Chatfield Reservoir[4]	Lake	COSPUS06b	-	-	3,018
3	South Platte River	Stream	COSPUS14	Arsenic	High	3,024.1
4	McLellan Reservoir	Lake	COSPUS22a	-	-	9.24
5	Dad Clark Gulch	Stream	COSPUS16c	Selenium	Low	7.61
6	Lee Gulch	Stream	COSPUS16c	Selenium	Low	0.12
7	Big Dry Creek	Stream	COSPUS16c	Selenium	Low	12.36
8	Willow Creek	Stream	COSPUS16c	Selenium	Low	4.91

1. Colorado Department of Public Health and Environment, Water Quality Control Division (CDPHE, 2013)
2. Clean Water Act (1987).
3. Watershed size of lake or portion of stream located upstream of C-470.
4. Chatfield Reservoir was removed from the 303(d) list for phosphorous impairment in 2009, when its TMAL went into effect, per WQCC Regulation 73 in 2009.

The approximate portions of the project area that contribute runoff to each of the receiving waters are shown in **Table 3**. Several receiving waters are listed as impaired in the State of Colorado Section 303(d) list. The segment of the South Platte River that crosses through the project area has a "high priority" impairment for arsenic. Dad Clark Gulch, Lee Gulch, Big Dry Creek, and Willow Creek each have "low-priority" impairment for selenium. Chatfield Reservoir is no longer listed as impaired for phosphorous since it is now governed by Regulation 73—Chatfield Reservoir Control Regulation (2009).

Figure 6. Receiving Waters of Interest

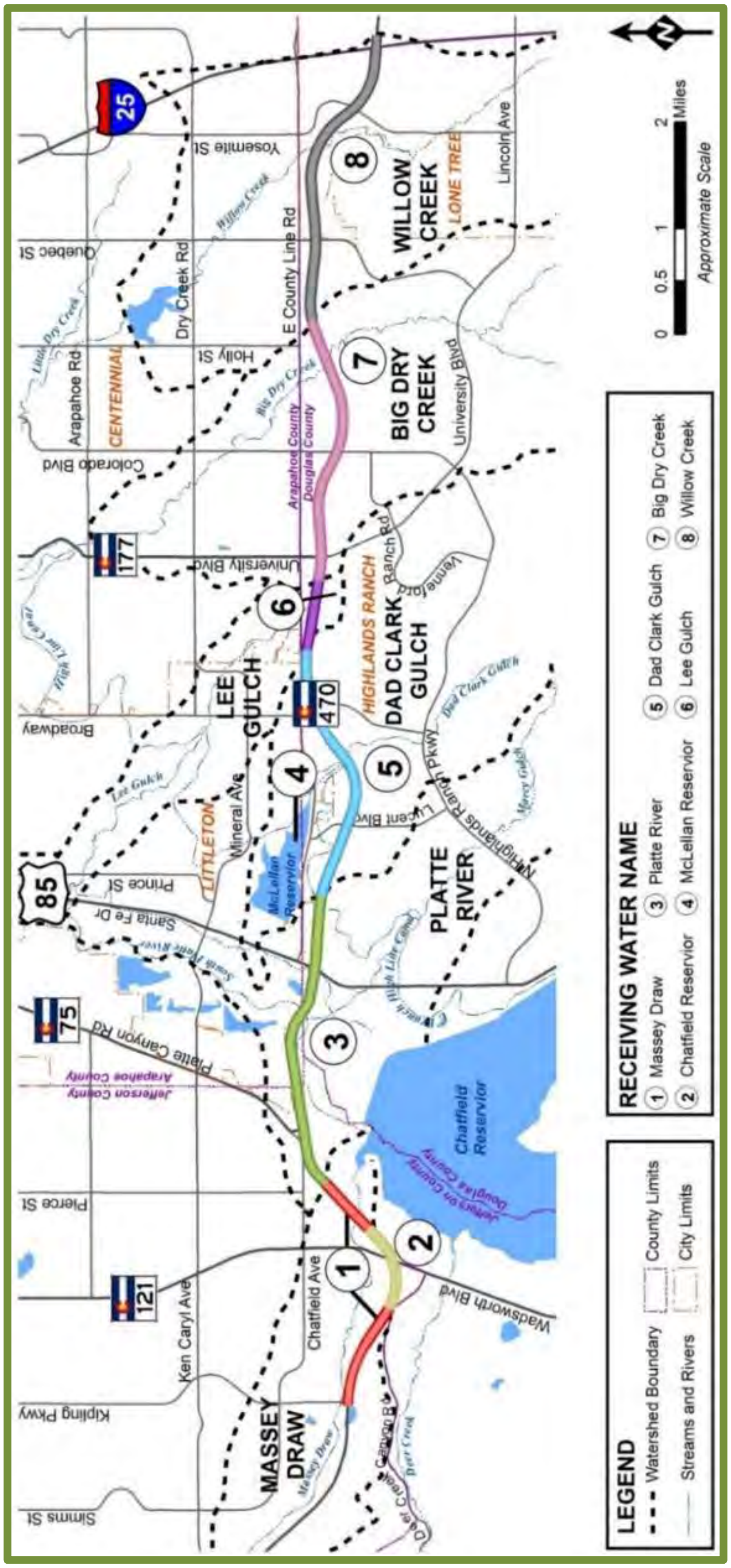


Table 3. Contributing Project Area Summary

Receiving Water	Approximate Limits of Contributing Project Area (Roadway Stations)	Approximate Contributing Project Area* (acres)
Massey Draw	690+00 to 724+00 and 757+00 to 819+00	57.4
Chatfield Reservoir	724+00 to 780+00	19.3
South Platte River	819+00 to 971+00	94.9
McLellan Reservoir and Dad Clark Gulch	971+00 to 1115+00	118.6
Lee Gulch	1115+00 to 1145+00	17.5
Big Dry Creek	1145+00 to 1273+00	68.7
Willow Creek	1273+00 to 1413+00	185.5
Totals	**690+00 to 1413+00**	**562.0**

*Area includes entire drainage basin, including pervious and impervious surfaces.

3.0 ISSUES

3.1 Existing Issues

C-470 was constructed in the 1980s, prior to development of the 2014 NDRD stormwater runoff water quality treatment requirements. As noted earlier, less than ten percent of the existing roadway pavement discharges to water quality treatment facilities that meet current requirements. Thus, water quality mitigation for the Proposed Action offers an opportunity to improve water quality for runoff from the existing freeway.

3.2 Potential Construction Phase Issues

During construction of the Proposed Action, roadside vegetation would be temporarily removed to accommodate grading and other construction activities. Soil would be exposed and more vulnerable to erosion and downstream sedimentation during rainfall and snowmelt events. In addition, materials and equipment common to the construction of highways could contaminate surface waters if not properly handled.

3.3 Potential Post-Construction Issues

The Proposed Action would result in the following potential post-construction issues that could negatively impact water quality if not properly managed and mitigated.

- The Proposed Action would increase impervious surfaces in the C-470 project right-of-way (ROW) and thus, would result in increased runoff volume and peak flow rates from the roadway. The Proposed Action increases in impervious areas and impervious areas to be treated with BMPs are summarized in **Table 4** by receiving water. The increased volumes and flow rates could erode soils along concentrated flow paths resulting in increased sediment and pollutants in the runoff if proper stabilization and permanent water quality BMPs are not implemented.

- The Proposed Action would add vehicle capacity to the roadway which is expected to result in increased traffic volumes. Existing annual average daily traffic ranges from 61,000 to 106,000 vehicles per day in 2013 and volumes are expected to increase by about 51% over the next two decades (CDOT, 2015a), or to 92,000-162,000 vehicles per day. This could result in additional pollutants being deposited on the roadway which may be mobilized and conveyed by runoff from the roadway (Smith and Granato, 2009). Any additional pollutants could flow to downstream receiving waters if proper permanent BMPs are not implemented.
- The Proposed Action would require grading of slope areas which could erode and result in additional sediment conveyed in runoff to receiving waters if the slope areas are not properly stabilized.
- The paved surface added by the Proposed Action would increase the application of deicing material in the corridor.

Table 4. Approximate Impervious Areas and Proposed Action Impervious Areas Treated with BMPs

Receiving Water	Impervious Area (acres)		Impervious Area Increase (acres)	Proposed Action Impervious Area Treated with BMPs	
	No-Action (Existing)	Proposed Action		(acres)	(Percent of Area Req'd)
Massey Draw	19.1	29.6	10.6	14.9	156%
Chatfield Reservoir	8.7	14.5	5.8	13.3	255%
South Platte River*	34.1	56.4	22.2	28.4	142%
McLellan Reservoir and Dad Clark Gulch	39.2	68.1	28.9	65.8	253%
Lee Gulch	7.2	12.5	5.3	6.1	128%
Big Dry Creek	24.8	46.4	21.7	15.4	79%
Willow Creek	71.8	97.2	25.3	41.2	180%
Totals	**204.9**	**324.7**	**119.8**	**185.1**	**172%**

* About 5.7 acres of existing impervious area is being treated by existing water quality ponds at Santa Fe Dr. and about 4.4 acres of new impervious area will also be treated at these facilities.

4.0 METHOD OF EVALUATION

4.1. Method

The CDOT NEPA Manual is the basis for determining whether or not water quality modeling is required for this project. Based on the Water Quality Modeling Decision Tree (Chapter 9, CDOT, 2013b), when a proposed action includes commitments to treat highway runoff, and the result is agreed upon as being beneficial, further modeling is not required (per Footnote #5 of the Decision Tree, CDOT 2013b). By adhering to the requirements of the 2014 Interim NDRD Program, the C-470 Proposed Action would result in less untreated runoff leaving the project site than in the No-Action Alternative (existing condition). Specifically, while the project increases impervious area by 119.8 acres (**Table 4**), the Proposed Action would treat 185.1 acres, including about 65.3 acres of existing impervious surface that is untreated in the existing condition. Thus, the Proposed Action would be beneficial for water quality.

4.2 Data Collection

The 303(d) and 305(b) lists as published in the “Integrated Water Quality Monitoring and Assessment Report, for the State of Colorado”, 2012 Update were reviewed to obtain information about receiving waters impairments and designated use classifications. (CDPHE, 2012b). GIS maps available on the WQCD internet site were used to obtain stream segment identification numbers. Additionally, WQCD staff members were consulted for clarification or confirmation of stream segment and impairment information.

A computer-aided design program was used to calculate areas of the project contributing to individual receiving waters and impervious areas associated with the No-Action Alternative and the Proposed Action Alternative.

5.0 CONTEXT SUMMARY

5.1 Receiving Waters Classifications

Colorado Water Quality Control Commission Regulation 31 identifies how the state classifies water bodies and Regulation 38 identifies the classifications for the South Platte River Basin, which includes the C-470 project area. These classifications indicate the beneficial uses served by the various surface waters, in terms of their ability to support aquatic life, recreation, water supply and agriculture. Classifications for the receiving waters associated with the C-470 project area are shown in **Table 5.**

5.2 Receiving Waters Impairments

WQCC Regulation 93 identifies impaired waters in the State of Colorado. **Table 6** summarizes impairments of Project Area runoff receiving waters in the 303(d) list for 2012 (WQCC, 2012). The South Platte River is impaired for arsenic, whereas most other drainages are impaired for selenium. Arsenic and selenium are naturally occurring elements which are commonly found in bedrock in the Denver Metro Area. Arsenic has been reported in some summaries of highway runoff pollutants, but is rarely listed.

Minute amounts of arsenic may be found in liquid deicers, although CDOT limits the amount to less than 5 ppm. Arsenic has been found in very low levels in about 10% of the CDOT Wet Weather Monitoring program (CDOT, 2009-2012). Thus, it is included as one of seven pollutants that trigger additional 2014 NDRD requirements (as noted above, and in **Table 7**). Selenium is not directly associated with roadway use. However, soils in the project area may contain these elements and could be carried downstream if erosion is not kept in check. Regulation 73 limits phosphorous within the Chatfield Reservoir Basin through a Total Annual Maximum Load (TMAL). Although phosphorous is not directly related to highways, it can be found in some deicers (limited to 25 ppm in CDOT deicers) and attaches to sediment. In addition, increased erosion carries phosphorous into receiving streams.

