US 160/550 Connection South Design Build

Preliminary Drainage Report

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FOREWORD

Multiple projects along the US 550 and US 160 corridors in the southwest region of Colorado have been under development since completion of the *US 550 Environmental Assessment and Finding of No Significant Impact* in 2005 and *US 160 Environmental Impact Statement/Section 4(f) Evaluation and Record of Decision* in 2006. This project is composed of two separate segments that each started as individual projects and were combined into a single project. Throughout this report, those segments will be referred to as "Connection" and "302 North".

The Connection segment begins near La Plata County Road 220 (CR 220) and extends north to the junction with US 160 south of Durango. FIR-level design on this segment was completed in 2016. The Connection segment also represents the Basic Configuration for the project. The 302 North segment extends from La Plata County Road 302 (CR 302) north to the southern end of the Connection segment near the intersection at CR 220. FIR-level design on this segment was completed in 2007.

This report reflects the compilation of these two segments and will cover the design discussions for each section separately due to the nuances in design and methodology that occur between the two segments.

At the inception of both projects, permanent water quality was needed as an environmental mitigation requirement. However, regulations were updated in 2017 and because the project area does not lie within CDOT's MS4 permit boundary, the requirement was lifted for both segments by CDOT in September of 2018 with approval from FHWA as part of the environmental re-evaluation process.

The plans contained in the reference documents and this report reflect the original design requirements related to permanent water quality. For example, the Connection segment still depicts some water quality ponds from the FIR design. Although water quality features have been removed from the 302 North segment plans, the ditches designed to convey onsite flows to specific locations for treatment are still present in the current configuration. Design teams should take into consideration the updated water quality requirements as a part of the final design process.

Ultimately, drainage design must ensure that the improvements do not cause adverse impacts to adjacent property owners. Appendix A and Appendix B contain all the design calculations for the Connection and 302 North segments, respectively.

In the event that discrepancies between this report and the RFP are discovered, the information in the RFP shall govern the design.

1 INTRODUCTION

Muller Engineering, on behalf of the Colorado Department of Transportation, Region 5, has prepared the following preliminary drainage report for the US 550/160 Connection South Design Build project. This report describes the existing site conditions, the proposed improvements, the hydrologic and hydraulic analyses, and the proposed drainage design improvements recommended for the project.

1.1 Project Site Location and Description

US 550 is a north-south highway that spans from Montrose, Colorado to the New Mexico state border. Much of the highway is two lanes with select areas of improvement to a four-lane dived highway. The project site begins south of Durango at the US 160 Grandview Interchange and realigns US 550 from the interchange to CR 220. From CR 220, the project follows the existing US 550 alignment to CR 302. Specifically, the project lies in Sections 5U, 8U, 9U,10, 17, 19, and 20, Township 34 North, Range 9 West of the New Mexico Principal Meridian in La Plata County, Colorado. Refer to **Figure 1**, *Project Vicinity Map*.

The north end of the project begins perched along the edge of the mesa, which is comprised of exposed shale, rocks, and sparsely covered terrain with woody vegetation and trees. The existing topography has slopes ranging from 10 to 55 percent.

At the top of the mesa, from about CR 220 to CR 302, the area surrounding the project corridor is mostly irrigated farmland along with some residential and commercial properties. Several well pads are also located adjacent to the corridor. The project corridor contains archeological artifacts and historic irrigation systems.

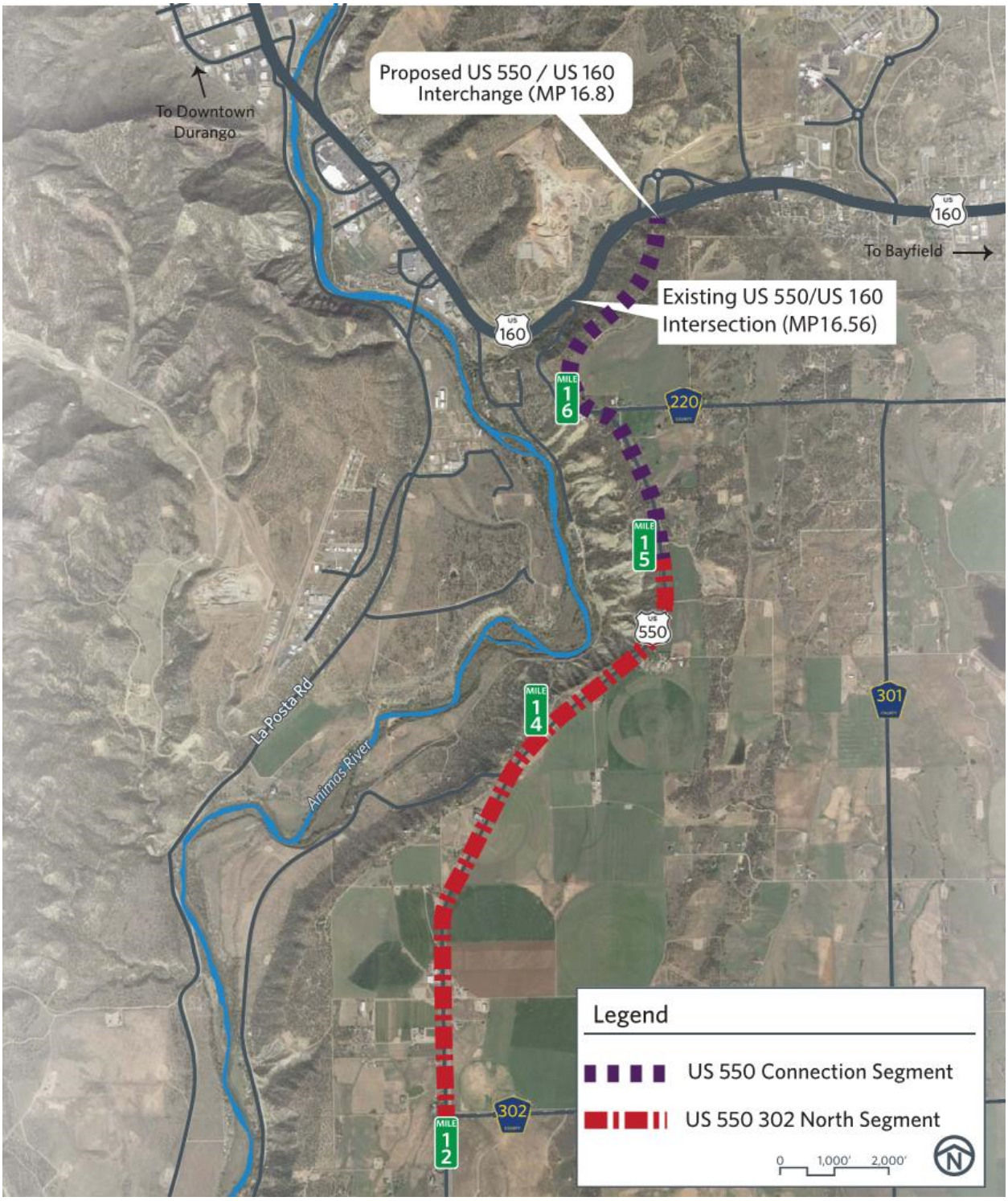
A Soil Resource Report was completed using the Web Soil Survey application provided by the United States Department of Agriculture under the Resources Conservation Service. There are multiple soil types within the project vicinity; soils type information and maps were downloaded from the Web Soil Survey website and can be found in **Appendix A**. The data indicates that the majority of the drainage area consists of Type C and Type D soils. Additional detail can be found in the environmental documents and Book 2, Section 5.

The drainage design will consider and minimize design implications that would interfere or impact the existing irrigation system, historic sites, or existing irrigated farmland and remain within the defined right-of-way for the project.