Table 5. Receiving Waters Classification Summary

Receiving Water	Regulation #38 Classification / Beneficial Uses
Massey Draw	Aquatic Life Cold Water 2, Recreation E, Agriculture
Chatfield Reservoir	Aquatic Life Cold Water 1, Recreation E, Water Supply, Agriculture
Platte River	Aquatic Life Warm Water 1, Recreation E, Water Supply, Agriculture
McLellan Reservoir	Aquatic Life Cold Water 2, Recreation E, Water Supply, Agriculture
Dad Clark Gulch	Aquatic Life Warm 2, Recreation E, Agriculture
Lee Gulch	Aquatic Life Warm 2, Recreation E, Agriculture
Big Dry Creek	Aquatic Life Warm 2, Recreation E, Agriculture
Willow Creek	Aquatic Life Warm 2, Recreation E, Agriculture

Table 6. Receiving Waters Impairment Summary

Receiving Water	303 (d) Impairment	Approved TMDL/TMAL	303(d) Priority
Massey Draw	-	No	-
Chatfield Reservoir	-	Yes (Reg. 73)	-
Platte River	Arsenic	No	High
McLellan Reservoir	-	No	-
Dad Clark Gulch	Selenium	No	Low
Lee Gulch	Selenium	No	Low
Big Dry Creek	Selenium	No	Low
Willow Creek	Selenium	No	Low

6.0 IMPACT SUMMARY

6.1 Permanent Impacts

Water Quality in the Project Area receiving waters should benefit from the Proposed Action since more runoff from the C-470 corridor would be treated. With the No-Action Alternative (existing condition), only a small portion of the runoff from the roadway is currently treated. Permanent Water Quality BMPs constructed with the Proposed Action would treat runoff from an area of roadway surface equal to or greater than ninety percent (90%) of the increased roadway surface added due to the Proposed Action. Because the South Platte River segment receiving runoff from the project is listed for arsenic, one of the seven pollutants specified in the 2014 NDRD requirements (**Table 7**), ninety percent of the increased roadway surface area within this specific drainage basin will be treated by facilities within the basin.

6.2 Temporary Impacts

Temporary Impacts during construction are expected to include working within and adjacent to some of the identified receiving waters. For example, the Proposed Action would remove and replace the two parallel C-470 bridges over the South Platte River. Implementation of temporary BMPs will be required to prevent the transport of sediment from exposed, erodible soils into the receiving waters. The management and handling of materials and equipment during the construction phase would be conducted in accordance with pertinent sections of the CDOT Standard Specifications for Road and Bridge Construction and the CDOT Erosion Control and Stormwater Quality Guide, in compliance with a CDPS Construction Stormwater Permit.

6.3 Effect of the Proposed Action

Impacts of highway development on water quality may result from:

- Erosion and sedimentation related to cut and fill slopes,
- Increased concentrated runoff from impervious surfaces, and
- Increased highway-related pollutants related to winter maintenance.

Water running off roadways can contain pollutants. Pollutants of concern are identified in CDOT's New Development Redevelopment Program, Interim Guide (9/18/2014) and in CDPHE's letter to CDOT regarding CDPS Permit-New Development and Redevelopment Program Description Modification-Conditional Approval, CDPS Permit No.: COS 000005 (1/8/2015). **Table 7** lists CDOT highway runoff pollutants of concern and their normal sources.

Other common pollutants in CDOT highway runoff and their sources are: oil and grease from spills and leaks from motorized vehicles; phosphorus from the atmosphere, roadside fertilizer use and erosion; and nitrogen from the atmosphere, roadside fertilizer use and erosion. Highways do not generate phosphorus and nitrogen, but erosion and activities adjacent to highways lead to more of these nutrients in runoff. Winter maintenance in this area does not include sanding, which can also entrain nutrients.

Table 7. CDOT Highway Runoff Pollutants of Concern

Runoff Pollutant of Concern	Normal Pollutant Source
Arsenic	Soils, erosion, deicers (minor)
Chloride	De-icing salts
Chromium	Metal plating, engine parts, brake lining wear
Copper	Metal plating, bearing and bushing wear, moving engine parts wear, brake lining wear, fungicides, insecticides
Manganese	Moving engine parts
Zinc	Tire wear, motor oil, grease
Sediment	Pavement wear, vehicle fall-off, atmosphere, traction sand, erosion

The constituents listed in **Table 7** and the other common pollutants were found in wet-weather sampling along CDOT highways. This list is shorter than earlier summaries of constituents because the wet-weather monitoring demonstrated that several constituents considered to be common in highway runoff (CH2MHill, 2009) are not present in detectible amounts (CDOT, 2009-2012). For example, cadmium, chromium, nickel and selenium were not present or were below detection limits. In addition, all pH measurements were within the standard range of 6.5 to 9.0.

Annual Average Daily Traffic (AADT) for C-470 within the project area varies significantly between various segments. AADT in the project area ranged from 61,000 to 106,000 vehicles per day in 2013, and is projected to range from 93,000 to 161,000 by 2035 (Cambridge Systematics, 2014). Some highway-related pollutants (specifically metals and nutrients) may increase with large increases in traffic counts (Smith and Granato, 2009). Thus, increasing water quality treatment in the project area is important for both the No-Action and the Proposed Action.

Any Proposed Action must follow three steps to protect resources: (1) avoid impacts; (2) minimize impacts, and (3) mitigate for impacts. These are in sequential order, with avoidance having the highest priority.

Proposed Action impacts to the receiving waters would be minimized through implementation of temporary BMPs during construction and permanent BMPs post-construction including water quality conscious maintenance practices. Proposed BMPs are described in the following section.

7.0 MITIGATION STRATEGIES

The following are preliminary strategies for mitigation of impacts and are subject to change. Final mitigation measures will be determined in the design-build process.

7.1 Efforts to Avoid Impacts

Every reasonable effort will be made to avoid impacts to waterways and wetlands. One way this will be achieved is by the installation of retaining walls where roadway widening would normally require the extension of cross-culverts and disturbance of the adjacent drainageways. By placing retaining walls between the widened roadway and the culvert entrance and exits at some crossings, there will be no encroachment into the adjacent drainageways or their floodplains, avoiding potential impacts. However, given the increased impervious area that is required to achieve additional traffic capacity, total avoidance of impacts is not practical for the Proposed Action. In those areas, minimizing and/or mitigation will be implemented.

7.2 Efforts to Minimize Impacts

During the concept design phase of the project, engineers have worked to minimize project impacts. Examples include:

- Proposed narrowing of shoulders and buffer zones for short distances to accommodate the addition of ingress/egress lanes without widening the pavement area;
- Eliminating concrete barriers that were proposed in the 2006 EA between the roadway express and general purpose lanes, thus reducing concentrated runoff; and
- Reducing peak flow rates to pre-project stormwater runoff rates (using methods described in mitigation).

7.3 Mitigation of Impacts during Construction

A Stormwater Management Plan (SWMP) detailing how and where temporary BMPs will be used before, during and after construction will be developed for the Proposed Action. This document will evolve as the construction progresses to meet the changing needs of the project. Work on the project shall conform to the requirements of the CDOT Standard Specifications for Road and Bridge Construction and the CDOT Erosion Control and Stormwater Quality Guide. A Stormwater Construction Permit issued by CDPHE will be required for the project. Work on the project will be monitored by CDOT through its “Construction Sites Program”.

Numerous temporary BMPs will be required during the construction phase of the project. Temporary BMPs are described in the CDOT Erosion Control and Stormwater Quality Guide. The primary objective of the SWMP is to control pollutants at the source and to minimize the potential for degradation of water quality in the waters that receive construction area discharges. The SWMP should include, but not be limited to, the following general measures:

- Erosion Control Measures including minimizing soil disturbances and adequately stabilizing disturbed areas as soon as possible to prevent erosion;
- Sediment Control Measures including using adequate BMPs to collect and remove pollutants from runoff before it is discharged from areas under construction;

- Using adequate measures to prevent materials from being tracked by vehicles or carried by wind and deposited off-site; and
- Proper spill prevention, management and control measures.

7.4 Mitigation of Post-Construction Impacts

7.4.1 Permanent Water Quality BMP Design

Structural BMPs

Assuming that the Proposed Action is designed prior to implementation of the new MS4 permit, Permanent Water Quality BMPs will be constructed in adherence to the 2014 Interim NDRD Program. For the areas to be treated (as described above) the BMPs must meet one of the following design criteria (CDOT, 2014):

1. **WQCV Standard**: Provide treatment and/or infiltration of the water quality capture volume (WQCV) for all tributary areas to the BMP;

2. **Pollutant Removal Standard**: Provide for removal of Total Suspended Solids (TSS) equal to the mass of 80% of the expected annual TSS loading from stormwater runoff from 100% of all tributary areas to the BMP; or

3. **Infiltration Standard/Volume Reduction**: Infiltrate the water quality capture volume (WQCV) for all tributary areas through practices such as green infrastructure, for a quantity of water equal to 70% of what the calculated WQCV would be if all new impervious area for the project discharged without infiltration.

For the Front Range of Colorado, the WQCV is the first 0.5 inch of runoff from a storm event.

Permanent BMPs proposed for implementation with the Proposed Action will dominantly consist of, but not be limited to extended detention basins. Design will maximize ease of safe access, and will include input from Maintenance staff to accommodate available maintenance equipment. Depending on site conditions, local agency requirements, and space available, the following BMPs will be considered:

- Ecology Embankments/Media Filter Drains; and
- Pre-Manufactured Treatment Devices (Mechanical Devices).

These permanent BMPs and strategies are briefly described in the following sections. Vegetated swales may be included in the design, in series with other BMPs, but do not meet the above design criteria. More detailed information and design criteria for these BMPs can be found in the CDOT Erosion Control and Stormwater Quality Guide (2002a), the CDOT Drainage Design Manual (2002b), and Volume 3 of the Urban Drainage and Flood Control District Drainage Criteria Manual (2010).

Extended Detention Basins

Extended detention basins (EDBs) are sedimentation basins designed to detain stormwater for up to 72 hours in order to allow sediment time to settle out of the detained water. Given their detention function, EDBs also provide significant peak discharge rate mitigation in frequent runoff events which benefits downstream waterways. If EDBs are constructed in well-drained soils and maintained on a regular basis, they also facilitate reduction in runoff volume through infiltration. EDBs will be designed to provide 100% of the WQCV for their contributing watersheds on this project to satisfy the 2014 Interim NDRD Program requirements.

Ecology Embankments/Media Filters Drains

Ecology embankments/Media Filter Drains (MFDs) are designed for linear treatment of un-concentrated runoff (sheet flow) from paved surfaces. The MFDs are constructed into the side slopes of roadway embankments. They consist of a vegetated filter strip adjacent to the roadway shoulder and a downstream strip of filter media. After flowing through the filter and collecting in an underdrain system, the treated runoff is released to a downstream conveyance facility.

The filter media consist of crushed rock mixed with three amendments. The rock and amendments provide physical filtration of solids, while the amendments provide chemicals and the environment needed for pollutant removal by precipitation, ion-exchange, and sorption. Testing of MFDs has demonstrated water quality treatment for roadway runoff that includes greater than 80% removal of TSS in the water quality design event (Herrera, 2006).

CDOT has used this BMP in limited applications in recent years. MDFs would be used on an as-needed basis, especially where adjacent ROW is narrow and the slopes are conducive to use, or where planned EDBs are not feasible.

Pre-Manufactured Treatment Devices (Mechanical Devices)

Pre-manufactured treatment devices, or “mechanical devices” (MDs), include various filter and solids separation devices to enhance water quality. These devices are typically contained in an underground vault and can be placed virtually anywhere without impacting ROW requirements. However, this advantage is offset by high frequency of labor-intensive maintenance, enclosed-space safety concerns, and high equipment costs. MDs are only expected to be used on the project where there are no other reasonable options for treatment. Where used, MDs should be designed to provide treatment equivalent to either 100% storage of the WQCV or 80% TSS removal for the watershed contributing to the BMP.

> Due to CDOT staffing and equipment constraints, it is important to design BMPs that will operate successfully with minimal required maintenance.

Vegetated Swales

Conveyance of runoff though stable, unpaved, vegetated swales and ditches can have the benefit of reducing the volume of runoff through infiltration, reduction of peak rates though infiltration and longer travel times, as well as some pollutant removal through filtration and sedimentation. Thus, where it is practical to do so, vegetated swales and roadside ditches will be used to collect runoff generated in the project area and convey it to downstream BMPs for additional treatment. Because they tend to be sparsely vegetated in the western U.S., such swales should primarily be used as conveyance facilities with some pretreatment benefits on this project. Swales may be used in conjunction with other BMPs to reach 80% TSS removal.

Non Structural BMPs/Operations

Non-structural BMPs will continue to be implemented in the maintenance of the roadway corridor. According to CDOT maintenance personnel, current practices by CDOT to mitigate water quality impacts from highway runoff include the following policies:

- Sand/salt mixtures are not used on C-470, because of the impact to air quality (from fugitive dust) and reduction of sediment (and entrained nutrients and metals) reaching local streams.

- CDOT is no longer pre-treating roads with liquid deicers. Applications begin with snowfall in order to minimize use of deicers.

- Liquid de-icing products used are magnesium chloride (“mag chloride”) and Caliber (a mixture of mag chloride, corn starches, alcohol, and tree sap). All of these deicers must meet strict limits on metals and phosphorous.

- For colder conditions, CDOT uses a product called Ice Slicer, an all-natural road salt that contains corrosion inhibitors.

- The C-470 corridor is not in the “core” sweeping area as defined for air quality purposes by the Denver Regional Council of Governments (DRCOG). Therefore, CDOT has up to four days to sweep 35 percent of the salt after snow events. Records from past years show that 100 percent of C-470 has been swept within four days.

- Pickup sweepers are used as part of on-going fleet upgrades; trash within the ROW is cleaned up prior to each sweeping.

- Fleet upgrades also include onboard computers to track and adjust the application rates of de-icing materials. Currently, 35 percent of the CDOT Region 1 fleet has this capability.

- The solid deicers are stockpiled at three covered storage facilities in the corridor to protect them from precipitation. This minimizes deicer loss and prevents saline from running off into receiving waters.

7.4.2 Permanent Water Quality Approach

The 2014 Interim NDRD Program encourages flexibility by allowing for coordination to create regional water quality BMPs where feasible, and for treating the equivalent area of new impervious surface where necessary.

Regional Treatment

Where practical, water quality treatment of runoff from the project area will be accomplished in regional water quality treatment facilities to reduce maintenance efforts and to better ensure long term effectiveness of the BMP. It is more efficient and cost-effective to monitor and maintain a smaller number of larger facilities that treat runoff from large areas than to maintain a larger number of smaller facilities treating runoff from an equivalent area.

To remain effective in the long term, BMPs will need to be maintained. Due to CDOT staffing and equipment availability constraints, it is important to design BMPs that will operate successfully with minimal maintenance.

Implementation of regional treatment will likely require the execution of maintenance agreements between CDOT and other agencies that have existing facilities or an interest in regional treatment facilities. CDOT will pursue such opportunities, with a focus on obtaining maintenance commitments from the local agencies in exchange for CDOT paying for much of the BMP construction or all retrofitting.

Equivalent Area Treatment

In some portions of the project, topography or limited space make treatment of new impervious area extremely difficult. The 2014 Interim NDRD Program allows for treatment of an equivalent area of existing impervious surfaces. This allows CDOT to focus on treating more area where it is easier and less expensive to treat. The result is that treated areas are anticipated to be 172% of the minimum required treated area (**Table 4**).

Other Mitigation Considerations

In several locations it will be very difficult and expensive to provide permanent BMPs within the existing ROW due to the presence of grading, utilities, and other constraints. Permanent BMPs in these areas may need to be located, at least partially, outside of the existing ROW and are likely to require the acquisition of additional ROW or the execution of maintenance agreements with owners of the adjacent parcels that the BMPs will be located on. In several locations the additional ROW needed for permanent BMPs is part of adjacent undeveloped land controlled by local governments.

Design of permanent BMPs for the portion of the project that is located adjacent to Chatfield Reservoir on land controlled by USACE will present special challenges. USACE has indicated that they do not support the construction of permanent BMPs for the project outside of the existing C-470 easement area due to maintenance concerns (USACE, 2013). They also would like to see runoff from the project area collected and conveyed within the existing ROW to waterways that cross the roadway corridor instead of allowing discharge of runoff to adjacent USACE land. Where runoff is discharged to USACE land the rate of discharge must not exceed pre-project rates. Due to the limited area between the proposed roadway and the limits of the existing easement, it will be necessary to collect and convey project runoff to areas where adequate space is available.

8.0 AGENCIES CONTACTED

WQCD staff were contacted via phone calls and e-mail to provide clarification on stream segment identification and impairments. A meeting was held with USACE staff at Chatfield Reservoir to discuss the Proposed Action as it related to the Chatfield Reservoir property and USACE's preference for management of stormwater runoff from the portion of the roadway that passes through their property. Meetings were also held with local agencies including: City of Englewood (Englewood McLellan Reservoir District), Highlands Ranch Metropolitan District, City of Lone Tree, Arapahoe County, Douglas County and Jefferson County to discuss opportunities for cooperation, stormwater management issues and planned improvements. Drainage reports were collected from the various agencies with water quality jurisdiction along the corridor.

9.0 CONSULTATION WITHIN CDOT

Meetings were held with CDOT Region 1 water quality and maintenance staff members in the preparation of this document to discuss preferences, constraints and concerns related to the design and maintenance of permanent water quality treatment facilities for the project and long term maintenance practices associated with the roadway.

10.0 PERMITS NEEDED

Implementation of the Proposed Action would require water quality permits as follows:

- Any work within this project that goes below Ordinary High Water in Waters of the U.S. will require a 404 permit from the U.S. Army Corps of Engineers. This permit is discussed elsewhere within this EA.
- An individual 404 permit triggers the need for a 401 certification from Colorado Department of Public Health and Environment Water Quality Control Division. A nationwide 404 permit triggers an automatic and concurrent 401 certification.
- Proposed Action construction activities will disturb more than an acre of land and thus will need to be covered under a Stormwater Construction Permit under the Colorado Discharge Permit System.

The timing of the application for these permits will be determined as the project develops and the bid documents are prepared.

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Wetland Delineation Report

For the C-470 Corridor
Revised Environmental Assessment

April 2015

Submitted to:
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1.0 INTRODUCTION

This report identifies existing waters of the U.S, including wetlands, present within the Colorado State Highway 470 (C-470) Revised Environmental Assessment (EA) Study Area located in the southwestern part of the Denver metropolitan area. The report will identify both jurisdictional and non-jurisdictional wetlands delineated within the study area. C-470 is located about 13 miles south of downtown Denver. The project study area is located in Arapahoe, Douglas, and Jefferson counties. Figure 1 shows the study area.

Figure 1. C-470 EA Study Corridor

The Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) have initiated the Revised EA for the 13-mile portion of C-470 between Kipling Parkway and Interstate 25 (I-25) to address congestion and delay, and to improve travel time reliability for C-470 users. The Proposed Action in the 2013 Revised EA differs slightly from the Express Lanes alternative identified in the previous EA that was approved by CDOT and FHWA in 2006.

The purpose of this report is to document the wetland delineation completed for the project, and identify potential mitigation and permitting commitments for the project. This report will be used as the data source for the C-470 Revised EA and CDOT Wetland Finding Report when project impacts to wetlands and waters of the U.S. have been determined.

1.1 Project Description

The existing C-470 freeway includes two general purpose lanes in each direction with a depressed median, resulting in a typical cross section approximately 110 feet wide. This width expands near grade-separated interchanges to include off-ramps, on-ramps, and in some cases, auxiliary lanes. In the No-Action Alternative, this configuration would remain unchanged, but would receive maintenance as needed to maintain the safety and functionality of the existing four-lane freeway.

The Proposed Action would add two tolled Managed Express Lanes in each direction, expanding the four-lane freeway to an eight-lane freeway. To aid motorists in merging onto or off of the highway, auxiliary lanes will be provided between closely spaced interchanges (e.g., one mile apart). The typical cross-section will vary from 154 feet without auxiliary lanes to 174 feet in areas with auxiliary lanes. The Proposed Action does not include any new interchanges or any major interchange modifications.

2.0 WETLAND DELINEATION METHODS

Robert Belford, Senior Biologist with Wilson & Company, conducted a wetland delineation of the study corridor in accordance with U.S. Army Corps of Engineers (USACE) wetland definitions on July 2, 3, 17, 22, and 27, 2013. Wetlands were delineated using the procedures outlined in the "*1987 Corps of Engineers Wetland Delineation"* and the "*Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region"* (USACE 2010). The study area for wetlands is defined as the area within the existing CDOT C-470 right of way between Kipling Boulevard and I-25.

The weather during the 2013 field review was generally sunny with scattered afternoon clouds. Temperatures ranged from the upper 80s to middle 90s. No precipitation occurred during the field visits.

Wetland delineations were completed in January 2015 in response to design changes that added potential stormwater detention facilities outside the 2013 Wetland Study Area. These delineations were completed by Robert Belford, Senior Biologist with ENERCON.

The January 2015 wetland delineation was completed during an abnormally warm period that had highs reaching the low 70s under generally sunny skies. Wetland data collection during January is not typically initiated because of the dormant plants and frozen soils. Therefore, this wetland delineation was initiated with the assumption that some soils and plant data may not be available to the delineator. This assumption was verified in the field, as some wetland sites had frozen soils and desiccated plants. Plants were present at each site that could be identified by species for the wetland determination form. While in locations with frozen soils, the delineator noted when the soil profile condition and indicators could not be documented on the data form.

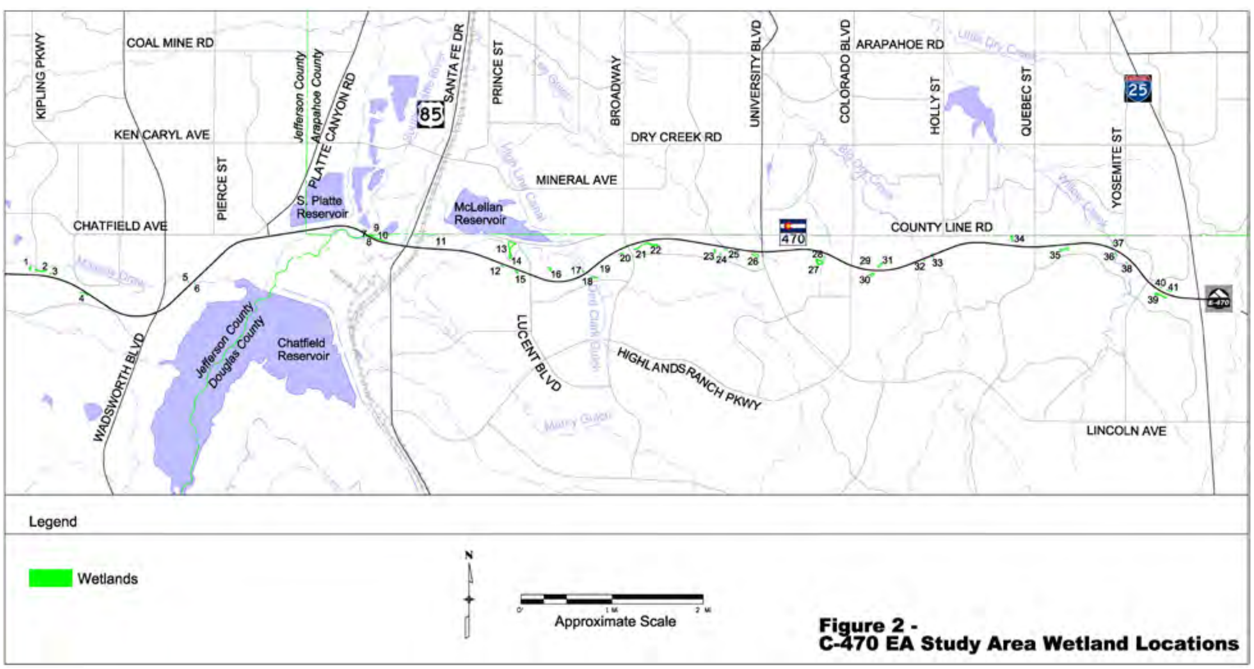
All study area wetlands were delineated with a handheld GPS unit that collects data to sub-meter accuracy. All dominant plants were recorded and the wetland indicator status was determined by sourcing the "*2012 Great Plains National Wetland Plant List*" (USACE 2012). All plant, soil, and hydrology data were recorded on the USACE Great Plains Region Data Forms.

3.0 WETLAND RESOURCES

The study area wetlands encompass a total of 12.05 acres. The wetlands identified in this section include both jurisdictional and non-jurisdictional wetlands. A jurisdictional determination has not been completed for study area wetlands. The wetlands present in the study area were present along river and stream corridors, and also at detention ponds, drainage basins, and roadside depressions.

Figure 2 shows the location of the wetlands. The data collected during the wetland delineation are recorded on the *Wetland Determination Great Plains Region Data Forms* that are provided in Appendix A. Representative wetland photographs are provided in Appendix B.

Figure 2. C-470 EA Study Area Wetland Locations



Using the standard wetland classification system (Cowardin et al. 1979) the wetland areas in the study area are classified as:

- palustrine emergent (PEM)
- palustrine scrub/shrub (PSS)
- combination of palustrine emergent and palustrine scrub/shrub (PEM/PSS).

This report identifies the wetland resources that exist within the study area. It does not evaluate wetland resource impacts that could result from implementing the 2013 C-470 EA Proposed Action.

The PEM/PSS wetland areas are composed of equal parts PEM and PSS attributes. Wetland vegetation mostly occurs along narrow overbank areas along study area streams and in existing stormwater drainage basins. The drainage basin and roadside wetland features are not likely to be jurisdictional; but the preliminary or final designation will need to be completed by USACE.

3.1 Study Area Wetlands

The following section identifies the 41 wetland areas that were delineated in the study area, totaling 12.05 acres. Table 1 lists wetlands by location from west to east.

The following descriptions identify size, location, dominant vegetation, soil characteristics, and hydrological indicators for each wetland area. The wetland areas are identified in geographic order from west to east, consistent with the numbering of wetland areas on Figure 2.

The abbreviations OBL and FACW in the following descriptions refer to indicator status codes for obligate (OBL), meaning that the plant occurs only in wetlands, or facultative wetland (FACW), meaning that the plant usually occurs in wetlands but may also occur in non-wetland areas.

Wetland Area 1 (0.29 acre)

Wetland Area 1 is located on the west side of Kipling Boulevard along Massey Draw.

Dominant Vegetation:
Sandbar willow (*Salix exigua*) - OBL
Reed canary grass (*Phalaris arundinacea*) - OBL
Sedge (*Carex sp.*) – OBL/FACW

Soils:
Soils consist of a silty loam texture with minimal organic content.

Hydrology:
Soils are saturated in the 2 – 6 inch soil profile. The drainage does convey higher flows during precipitation events as drift deposits were observed.

Table 1. Summary of Wetlands within C-470 Right of Way, Kipling Parkway to I-25

ID	Association	Type	Jurisdictional[1]	Size in Acres		
				Less than 0.1 acre	0.1 to 0.5 acre	0.5 to 1.3 acre(s)
1	Massey Draw	PSS	yes		0.29	
2	Massey Draw	PSS	yes			0.61
3	Massey Draw	PEM	yes	0.05		
4	Massey Draw	PSS	yes		0.18	
5	Massey Draw	PEM/PSS	yes	0.02		
6	Massey Draw	PEM/PSS	yes	0.01		
7	South Platte R.	PSS	yes	0.07		
8	South Platte R.	PSS	yes	0.05		
9	South Platte R.	PEM/PSS	yes	0.002		
10	South Platte R.	PEM/PSS	yes		0.44	
11	Erickson Blvd.	PEM	no	0.02		
12	Lucent Blvd.	PEM	no	0.05		
13	Lucent Blvd.	PEM	no			0.84
14	Lucent Blvd.	PEM	no		0.43	
15	Lucent Blvd.	PEM	no		0.23	
16	E. of Lucent	PSS	no		0.49	
17	Broadway	PEM	yes	0.06		
18	Dad Clark Gulch	PEM	no		0.14	
19	Broadway	PEM	no	0.005		
20	Broadway	PEM	no	0.09		
21	Broadway	PEM/PSS	no		0.42	
22	Broadway	PEM/PSS	no			1.08
23	University	PSS	no		0.26	
24	University	PEM	no	0.06		
25	University	PEM	no	0.07		
26	University	PEM/PSS	no			1.23
27	East of U.	PEM/PSS	no			1.17
28	East of U.	PEM	no	0.02		
29	Colorado-Holly	PSS	no	0.007		
30	Colorado-Holly	PEM	no			0.59
31	Colorado-Holly	PEM	no			0.65
32	Big Dry Creek	PSS	yes		0.29	
33	Big Dry Creek	PSS	yes	0.08		
34	Quebec St.	PSS	no		0.41	
35	East of Quebec St.	PEM	no			1.29
36	Willow Creek	PSS	yes		0.11	
37	Willow Creek	PSS	yes	0.02		
38	Willow Creek	PSS	yes	0.04		
39	Yosemite St.	PSS	no			0.71
40	Yosemite St.	PSS	no	0.03		
41	Yosemite St.	PSS	no	0.09		

[1] The jurisdictional identification is based on the wetland connection to a stream. The determination is not based on a preliminary or final determination from the USACE. The USACE is the agency responsible for a jurisdictional determination.

Wetland Area 2 (0.61 acre)

Wetland Area 2 is located on the east side of Kipling Boulevard along Massey Draw.

Dominant Vegetation:
Sandbar willow – OBL
Common cattail (*Typha angustifolia*) – OBL
Soft-stemmed bulrush - (*Scirpus validas*) – OBL

Soils:
Soils consist of a silty loam texture with a distinct depleted matrix.

Hydrology:
Soils are saturated in the 2 – 4 inch soil profile. The drainage is a perennial stream that has flows dependent on precipitation events. Sediment deposits were observed along the banks of the stream that were significantly higher than current flows.

Wetland Area 3 (0.05 acre)

Wetland Area 3 is located on the east side of Kipling Boulevard along a drainage that discharges to Massey Draw.

Dominant Vegetation:
Common cattail - OBL

Soils:
Soils consist of a silty loam texture with a distinct depleted matrix.

Hydrology:
Soils are saturated in the 3 – 4 inch soil profile. Drift deposits were observed in the wetlands. This drainage did not have water currently and likely only conveys flows during precipitation events.

Wetland Area 4 (0.18 acre)

Wetland Area 4 is located along C-470 eastbound between Kipling Boulevard and Wadsworth Boulevard. It is located along a drainage that conveys flows during precipitation events.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL

Soils:

The soils consist of a course loam texture with minimal organic content.

Hydrology:

Soils are saturated in the 5 – 6 inch soil profile. Drift deposits were observed in the wetlands.

Wetland Area 5 (0.02 acre)

Wetland Area 5 is located just west of Wadsworth Boulevard. It is associated with Massey Draw that flows under C-470.

Dominant Vegetation:

Sandbar willow – OBL
Reed canary grass – OBL
Baltic rush (*Juncus arcticus*) – FACW
Redtop (*Agrostis alba*) – FACW

Soils:

Soils consist of a silty loam texture and a depleted matrix.

Hydrology:

Soils are saturated in the 1 – 4 inch soil profile. Sediment and drift deposits were observed in and adjacent to the wetland.

Wetland Area 6 (0.01 acre)

Wetland Area 6 is an extension of the overbank Wetland Area 5 located along Massey Draw.

Dominant Vegetation:

Sandbar willow – OBL
Baltic rush – FACW
Redtop – FACW
Reed canary grass – OBL

Soils:

Soils consist of a silty loam texture and a depleted matrix.

Hydrology:

Soils are saturated in the 1 – 2 inch soil profile. Drift deposits were observed in and adjacent to the wetland.

Wetland Area 7 (0.07 acre)

Wetland Area 7 is located on the west bank of the South Platte River and is located upstream and downstream of the C-470 Bridge at this location.

Dominant Vegetation:
Sandbar willow – OBL
Baltic Rush – FACW
Nebraska sedge (*Carex nebrascensis*) – OBL

Soils:
Soils consist of a sandy/silty loam texture with a depleted dark surface.

Hydrology:
Soils are saturated within the one inch of the soil surface. Drift and sediment deposits were observed in and adjacent to the wetland.

Wetland Area 8 (0.05 acre)

Wetland Area 8 is located on the east bank of the South Platte River. It extends both upstream and downstream of the C-470 Bridge at this location.

Dominant Vegetation:
Sandbar willow – OBL
Baltic rush – FACW

Soils:
Soils consist of a sandy/silty loam texture with a depleted matrix.

Hydrology:
Soils are saturated within one-inch of the soil surface. Drift and sediment deposits were observed along the wetland edge.

Wetland Area 9 (0.002 acre)

Wetland Area 9 is located on the northeast bank of the South Platte River. The wetland area is located downstream of the C-470 Bridge. This wetland area was delineated in January 2015 and was being considered as the location for a stormwater outfall.

Dominant Vegetation:
Sandbar willow – OBL
Baltic rush – FACW

Soils:
Soils consist of a sandy loam texture with a depleted matrix.

Hydrology:
Saturated soils were present within one-inch of the soil surface. Sediment and drift deposits were also present.

Wetland Area 10 (0.44 acre)

Wetland Area 10 is located along a drainage that is east of the South Platte River and is located on the north side of C-470. This drainage flows into the South Platte River.

Dominant Vegetation:
Sandbar willow – OBL
Common Cattail – OBL
Nebraska sedge – OBL
Reed canary grass - OBL
Watercress (*Nasturtium officina*l) – OBL

Soils:
Soils consist of a sandy loam texture with a depleted matrix.

Hydrology:
Soils are saturated within one inch of the soil surface.

Wetland Area 11 (0.02 acre)

Wetland Area 11, located on the northwest corner of Erickson Boulevard, is a small drainage ditch or basin.

Dominant Vegetation:
Common Cattail – OBL

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 5 – 7 inch soil profile.

Wetland Area 12 (0.05 acre)

Wetland Area 12 is located along eastbound C-470 along the Lucent Boulevard exit. The wetland is associated with a drainage feature.

Dominant Vegetation:
Narrow-leaf cattail (*Typha latifolia*) – OBL

Soils:
Soils consist of a sandy loam texture.

Hydrology:
Soils are saturated in the 4 – 5 inch soil profile.

<u>Wetland Area 13 (0.84 acre)</u>

Wetland Area 13 appears to be an older detention basin that is located adjacent to Lucent Boulevard and is north of C-470. Vegetated wetland was located around the edge of the pond, with open water present for the most of the wetland acreage.

Dominant Vegetation:
Common Cattail – OBL

Soils:
This site was delineated in January 2015 when soils were frozen. Therefore, no soil data was collected.

Hydrology:
Soils appeared to be saturated at the surface. Surface water was also noted in the wetland area.

<u>Wetland Area 14 (0.43 acre)</u>

Wetland Area 14 is an older detention basin that is located adjacent to Wetland Area 13. The two basins are connected and appear to be the same age based on the condition of the vegetation.

Dominant Vegetation:
Common Cattail – OBL
Sandbar Willow - OBL

Soils:
This site was delineated in January 2015 when soils where frozen. Therefore, no soil data was collected.

Hydrology:
Soils appear to be saturated at the surface. Some surface water was also noted in the wetland area.

<u>Wetland Area 15 (0.23 acre)</u>

Wetland Area 15 is located at the C-470 eastbound Lucent Boulevard exit. The wetland is a detention pond that is located between the exit ramp and C-470.

Dominant Vegetation:
Narrow-leaf cattail – OBL
Nebraska sedge – OBL
Reed Canary Grass – OBL

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 2 – 3 inch soil profile. Sediment deposits were observed in the wetland.

<u>Wetland Area 16 (0.49 acre)</u>

Wetland Area 16 is located along westbound C-470 east of the Lucent Boulevard exit. This wetland is a detention pond located in an area bordered by commercial buildings.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL
Horsetail (*Equisetum hyemale L.*) - FACW

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 5 – 6 inch soil profile.

<u>Wetland Area 17 (0.06 acre)</u>

Wetland 17 is located on westbound C-470 before the Broadway exit. The wetland area is a detention basin and receives hydrology via a large culvert that is installed under C-470.

Dominant Vegetation:
Sandbar willow – OBL

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 4 - 5 inch soil profile.

Wetland Area 18 (0.14 acre)

Wetland 18 is located on or adjacent to Dad Clark Gulch. It appears to be a detention facility that is supported by a culvert that is installed under Plaza Drive.

Dominant Vegetation:
Sandbar willow – OBL
Nebraska Sedge – OBL

Soils:
Soils consist of a silty loam texture with a depleted matrix.

Hydrology:
Soils are saturated in the top one-inch of the soil profile.

Wetland Area 19 (0.005 acre)

Wetland Area 19 is located adjacent to eastbound C-470 before the Broadway Exit. It is a small “ditch” wetland.

Dominant Vegetation:
Narrow-leaf cattail – OBL

Soils:
Soils consist of silty-loam texture.

Hydrology:
Soils were saturated within the top 4-5 inches of the surface.

Wetland Area 20 (0.08 acre)

Wetland Area 20 is located adjacent to the C-470 Broadway exit ramp. The wetland is associated is associated with ditch or drainage area adjacent to the exit ramp.

Dominant Vegetation:
Reed canary grass - OBL

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 5 - 6 inch soil profile.

Wetland Area 21 (0.42 acre)

Wetland Area 21 is located adjacent to the Broadway eastbound C-470 ramp. The wetland is associated with a drainage feature that appears to receive sufficient hydrology to support woody vegetation.

Dominant Vegetation:
Sandbar willow – OBL
Knotted rush - OBL

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 1 – 3 inch soil profile.

Wetland Area 22 (1.08 acre)

Wetland Area 22 is connected to Wetland Area 22.

Dominant Vegetation:
Sandbar willow – OBL

Soils:
Soils consist of a silty textures with a gleyed matrix.

Hydrology:
Soils are saturated in the 1-3 inch soil profile.

Wetland Area 23 (0.26 acre)

Wetland Area 23 is a detention basin located adjacent to eastbound C-470 near University Boulevard. This wetland area was delineated in January 2015.

Dominant Vegetation:
Sandbar Willow – OBL

Soils:
The soils were frozen when this wetland delineation was completed in January 2015. Therefore, no soils data was collected.

Hydrology:
The soils at this site appear to be seasonally saturated in response to stormwater runoff. Drift lines and sediment deposits were noted in the January 2015 fieldwork.

Wetland Area 24 (0.06 acre)

Wetland Area 24 is a small detention basin located adjacent to a school. A small outfall is located on the feature.

Dominant Vegetation:
Common cattail – OBL

Soils:
The soils were frozen when the wetland delineation was completed in January 2015. Therefore, no soils data was collected.

Hydrology:
The soils at the site appear to be seasonally saturated in response to stormwater runoff. Some surface water was noted in the feature.

Wetland Area 25 (0.07 acre)

Wetland Area 25 is located along eastbound C-470 between Broadway and University Boulevard.

Dominant Vegetation:
Narrow-leaf cattail – OBL

Soils:
Soils consist of a silty texture.

Hydrology:
Soils are saturated in the 3 - 4 inch soil profile.

Wetland Area 26 (1.23 acres)

Wetland Area 26 is located on eastbound C-470 at the University Boulevard Interchange. It is a drainage basin that collects run-off from the roadway and adjacent commercial development.

Dominant Vegetation:
Sandbar willow – OBL
Narrow-leaf cattail – OBL
Baltic rush – FACW
Cloaked bulrush (*Scirpus pallidis*) - OBL

Soils:
Soils consist of a silty texture with a depleted matrix.

Hydrology:
Soils are saturated in the 3 – 4 inch soil profile.

Wetland Area 27 (1.17 acre)

Wetland Area 27 is located along eastbound C-470 between University Boulevard and Colorado Boulevard. The feature is a drainage basin that collects stormwater runoff from adjacent residential development. This feature was delineated in January 2015.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL

Soils:
The soils were frozen when the delineation was conducted in January 2015. Therefore, no soils data was collected.

Hydrology:
Soils appear to be seasonally saturated during episodes of storm runoff. Drift deposits were noted during January 2015 fieldwork.

Wetland Area 28 (0.02 acre)

Wetland area 28 is located adjacent to Wetland Area 28. The feature is outlet area associated with Wetland Area 27.

Dominant Vegetation:
Sandbar willow – OBL

Soils:
Soils were frozen during the January 2015 fieldwork.

Hydrology:
Drift deposits and sediment deposits were observed.

Wetland Area 29 (0.007 acre)

Wetland Area 29 is located on westbound C-470 at Colorado Boulevard.

Dominant Vegetation:
Narrow-leaf cattail - OBL

Soils:
Soils consist of a silty texture.

Hydrology:
Soils are saturated in the 4 – 5 inch soil profile.

Wetland Area 30 (0.59 acre)

Wetland Area 30 is located along eastbound C-470 between Colorado Boulevard and Holly Street. It is a large detention facility that captures run-off from adjacent commercial and residential development.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL
Narrow-leaf cattail – OBL

Soils:
Soils consist of a silty loam texture.

Hydrology:
Soils are saturated in the 4 – 5 inch soil profile.

Wetland Area 31 (0.65 acre)

Wetland Area 31 is a drainage basin located along westbound C-470 between Colorado and Holly Street. The feature is supported by a culvert that is installed under C-470. This feature was delineated in January 2015.

Dominant Vegetation:
Sandbar Willow- OBL
Nebraska sedge – OBL
Reed canary grass – OBL

Soils:
Soils were frozen in January 2015. Therefore no soils data was collected.

Hydrology:
Soils appeared saturated in the top 1-2 inches as some surface water was observed in the wetland area. Drift deposits were observed in the feature.

Wetland Area 32 (0.29 acre)

Wetland Area 32 is located along eastbound C-470 near Holly Street.

Dominant Vegetation:
Nebraska sedge – OBL
Baltic rush – FACW

Watercress - OBL
Reed canary grass – OBL

Soils:
Soils consist of a silty texture with a depleted matrix.

Hydrology:
Soils are saturated in the upper one-inch soil profile.

Wetland Area 33 (0.08 acre)

Wetland Area 33 is associated with Big Dry Creek that flows under east and west bound C-470. It is located along the banks of Big Dry Creek and is connected to the riparian floodplain of the creek. These wetlands are “overbank” features that form along the edge of stream banks in this region.

Dominant Vegetation:
Sandbar willow – OBL
Nebraska sedge – OBL
Baltic rush – FACW
Reed canary grass – OBL

Soils:
Soils in the wetland areas consist of silty to sandy loam texture. A depleted matrix was observed in some of the soils.

Hydrology:
Soils are generally saturated in the 3 – 4 inch soil profile. Drift and sediment deposits were observed within and adjacent to the wetlands.

Wetland Area 34 (0.41 acre)

Wetland Area 34 is associated with a detention pond located along westbound C-470 near Quebec Street.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL
Narrow-leaf cattail – OBL

Soils:
Soils in the wetland consist of a sandy loam texture. A depleted matrix was observed in the soils.

Hydrology:
Soils are saturated in the 4 – 5 inch soil profile.

Wetland Area 35 (1.29 acres)

Wetland Area 35 is associated with a detention pond located along eastbound C-470 near Quebec Street. The feature was delineated in January 2015.

Dominant Vegetation:
Common cattail – OBL
Reed canary grass – OBL

Soils:
Soils were frozen in January 2015. Therefore, no soils data was collected.

Hydrology:
Soils are seasonally flooded during stormwater runoff. Drift deposits were observed. Some surface saturation was also observed in the feature.

Wetland Area 36 (0.11 acre)

Wetland Area 36 is located along eastbound C-470 at Willow Creek. It is associated with a narrow strip of the riparian vegetation zone along the stream.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL
Baltic rush – FACW

Soils:
Soils in the wetland consist of a sandy loam texture.

Hydrology:
Soils are saturated in the 1-2 inch soil profile.

Wetland Area 37 (0.02 acre)

Wetland Area 37 is located along westbound C-470 at Willow Creek. It is associated with the narrow riparian corridor along Willow Creek.

Dominant Vegetation:
Sandbar willow – OBL
Reed canary grass – OBL
Common three-square (*Schoenoplectus pungens*) - OBL

Soils:
Soils in the wetland consist of a silty loam texture.

Hydrology:
Soils are saturated in the 1 – 2 inch soil profile.

<u>Wetland Area 38 (0.04 acre)</u>

Wetland Area 38 is located along eastbound C-470 at Willow Creek. It is located along the northeast bank of Willow Creek.

Dominant Vegetation:
Sandbar willow – OBL
Reed Canary grass – OBL
Horsetail – FACW
Common three-square - OBL

Soils:
Soils in the wetland consist of a silty texture. A depleted matrix was observed in the soils.

Hydrology:
Soils are saturated in the 3 – 4 inch soil profile. Drift deposits were observed in the wetland.

<u>Wetland Area 39 (0.71 acre)</u>

Wetland Area 39 is a detention basin located east of Yosemite Street. The wetland is adjacent to eastbound C-470. This feature was delineated in January 2015.

Dominant Vegetation:
Reed canary grass – OBL
Narrow-leaf cattail – OBL

Soils:
Soils were frozen during the January 2015 field study. Therefore, no soils data was collected.

Hydrology:
Soils appear to have some surface saturation. Drift deposits were observed in the wetland area.

Wetland Area 40 (0.03 acre)

Wetland Area 40 is a narrow drainage feature located along westbound C-47 near Yosemite Street. The feature was delineated in January 2015.

Dominant Vegetation:
Reed canary grass – OBL

Soils:
Soils were frozen during the January 2015 field study. Therefore, no soils data was collected.

Hydrology:
Soils were visually saturated. Some drift deposits were observed.

Wetland Area 41 (0.09 acre)

Wetland Area 41 is a narrow drainage feature connected to Wetland Area 40. The feature was delineated in January 2015.

Dominant Vegetation:
Reed canary grass – OBL

Soils:
Soils were frozen during the January 2015 field study. Therefore, no soils data was collected.

Hydrology:
Some saturation in the soils was observed. Drift deposits were also observed.

4.0 OTHER WATERS OF THE U.S.

The proposed C-470 Project will cross other waters of the U.S. as defined by the USACE. The USACE typically will claim jurisdiction on any river or stream that is shown as a blue line on a topographical map. These regulated streams can be perennial, intermittent, or ephemeral. Within the study area the following streams and rivers will be defined as jurisdictional by the USACE:

- South Platte River
- Massey Draw
- Dad Clark Gulch
- Lee Gulch
- Big Dry Creek
- Willow Creek

These streams will be under USACE regulatory jurisdiction for any proposed actions within their ordinary high water mark (OHWM).

The High Line Canal is also present within the study area. This feature is not a USACE jurisdictional waters of the U.S.

5.0 PERMITTING

The study area jurisdictional wetlands and streams will be subject to USACE Section 404 permitting. The USACE is responsible for formal designation of jurisdictional wetlands and streams. Permitting will likely be completed under a Nationwide 14 for Transportation Projects. However, if impacts exceed greater than .50 acre, an Individual Permit will be required.

6.0 MITIGATION

The C-470 Proposed Action will result in permanent and temporary impacts to wetlands and other waters of the U.S. Impacts to jurisdictional and non-jurisdictional wetlands will be required to be mitigated at a 1:1 ratio. Non-jurisdictional wetlands permanently impacted will be mitigated per an agreement between CDOT and the FHWA.

Temporary impacts to wetlands and other waters of the U.S. will also be mitigated. During development of the design plans, wetland scientists will work closely with project engineers to avoid and minimize impacts to wetlands and waters of the U.S. In addition the following wetland mitigation commitments are typically implemented for CDOT projects:

- In designated temporary work areas within wetlands and riparian areas, shrubs (primarily willows) will be trimmed to the ground level (not grubbed), and then covered with a geo-textile fabric and an additional layer of straw. These areas (including wetlands) will then be covered with a minimum of 2 feet of clean fill. As soon as possible, all temporary fill will be removed to an upland location. This will protect riparian shrub rootstock and wetland seed banks. If possible, temporary fill of wetlands will occur during periods when plants are dormant or toward the end of the growing season.

- Wetland areas not temporarily impacted by the project will be protected from construction activities by temporary and/or construction limit fencing.

- Sediment control measures will be installed where needed to prevent sediment filling wetlands.

- Fertilizers or hydro-mulching will not be allowed within 50 feet of a wetland.

- All disturbed areas will be revegetated with native grass and forb species. Seed, mulch, and mulch tackifier will be applied in phases throughout construction.
- Where permanent seeding operations are not feasible because of seasonal constraints (e.g., summer and winter months), disturbed areas will have mulch and mulch tackifier applied to prevent erosion.
- A stormwater management plan will be developed with best management practices to minimize adverse effects to water quality.
- Erosion bales, erosion logs, silt fence, or other sediment control devices will be used as sediment barriers and filters adjacent to wetlands, surface waterways, and at inlets where appropriate.
- Construction staging areas will be located at a distance of greater than 50 feet from adjacent stream/riparian areas to avoid disturbance to existing vegetation, avoid point source discharges, and to prevent spills from entering the aquatic ecosystem (including concrete washout).
- Temporary impacts to waters of the U.S. and adjacent habitat will be reclaimed with native plants and shrubs. In addition, this project will likely require a Senate Bill 40 (SB 40) Certification from Colorado Parks and Wildlife (part of the Colorado Department of Natural Resources), to protect riparian habitat.

7.0 REFERENCES

Cowardin, Lewis M., Virginia Carter, Frances C. Golet, and Edward T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Department of the Interior, U.S. Fish and Wildlife Service, FWS/OBS – 79/31.

Lichvar, R.W. 2012. *The National Wetland Plant List*. ERDC/CRREL TR-12-11. Hanover, NH: U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory.

U.S. Army Corps of Engineers. 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region*.

APPENDIX A
Wetland Determination Great Plains Region Data Forms

Kipling Boulevard - NW Ramp
West bound Ramp Side
Wetland #1

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/3/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): ______ Local relief (concave, convex, none): ______ Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	35%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	35%		
Herb Stratum (Plot size: ______)			
1. Phalaris arundinacea	15%	Yes	OBL
2. Carex Sp.	10%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	25%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	25%		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	______	x 1 =	______
FACW species	______	x 2 =	______
FAC species	______	x 3 =	______
FACU species	______	x 4 =	______
UPL species	______	x 5 =	______
Column Totals:	______ (A)		______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ 1 - Rapid Test for Hydrophytic Vegetation

✓ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Kipling Boulevard - NW West Bound Ramp

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12	10yr 5/3	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___________

Depth (inches): ___________

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___

Water Table Present? Yes ___ No ___ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 2-6"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Kipling Boulevard -
East Access Road
Wetland #2

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/3/13

Applicant/Owner: Douglas County State: CO Sampling Point: 1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	30	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	30		
Herb Stratum (Plot size: ______)			
1. Typha angustifolia	20	Yes	OBL
2. Scirpus validus	5	No	OBL
3. Juncus sp.	5	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	30		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Kipling Boulevard –
East Access Road

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) **(LRR F)**
___ 1 cm Muck (A9) **(LRR F, G, H)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
_✓_ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16)
(MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR I, J)**
___ Coast Prairie Redox (A16) **(LRR F, G, H)**
___ Dark Surface (S7) **(LRR G)**
___ High Plains Depressions (F16)
(LRR H outside of MLRA 72 & 73)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____________
Depth (inches): ____________

Hydric Soil Present? Yes _✓_ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
_✓_ Saturation (A3)
___ Water Marks (B1)
_✓_ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3)
(where not tilled)
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3)
(where tilled)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ____
Water Table Present? Yes ____ No ____ Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes _✓_ No ____ Depth (inches): 2-4"

Wetland Hydrology Present? Yes _✓_ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Kipling Boulevard
East Ramp
Wetland #3

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/3/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): ≤2
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1. Typha angustifolia	90%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	90		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	90		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Kipling Boulevard - East Access Road Side Drainage - Ramp

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12'	10yr 4/2	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ___ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 3-4"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

C-470 - Drainage - Halfway between Kipling and Wadsworth
Wetland #4

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/3/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	20%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	20%		
Herb Stratum (Plot size: ______)			
1. Phalaris arundinacea	25%	Yes	OBL
2. Carex sp.	10%	Yes	OBL
3. Juncus sp.	5%	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	40%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

C-470 - Drainage - Halfway between Kipling and Wadsworth

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12	10yr 5/3	100"	—	—	—	—	Gravelly Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ✓ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 5-6"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #5

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/3/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	30%	Yes	OBL
2.			
3.			
4.			
5.			
	30% = Total Cover		
Herb Stratum (Plot size: ______)			
1. Juncus arcticus	5%	Yes	FACW
2. Phalaris arundinacea	10%	Yes	OBL
3. Agrostis alba	5%	Yes	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	20% = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	= Total Cover		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #5

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/3	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1-4"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #6

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/3/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ✓	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	35%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	35%		
Herb Stratum (Plot size: ______)			
1. Agrostis alba	15%	Yes	FACW
2. Phalaris arundinacea	10%	Yes	OBL
3. Juncus arcticus	3%	No	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	28%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 4%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #6

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/2	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ____

Water Table Present? Yes ___ No ___ Depth (inches): ____

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1-2"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #7
West shore of
South Platte River

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/2/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	50%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	50%		
Herb Stratum (Plot size: ______)			
1. Carex nebrascensis	10%	Yes	OBL
2. Juncus arcticus	5%	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	15%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum <2%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ✓ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #7

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/4	100%	—	—	—	—	Sandy Silty/loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #8
East shore of
South Platte River

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/2/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ___
Hydric Soil Present?	Yes ✓	No ___
Wetland Hydrology Present?	Yes ✓	No ___

Is the Sampled Area within a Wetland? Yes ✓ No ___

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	60%	Yes	OBL
2.			
3.			
4.			
5.			
	60%	= Total Cover	
Herb Stratum (Plot size: ______)			
1. Juncus arcticus	5%	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	5%	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
% Bare Ground in Herb Stratum <2%		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Wetland #8

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/4	100%	—	—	—	—	Sandy Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #9
Northeast Stream/Drainage to South Platte River

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 7/2/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): None Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ✓	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	30%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	30%		
Herb Stratum (Plot size: ______)			
1. Typha angustifolia	10%	Yes	OBL
2. Carex nebracensis	5%	Yes	OBL
3. Nasturtium officinal	3%	No	OBL
4. Phalaris arundinacea	15%	Yes	OBL
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	33%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum <3%			

Remarks:

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ____	x 1 = ____
FACW species ____	x 2 = ____
FAC species ____	x 3 = ____
FACU species ____	x 4 = ____
UPL species ____	x 5 = ____
Column Totals: ____ (A)	____ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:
- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Wetland #9

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/3	100%	—	—	—	—	Sandy loam	—

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ✓ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #10
Erickson Blvd.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 7/2/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ___
Hydric Soil Present?	Yes ✓	No ___
Wetland Hydrology Present?	Yes ✓	No ___

Is the Sampled Area within a Wetland? Yes ✓ No ___

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1. Typha angustifolia	80%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	80%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	80%		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Wetland #10

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-10"	10yr 5/3	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________________

Depth (inches): ____________________

Hydric Soil Present? Yes ✓ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): __________

Water Table Present? Yes _____ No _____ Depth (inches): __________

Saturation Present? (includes capillary fringe) Yes ✓ No _____ Depth (inches): 5-7"

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

C-470 – west of Broadway East Bound [redacted] Side Drainage Lamp Wetland #11

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas Sampling Date: 7/10/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	______ = Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
Herb Stratum (Plot size: ______)			
1. Typha latifolia	35	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	35 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	______ = Total Cover		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

C-470 - West of Broadway
East Bound
Side Drainage

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
1-22"	10YR 5/3	100%	—	—	—	—	Sandy loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (LRR F)
___ 1 cm Muck (A9) (LRR F, G, H)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
___ 5 cm Mucky Peat or Peat (S3) (LRR F)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16)
(MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (LRR I, J)
___ Coast Prairie Redox (A16) (LRR F, G, H)
___ Dark Surface (S7) (LRR G)
___ High Plains Depressions (F16)
(LRR H outside of MLRA 72 & 73)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ________
Depth (inches): ________

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
✓ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3)
(where not tilled)
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3)
(where tilled)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ________
Water Table Present? Yes ___ No ___ Depth (inches): ________
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 5"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Broadway Exit - Eastbound Exit

Wetland #2

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas Sampling Date: 7/10/13

Applicant/Owner: Douglas County State: CO Sampling Point: #2

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______
Hydric Soil Present?	Yes ✓	No ______
Wetland Hydrology Present?	Yes ✓	No ______

Is the Sampled Area within a Wetland? Yes ✓ No ______

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1. Typha latifolia	30%	Yes	OBL
2. Juncus nodosus L.	10%	Yes	OBL
3. Carex nebrascensis	5%	No	OBL
4. Phalaris arundinacea	10%	Yes	OBL
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	55%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Broadway Exit – Eastbound Exit

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/4	100%	—	—	—	—	Silty Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ______

Water Table Present? Yes ____ No ____ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 2-3"

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #13
East of Broadway

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe Sampling Date: 7/10/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______
Hydric Soil Present?	Yes ✓	No ______
Wetland Hydrology Present?	Yes ✓	No ______

Is the Sampled Area within a Wetland? Yes ✓ No ______

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	25%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	25%		
Herb Stratum (Plot size: ______)			
1. Phalaris arundinacea	15%	Yes	OBL
2. Juncus nodosus	10%	Yes	OBL
3. Scirpus validis	5%	No	OBL
4. Equisetum hyemale L.	10%	Yes	FACW
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	40%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	65%		

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #13

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
6-12"	10yr 5/6	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR F**)
- ___ 1 cm Muck (A9) (**LRR F, G, H**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR I, J**)
- ___ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ___ Dark Surface (S7) (**LRR G**)
- ___ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ✓ High Water Table (A2)
- ___ Surface Water (A1)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ___ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 5-6"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

University Blvd. – East Bound Ramp #2 – Small polygon at this location Wetland #14

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas Sampling Date: 7/10/13

Applicant/Owner: Douglas County State: Co Sampling Point: 1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): None Slope (%): 3>

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓	No ______	
Wetland Hydrology Present?	Yes ✓	No ______	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1. Typha latifolia	60%	yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	60%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

University Blvd. – East Bound Ramp
#2 – Small polygon at this location
Wetland #14

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (LRR F)
___ 1 cm Muck (A9) (LRR F, G, H)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
___ 5 cm Mucky Peat or Peat (S3) (LRR F)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (LRR I, J)
___ Coast Prairie Redox (A16) (LRR F, G, H)
___ Dark Surface (S7) (LRR G)
___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
✓ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ___ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 5"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

University Blvd. – Eastbound Ramp
Wetland #15 #1 – Larger polygon than #2 at this location.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/10/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	30%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	30		
Herb Stratum (Plot size: ______)			
1. Typha latifolia	10%	Yes	OBL
2. Juncus sp.	5	No	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	15%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

University Blvd. - Eastbound Ramp
Wetland #15 #1 - larger polygon than #2 at this location.

SOIL

Sampling Point: 1#

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/4	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ______
Water Table Present? Yes ____ No ____ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 5"

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #16

East Bound - University L
West side of Exit
Polygon 1 of 2 at this location

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/10/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): None Slope (%): 3>

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83

Soil Map Unit Name: ______ NWI classification: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland?	Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___		
Wetland Hydrology Present?	Yes ✓ No ___		

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	35%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	35%		
Herb Stratum (Plot size: ______)			
1. Juncus nodosus L.	10%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	10%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	[redacted]		
% Bare Ground in Herb Stratum 10%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

✓ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Wetland #16

Broadway Exit – East Bound
West side of Exit
Polygon 1 of 2 at this location

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/6	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______
Water Table Present? Yes ___ No ___ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 6"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #17 ~~[illegible]~~ University Eastbound - West Side of Exit
Polygon 2 of 2 at this location

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/10/13
Applicant/Owner: Douglas County State: CO Sampling Point: 1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	40%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	40%		
Herb Stratum (Plot size: ______)			
1. Juncus nodosus	15%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	15%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum <5%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ______	x 1 = ______
FACW species ______	x 2 = ______
FAC species ______	x 3 = ______
FACU species ______	x 4 = ______
UPL species ______	x 5 = ______
Column Totals: ______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No ___

Remarks:

Wetland #17

Broadway Eastbound - West Side of Exit Polygon 2 of 2 at this location

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ✓ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ________

Water Table Present? Yes ____ No ____ Depth (inches): ________

Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 1-3"

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #18

C-470 East Bound
Between ~~[illegible]~~
University and Colorado

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/10/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ✓	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: ______)			
1. Typha latifolia	70%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	70% = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	= Total Cover		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ______	x 1 = ______
FACW species ______	x 2 = ______
FAC species ______	x 3 = ______
FACU species ______	x 4 = ______
UPL species ______	x 5 = ______
Column Totals: ______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ____

Remarks:

Wetland 1B

C-470 East Bound Between University and Colorado

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/4	100%	—	—	—	—	Silty	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___

Water Table Present? Yes ___ No ___ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 3"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #19 C-470 East Bound [redacted]
Colorado Blvd. Interchange

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/12/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): None Slope (%): [redacted] 3>

Subregion (LRR): Western Great Plains Lat: ____ Long: ____ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix exigua	25%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	25%		
Herb Stratum (Plot size: ____)			
1. Typha latifolia	20%	Yes	OBL
2. Scirpus pallidus	15%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	35%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #19 C-470 East Bound - Colorado Blvd. Interchange

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5) **(LRR F)**
- __ 1 cm Muck (A9) **(LRR F, G, H)**
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- __ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)
- __ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- __ 1 cm Muck (A9) **(LRR I, J)**
- __ Coast Prairie Redox (A16) **(LRR F, G, H)**
- __ Dark Surface (S7) **(LRR G)**
- __ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- __ Reduced Vertic (F18)
- __ Red Parent Material (TF2)
- __ Very Shallow Dark Surface (TF12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Salt Crust (B11)
- __ Aquatic Invertebrates (B13)
- __ Hydrogen Sulfide Odor (C1)
- __ Dry-Season Water Table (C2)
- __ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- __ Presence of Reduced Iron (C4)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Drainage Patterns (B10)
- __ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Geomorphic Position (D2)
- __ FAC-Neutral Test (D5)
- __ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): __________

Water Table Present? Yes _____ No _____ Depth (inches): __________

Saturation Present? (includes capillary fringe) Yes ✓ No _____ Depth (inches): 3-4"

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #20
C-470 Eastbound
Colorado Blvd. Interchange

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas Sampling Date: 7/12/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland?	Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______		
Wetland Hydrology Present?	Yes ✓ No ______		

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	______ = Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
Herb Stratum (Plot size: ______)			
1. Typha latifolia	80%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	80% = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	______ = Total Cover		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #20

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10 yr 4/2	100%	—	—	—	—	Silty	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___

Water Table Present? Yes ___ No ___ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 4-5"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #2

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/12/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	20%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	20%		
Herb Stratum (Plot size: ______)			
1. Phalaris arundinacea	25%	Yes	OBL
2. Typha latifolia	10%	Yes	OBL
3. Scirpus validis	3%	no	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	38%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

✓ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Wetland #2

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/3	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___________

Depth (inches): ___________

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___________

Water Table Present? Yes ___ No ___ Depth (inches): ___________

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 4-5"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

C-470 East Bound before Big Dry Creek adjacent to Golf Course Wetland #22

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas Sampling Date: 7/17/13
Applicant/Owner: Douglas County State: CO Sampling Point: #2
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: ______ NWI classification: ______
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland?	Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______		
Wetland Hydrology Present?	Yes ✓ No ______		

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	______ = Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
Herb Stratum (Plot size: ______)			
1. Carex nebrascensis	10-15%	Yes	OBL
2. Juncus arcticus	20%	Yes	FACW
3. Nasturtium officinale	10%	Yes	OBL
4. Phalaris arundinacea	15%	Yes	OBL
5.			
6.			
7.			
8.			
9.			
10.			
	55% = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	______ = Total Cover		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #32 C-470 East Bound Before Big Dry Creek Adjacent to Golf Course

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/4	100%	—	—	—	—	Silty	—

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (LRR F)
___ 1 cm Muck (A9) (LRR F, G, H)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
___ 5 cm Mucky Peat or Peat (S3) (LRR F)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
_✓_ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR I, J)**
___ Coast Prairie Redox (A16) **(LRR F, G, H)**
___ Dark Surface (S7) **(LRR G)**
___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____________
Depth (inches): ____________

Hydric Soil Present? Yes _✓_ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
_✓_ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______
Water Table Present? Yes ___ No ___ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes _✓_ No ___ Depth (inches): 1"

Wetland Hydrology Present? Yes _✓_ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #23 C-470- Big Dry Creek
Between University and Yosemite
Polygon 1 of 4

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/17/18
Applicant/Owner: Douglas County State: CO Sampling Point: #2
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Stream Side Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	<2%	No	FAC
2.			
3.			
4.			
	<2% = Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	25-35%	Yes	OBL
2.			
3.			
4.			
5.			
	25-35% = Total Cover		
Herb Stratum (Plot size: ______)			
1. Carex nebrascensis	15%	Yes	OBL
2. Juncus [redacted] arcticus	20%	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	35% = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	___ = Total Cover		
% Bare Ground in Herb Stratum 0			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ______	x 1 = ______
FACW species ______	x 2 = ______
FAC species ______	x 3 = ______
FACU species ______	x 4 = ______
UPL species ______	x 5 = ______
Column Totals: ______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Wetland #23

C-470 - Big Dry Creek
Polygon 1 of 4

SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______
Water Table Present? Yes ___ No ___ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 3"-4"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #23 C-470 - Big Dry Creek Between University and Yosemite Polygon 2 of 4

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/17/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): None Slope (%): ≤2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland?	Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____		
Wetland Hydrology Present?	Yes ✓ No ____		

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1. Populus deltoides	<2%	No	FAC
2.			
3.			
4.			
= Total Cover	<2%		
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	25-35%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	25-35%		
Herb Stratum (Plot size: ______)			
1. Carex nebrascensis	15%	Yes	OBL
2. Juncus arcticus	30%	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	45%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #23

C-470 - Big Dry Creek
Between University
and Yosemite
Polygon 2 of 4

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/3	100%	—	—	—	—	Sandy loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) **(LRR F)**
___ 1 cm Muck (A9) **(LRR F, G, H)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16)
(MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR I, J)**
___ Coast Prairie Redox (A16) **(LRR F, G, H)**
___ Dark Surface (S7) **(LRR G)**
___ High Plains Depressions (F16)
(LRR H outside of MLRA 72 & 73)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______________
Depth (inches): ______________

Hydric Soil Present? Yes ✓ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
✓ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
✓ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3)
(where not tilled)
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3)
(where tilled)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ______ No ______ Depth (inches): ______________
Water Table Present? Yes ______ No ______ Depth (inches): ______________
Saturation Present? (includes capillary fringe) Yes ✓ No 3" Depth (inches): ______________

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #23

C-470 - Big Dry Creek
Between University and
Yosemite
Polygon 3 of 4

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/17/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Stream Side/Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	35%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	35%		
Herb Stratum (Plot size: ______)			
1. Carex nebrascensis	15%	Yes	OBL
2. Phalaris arundinacea	15%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	30%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	30%		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #23

C-470 – Big Dry Creek
Polygon 3 of 4

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/3	100%	—	—	—	—	Sandy loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5) (LRR F)
- __ 1 cm Muck (A9) (LRR F, G, H)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- __ 5 cm Mucky Peat or Peat (S3) (LRR F)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)
- __ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- __ 1 cm Muck (A9) (LRR I, J)
- __ Coast Prairie Redox (A16) (LRR F, G, H)
- __ Dark Surface (S7) (LRR G)
- __ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- __ Reduced Vertic (F18)
- __ Red Parent Material (TF2)
- __ Very Shallow Dark Surface (TF12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____
Depth (inches): ____

Hydric Soil Present? Yes ✓ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Salt Crust (B11)
- __ Aquatic Invertebrates (B13)
- __ Hydrogen Sulfide Odor (C1)
- __ Dry-Season Water Table (C2)
- __ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- __ Presence of Reduced Iron (C4)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Drainage Patterns (B10)
- __ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Geomorphic Position (D2)
- __ FAC-Neutral Test (D5)
- __ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ____
Water Table Present? Yes ✓ No ____ Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 4"

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #23

C-470 - Big Dry Creek
Between University and Yosemite
Polygon 4 of 4

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas Sampling Date: 7/17/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): ____ Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ____ Long: ____ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ✓	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix exigua	30%	Yes	OBL
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: ____)			
1. Phalaris arundinacea	30%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	30% = Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	= Total Cover		
% Bare Ground in Herb Stratum ____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #23 Polygon 4 of 4
C-470 – Big Dry Creek

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/3	100%	—	—	—	—	Silty	—

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5) (LRR F)
__ 1 cm Muck (A9) (LRR F, G, H)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
__ 5 cm Mucky Peat or Peat (S3) (LRR F)
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Loamy Mucky Mineral (F1)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)
__ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

__ 1 cm Muck (A9) (LRR I, J)
__ Coast Prairie Redox (A16) (LRR F, G, H)
__ Dark Surface (S7) (LRR G)
__ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
__ Reduced Vertic (F18)
__ Red Parent Material (TF2)
__ Very Shallow Dark Surface (TF12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
✓ Saturation (A3)
__ Water Marks (B1)
✓ Sediment Deposits (B2)
✓ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Water-Stained Leaves (B9)
__ Salt Crust (B11)
__ Aquatic Invertebrates (B13)
__ Hydrogen Sulfide Odor (C1)
__ Dry-Season Water Table (C2)
__ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
__ Presence of Reduced Iron (C4)
__ Thin Muck Surface (C7)
__ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Sparsely Vegetated Concave Surface (B8)
__ Drainage Patterns (B10)
__ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Geomorphic Position (D2)
__ FAC-Neutral Test (D5)
__ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ____
Water Table Present? Yes ____ No ____ Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 4-5"

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #24 C-470 West Bound - Before Quebec Street east of Big Dry Creek

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/17/13
Applicant/Owner: Douglas County State: CO Sampling Point: ______
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83
Soil Map Unit Name: ______ NWI classification: ______
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	20%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	20%		
Herb Stratum (Plot size: ______)			
1. Phalaris arundinacea	12%	Yes	OBL
2. Typha latifolia	20%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	32%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	32%		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #24 C-470 West Bound East of Big Dry Creek

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Sandy loam	—

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 4-5"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #25 Willow Creek
C-470 Eastbound

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/12/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	40%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	40%		
Herb Stratum (Plot size: ______)			
1. Phalaris arundinacea	20%	Yes	OBL
2. ~~Rubus~~ Juncus arcticus	3%	No	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	23%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum <5%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #25

SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/3	100%					Sandy loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1-2"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #26 Yosemete Blvd. → East Bound
3 of 3 polygons at this location

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/12/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ____
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ____ Long: ____ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ✓	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix exigua	45%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	45%		
Herb Stratum (Plot size: ____)			
1. Schoenoplectus pungens	20%	Yes	OBL
2. Phalaris arundinacea	10%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	25%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 25%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ____ (A)
Total Number of Dominant Species Across All Strata: ____ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Wetland #26 Yosemite Blvd. → East Bound 3 of 3 polygons

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/3	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___

Water Table Present? Yes ___ No ___ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #27

Yosemete Blvd. → East Bound
1of 3 polygons de linated
at this location

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/12/13
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ✓ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ✓ No ______	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	15%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	15%		
Herb Stratum (Plot size: ______)			
1. Schoenoplectus pungens	10%	Yes	OBL
2. Equisetum hyemale L.	15%	Yes	FACW
3. Phalaris arundinacea	5%	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	25%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum <5%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

Wetland #27

Yosemite Blvd. → East Bound
1 of 3 polygons

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___

Water Table Present? Yes ___ No ___ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 3-4"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #28

Yosemite Blvd → East Bound
2 of 3 polygons delineated at this location.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Douglas County Sampling Date: 7/12/13

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ___

Hydric Soil Present? Yes ✓ No ___

Wetland Hydrology Present? Yes ✓ No ___

Is the Sampled Area within a Wetland? Yes ✓ No ___

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	40%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	40%		
Herb Stratum (Plot size: ______)			
1. Schoenoplectus pungens	10%	Yes	OBL
2. Phalaris arundinacea	15%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	25%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum 15%			

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ 1 - Rapid Test for Hydrophytic Vegetation

✓ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Wetland #28

Yosemete Blvd. ⇒ East Bound
2 of 3 polygons delineated at this location.

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 4/2	100%	—	—	—	—	Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR F)
- ___ 1 cm Muck (A9) (LRR F, G, H)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (LRR G, H)
- ___ 5 cm Mucky Peat or Peat (S3) (LRR F)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR I, J)
- ___ Coast Prairie Redox (A16) (LRR F, G, H)
- ___ Dark Surface (S7) (LRR G)
- ___ High Plains Depressions (F16) (LRR H outside of MLRA 72 & 73)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where not tilled)
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) (where tilled)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (LRR F)

Field Observations:

Surface Water Present?	Yes ___	No ___	Depth (inches): ___
Water Table Present?	Yes ___	No ___	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ✓	No ___	Depth (inches): 3-4"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland #1
S. Platte

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Jefferson Sampling Date: 1/26/15
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Belford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Stream Terrace Local relief (concave, convex, none): ______ Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ____ No ____
Hydric Soil Present?	Yes ____ No ____	
Wetland Hydrology Present?	Yes ____ No ____	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	40%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	40		
Herb Stratum (Plot size: ______)			
1. Juncus articus	10%	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	10%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum 10%			

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:
__ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

S. Platte R.

SOIL

Sampling Point: #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
1-12"	10yr 5/4	100%		-	-	-	Sandy loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ✓ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Lucent Blvd.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): ______ Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ___	Is the Sampled Area within a Wetland?	Yes ✓ No ___
Hydric Soil Present? — Frozen Soils Likley hydric Yes ✓ No ___		
Wetland Hydrology Present? Yes ✓ No ___		

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	___ = Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	___ = Total Cover		
Herb Stratum (Plot size: ______)			
1. Typha latifolia	60%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	60 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	___ = Total Cover		
% Bare Ground in Herb Stratum ______			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

W-13
Lucent Blvd.

SOIL — Soils were frozen (likely hydric)

Sampling Point: #2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____________
Depth (inches): ____________

Soils Frozen
Hydric Soil Present? Yes ______ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ✓ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ✓ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): __________
Water Table Present? Yes _____ No _____ Depth (inches): __________
Saturation Present? (includes capillary fringe) Yes _____ No _____ Depth (inches): __________

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-19
Lucent Blvd.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______
Hydric Soil Present? Soils Frozen	Yes ______	No ______
Wetland Hydrology Present?	Yes ✓	No ______

Is the Sampled Area within a Wetland? Yes ✓ No ______

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	20%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	20%		
Herb Stratum (Plot size: ______)			
1. Typha latifolia	50%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	50%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC–): 2 (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

W- 11
Crcent Blvd.

SOIL

Soils were frozen

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Soil Frozen (likely Hydric)

Hydric Soil Present? Yes ____ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ✓ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ✓ No ____ Depth (inches): ____________

Water Table Present? Yes ____ No ____ Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches): ____________

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Dad Clark Gulch

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): None Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	30%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	30%		
Herb Stratum (Plot size: ______)			
1. Carex nebrascensis	20%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	20%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum 5%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 2 (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

Dad Clark Gulch

SOIL

Sampling Point: #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
6-12	10yr 5/3	100%					Silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ✓ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): 1"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-23
University Blvd.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): Concav Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ____ Long: ____ Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland?	Yes ✓ No ____
Hydric Soil Present? Frozen Soils	Yes ____ No ____		
Wetland Hydrology Present?	Yes ✓ No ____		

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix exigua	58%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	58%		
Herb Stratum (Plot size ____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover			
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	____	x 1 =	____
FACW species	____	x 2 =	____
FAC species	____	x 3 =	____
FACU species	____	x 4 =	____
UPL species	____	x 5 =	____
Column Totals:	____ (A)		____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

"University Blvd

SOIL Frozen Soil

Sampling Point: #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5) (**LRR F**)
__ 1 cm Muck (A9) (**LRR F, G, H**)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
__ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Loamy Mucky Mineral (F1)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)
__ High Plains Depressions (F16)
(MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

__ 1 cm Muck (A9) (**LRR I, J**)
__ Coast Prairie Redox (A16) (**LRR F, G, H**)
__ Dark Surface (S7) (**LRR G**)
__ High Plains Depressions (F16)
(LRR H outside of MLRA 72 & 73)
__ Reduced Vertic (F18)
__ Red Parent Material (TF2)
__ Very Shallow Dark Surface (TF12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Frozen Soils

Hydric Soil Present? Yes ___ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
✓ Saturation (A3)
__ Water Marks (B1)
✓ Sediment Deposits (B2)
✓ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Water-Stained Leaves (B9)
__ Salt Crust (B11)
__ Aquatic Invertebrates (B13)
__ Hydrogen Sulfide Odor (C1)
__ Dry-Season Water Table (C2)
__ Oxidized Rhizospheres on Living Roots (C3)
(where not tilled)
__ Presence of Reduced Iron (C4)
__ Thin Muck Surface (C7)
__ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Sparsely Vegetated Concave Surface (B8)
__ Drainage Patterns (B10)
__ Oxidized Rhizospheres on Living Roots (C3)
(where tilled)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Geomorphic Position (D2)
__ FAC-Neutral Test (D5)
__ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______
Water Table Present? Yes ___ No ___ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ___ No ___ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

University Blvd

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15
Applicant/Owner: Douglas County State: CO Sampling Point: #1
Investigator(s): Robert Beford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): ―― Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ___	Is the Sampled Area within a Wetland?	Yes ✓ No ___
Hydric Soil Present? Frozen Soils Yes ___ No ___		
Wetland Hydrology Present? Yes ✓ No ___		

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1. Typha latifolia	70%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	70%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

University Blvd

SOIL Frozen Soils

Sampling Point: #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5) (**LRR F**)
- __ 1 cm Muck (A9) (**LRR F, G, H**)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- __ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)
- __ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- __ 1 cm Muck (A9) (**LRR I, J**)
- __ Coast Prairie Redox (A16) (**LRR F, G, H**)
- __ Dark Surface (S7) (**LRR G**)
- __ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- __ Reduced Vertic (F18)
- __ Red Parent Material (TF2)
- __ Very Shallow Dark Surface (TF12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Frozen Soils

Hydric Soil Present? **Yes** ____ **No** ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Salt Crust (B11)
- __ Aquatic Invertebrates (B13)
- __ Hydrogen Sulfide Odor (C1)
- __ Dry-Season Water Table (C2)
- __ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- __ Presence of Reduced Iron (C4)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Drainage Patterns (B10)
- __ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Geomorphic Position (D2)
- __ FAC-Neutral Test (D5)
- __ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ______

Water Table Present? Yes ____ No ____ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches): ______

Wetland Hydrology Present? **Yes** ✓ **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-2 1
Between University and Colorado

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15
Applicant/Owner: Douglas County State: CO Sampling Point: #7
Investigator(s): Robert Belford Section, Township, Range: ____
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): — Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ____ Long: ____ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present? Frozen Soils	Yes ____ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix exigua	45%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	45%		
Herb Stratum (Plot size: ____)			
1. Phalaris Arundinacea	25%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	25%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): 2 (A)
Total Number of Dominant Species Across All Strata: ____ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

W-2 (

SOIL (Soils Frozen) Sampling Point: #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) **(LRR F)**
___ 1 cm Muck (A9) **(LRR F, G, H)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR I, J)**
___ Coast Prairie Redox (A16) **(LRR F, G, H)**
___ Dark Surface (S7) **(LRR G)**
___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Soils Frozen
Hydric Soil Present? Yes ___ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
✓ Saturation (A3)
✓ Water Marks (B1)
___ Sediment Deposits (B2)
✓ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:
Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ___ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No ___ Depth (inches): ___

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-20

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/26/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): — Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83

Soil Map Unit Name: ______ NWI classification: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ___
Hydric Soil Present? Soils Frozen	Yes ___	No ___
Wetland Hydrology Present?	Yes ✓	No ___

Is the Sampled Area within a Wetland? Yes ✓ No ___

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix exigua	60%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	60%		
Herb Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover			
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

w-o

SOIL Frozen Soils

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5) **(LRR F)**
__ 1 cm Muck (A9) **(LRR F, G, H)**
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
__ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Loamy Mucky Mineral (F1)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)
__ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

__ 1 cm Muck (A9) **(LRR I, J)**
__ Coast Prairie Redox (A16) **(LRR F, G, H)**
__ Dark Surface (S7) **(LRR G)**
__ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
__ Reduced Vertic (F18)
__ Red Parent Material (TF2)
__ Very Shallow Dark Surface (TF12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ________
Depth (inches): ________

Frozen Soils
Hydric Soil Present? Yes ____ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
__ Saturation (A3)
✓ Water Marks (B1)
__ Sediment Deposits (B2)
✓ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Water-Stained Leaves (B9)
__ Salt Crust (B11)
__ Aquatic Invertebrates (B13)
__ Hydrogen Sulfide Odor (C1)
__ Dry-Season Water Table (C2)
__ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
__ Presence of Reduced Iron (C4)
__ Thin Muck Surface (C7)
__ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Sparsely Vegetated Concave Surface (B8)
__ Drainage Patterns (B10)
__ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Geomorphic Position (D2)
__ FAC-Neutral Test (D5)
__ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ______
Water Table Present? Yes ____ No ____ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

vv 21
Between Colorado and Holly

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/27/15
Applicant/Owner: Douglas County State: CO Sampling Point: #7
Investigator(s): Robert Belford Section, Township, Range: —
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): ____ Slope (%): <2%
Subregion (LRR): Western Great Plains Lat: ____ Long: ____ Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ____ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present? Frozen Soils	Yes ____	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix exigua	25%	Yes	OBL
2.			
3.			
4.			
5.			
= Total Cover	25%		
Herb Stratum (Plot size: ____)			
1. Phalaris arundinacea	20%	Yes	OBL
2. Carex nebracensis	10%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	30%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

✓ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ____

Remarks:

W-31 Between Colorado and Holly

SOIL Frozen Soil

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5) (**LRR F**)
- __ 1 cm Muck (A9) (**LRR F, G, H**)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- __ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)
- __ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- __ 1 cm Muck (A9) (**LRR I, J**)
- __ Coast Prairie Redox (A16) (**LRR F, G, H**)
- __ Dark Surface (S7) (**LRR G**)
- __ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- __ Reduced Vertic (F18)
- __ Red Parent Material (TF2)
- __ Very Shallow Dark Surface (TF12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Frozen Soil

Hydric Soil Present? **Yes** ____ **No** ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- ✓ Saturation (A3)
- ✓ Water Marks (B1)
- __ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Salt Crust (B11)
- __ Aquatic Invertebrates (B13)
- __ Hydrogen Sulfide Odor (C1)
- __ Dry-Season Water Table (C2)
- __ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- __ Presence of Reduced Iron (C4)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Drainage Patterns (B10)
- __ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Geomorphic Position (D2)
- __ FAC-Neutral Test (D5)
- __ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ✓ No ____ Depth (inches): 1"

Water Table Present? Yes ____ No ____ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches): ______

Wetland Hydrology Present? **Yes** ✓ **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-35

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/27/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): Concave Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD83

Soil Map Unit Name: N/A NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______
Hydric Soil Present? Frozen Soils	Yes ______	No ______
Wetland Hydrology Present?	Yes ✓	No ______

Is the Sampled Area within a Wetland? Yes ✓ No ______

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1. Typha latifolia	30%	Yes	OBL
2. Phalaris arundinacea	20%	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	50%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	______	x 1 =	______
FACW species	______	x 2 =	______
FAC species	______	x 3 =	______
FACU species	______	x 4 =	______
UPL species	______	x 5 =	______
Column Totals:	______ (A)		______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

✓ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

W-38

SOIL Frozen Soils

Sampling Point: ________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) **(LRR F)**
- ___ 1 cm Muck (A9) **(LRR F, G, H)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR I, J)**
- ___ Coast Prairie Redox (A16) **(LRR F, G, H)**
- ___ Dark Surface (S7) **(LRR G)**
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ________

Depth (inches): ________

Frozen Soils

Hydric Soil Present? **Yes** ____ **No** ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ________

Water Table Present? Yes ____ No ____ Depth (inches): ________

Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): Surface

Wetland Hydrology Present? **Yes** ✓ **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Detention Pond
East of Yosemite

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/27/15

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: —

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): — Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: — Long: — Datum: NAD83

Soil Map Unit Name: — NWI classification: —

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present? Frozen Soils	Yes ____ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ____)			
1. Typha angustifolia	25%	Yes	OBL
2. Phalaris arundinacea	20	Yes	OBL
3. Scirpus pungens	10%	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	55		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum ____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 3 (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

V- -1

SOIL Frozen Soil

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR F**)
- ___ 1 cm Muck (A9) (**LRR F, G, H**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR I, J**)
- ___ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ___ Dark Surface (S7) (**LRR G**)
- ___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Frozen Soil

Hydric Soil Present? Yes ______ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
- ___ Presence of Reduced Iron (C4)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)
- ___ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): ____________

Water Table Present? Yes _____ No _____ Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes ✓ No _____ Depth (inches): Surface

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-40

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/27/15

Applicant/Owner: Douglas County State: CO Sampling Point: #7

Investigator(s): Robert Belford Section, Township, Range: —

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): — Slope (%): ≤2%

Subregion (LRR): Western Great Plains Lat: ______ Long: ______ Datum: NAD 83

Soil Map Unit Name: — NWI classification: —

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present? Frozen Soil	Yes —	No ____
Wetland Hydrology Present?	Yes ✓	No ____

Is the Sampled Area within a Wetland? Yes ✓ No ____

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ____)			
1. Phalaris arundinacea	70%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	70%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

✓ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

W-4

SOIL Frozen Soil

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) **(LRR F)**
___ 1 cm Muck (A9) **(LRR F, G, H)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
___ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16) **(MLRA 72 & 73 of LRR H)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR I, J)**
___ Coast Prairie Redox (A16) **(LRR F, G, H)**
___ Dark Surface (S7) **(LRR G)**
___ High Plains Depressions (F16) **(LRR H outside of MLRA 72 & 73)**
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Frozen Soil
Hydric Soil Present? Yes ___ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
✓ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3) **(where not tilled)**
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3) **(where tilled)**
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ___ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): Surface

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

W-41

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: C-470 City/County: Arapahoe County Sampling Date: 1/27/15

Applicant/Owner: Douglas County State: CO Sampling Point: #1

Investigator(s): Robert Belford Section, Township, Range: —

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): — Slope (%): <2%

Subregion (LRR): Western Great Plains Lat: — Long: — Datum: NAD 83

Soil Map Unit Name: — NWI classification: —

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present? Frozen Soil	Yes ___ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ___)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ___)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ___)			
1. Phalaris arundinacea	70%	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover			
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover	70%		

% Bare Ground in Herb Stratum ___

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ___ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

W-41

SOIL Frozen Soil

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (**LRR F**)
___ 1 cm Muck (A9) (**LRR F, G, H**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16)
(**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (**LRR I, J**)
___ Coast Prairie Redox (A16) (**LRR F, G, H**)
___ Dark Surface (S7) (**LRR G**)
___ High Plains Depressions (F16)
(**LRR H outside of MLRA 72 & 73**)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____
Depth (inches): ____

Frozen Soil

Hydric Soil Present? Yes ____ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
✓ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): ____
Water Table Present? Yes ____ No ____ Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): Surface

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

APPENDIX B
Representative Wetland Photographs

Photographs
C-470 EA Revision Wetland Delineation

Photograph 1- Willow Creek overbank wetlands at the eastbound C-470 Bridge.

Photograph 2- Willow Creek wetlands downstream of C-470 Bridge.

Photograph 3- Big Dry Creek wetland and riparian communities.

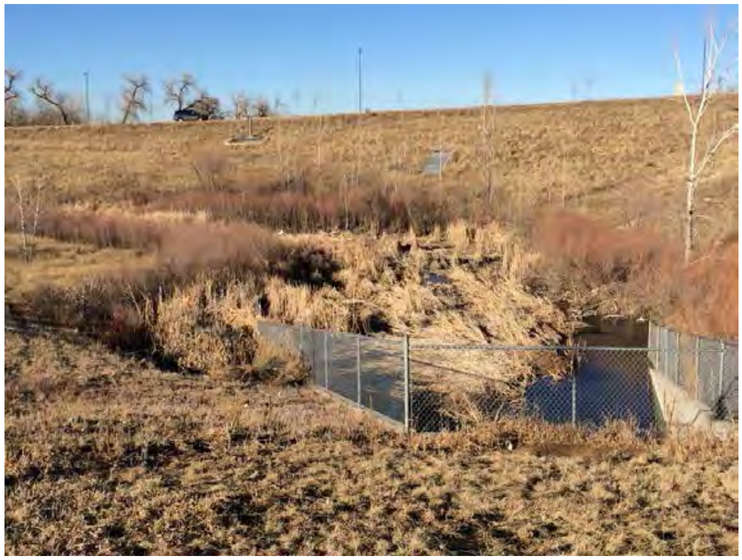
Photograph 4 – South Platte River Bridge wetland and riparian communities on southeast side of the bridge.

Photograph 5 – Northeast side of South Platte River Bridge. Narrow strip of riparian and wetlands are present along river bank.

Photograph 6 – Northwest side of South Platte River Bridge. Wetlands present along shore and bank of the river.

Photograph 7 – Massey Draw wetlands near Kipling Parkway

Photograph 8 – Detention pond wetlands near eastbound interchange to Lucent Boulevard. This wetland is representative of other larger detention pond and roadway created wetlands in the study corridor



Photograph 9 – Detention Pond Site delineated in January 2015

Photograph 10 – Detention Pond Site near Lucent Boulevard. Delineated in January 2015