1.2 Project Description

Today, US 550 climbs from US 160 to the top of the mesa via a narrow and steep section of road also known as Farmington Hill. The proposed US 550/160 Connection South Design Build project base configuration will realign and upgrade approximately 1.8 miles of US 550 to a four-lane facility from US 160 to the junction with CR 220. In addition to the base configuration, up to an additional 2.6 miles extending to CR 302 may be widened as funding allows. Along with an upgraded roadway facility, this project includes two major bridges, multiple small and large wildlife crossings, and drainage improvements. These improvements will accommodate increased traffic and result in a higher level of safety for vehicles.

Figure 1: Project Vicinity Map



2 EXISTING CONDITIONS

2.1 Major Drainage

Runoff from the project corridor drains to the Animas River, a tributary of the San Juan River Basin. Paralleling the west side of US 550, the river flows from north to south through Durango and on through the Southern Ute Reservation to the New Mexico border. The Southern Ute Reservation boundary crosses the project at approximately Station 988+00 (near the existing CR220 intersection). There are no FEMA regulated floodplains within the project limits. The project area is tributary to two sections of the Animas River designated by the Colorado's Section 303(d) and 303(b) for Impaired Waters (segment COSJAF05a & COSJAF05b). The Southern Ute Reservation border divides the two segments.

The project area from US 160 to Station 988+00 is tributary to segment COSJAF05a of the Animas River. A manganese impairment is identified for this section.

The area from Station 988+00 to the south is tributary to segment COSJAF05b, which is not listed on the 303(d) list for pollutants at this time.

2.2 Minor Drainage

From about CR 220, the existing US 550 alignment winds north down towards its intersection with US 160 perched along the edge of the mesa. This section of US 550 realignment will cross two distinctly defined topographical gulches, referred to in this design as Gulch A and Gulch B. The gulches flow from east to west down towards US 160 and outlet into Wilson Gulch which flows west to the Animas River. Also in this portion of the project, runoff collected in the roadside ditches is transported to the opposite side of the roadway via corrugated steel pipes (CSP) and continues flowing towards the Animas River. Because the mesa's edge is comprised of exposed shale, rocks, and soil, the roadside ditches are frequently filled with loose aggregate that has sloughed off the side of the mesa.

From CR 220 to the south, roadside ditches capture runoff and generally convey flows north to south. Existing cross culverts carry flows across US 550 to small tributaries, gullies and gulches that transport runoff from the top of the mesa down to the Animas River.

3 DRAINAGE DESIGN CRITERIA

The roadways of US 550 and US 160 are within CDOT's jurisdiction with county roads and access/frontage roads under La Plata County's jurisdiction. La Plata County design standards for roadway and drainage are addressed in the *Code of La Plata County, Colorado* (Code), adopted June 22, 1998. Chapter 74 Section 74-95 – Road structure design; general requirements under subsection (b) states that "*Road structure design shall be in accordance with the criteria and procedures outlined in the current CDOT Road Design Manual".* Therefore, drainage design shall adhere to CDOT design criteria for roadway drainage.

Several drainage design features will be utilized to adequately collect, route, and treat stormwater runoff tributary to this project site. Drainage features to be constructed with the roadway include: roadside ditches, cross culverts, side drains, and storm sewer systems. A discussion of the design and the criteria utilized will be outlined in this section.

3.1 Hydrologic Criteria

Currently CDOT drainage design requirements are controlled by the *CDOT Drainage Design Manual*. The 2004 edition was referenced in determining the design storm frequency of the proposed roadway improvements through the use of Table 7.2: *Table of Design Frequencies* which determines frequency based upon drainage feature and population and Table 13.2: *Design Frequency vs Spread Width* which utilizes roadway classification and speed to determine the design frequency and design spread width. The drainage design frequency criteria for the proposed improvements are shown in **Table 3-1**.

Table 3-1: Roadway Drainage Design Criteria

Roadway	Jurisdiction	Roadway Classification	Storm Event	
			Minor	Major
US 550	CDOT	Arterial	2 to 10-Year	50-Year
CR 220 / CR 302	La Plata County	Collector	2 to 10-Year	25-Year
Access Road/ Frontage Road	La Plata County	Local	2 to 10-Year	25-Year

Design frequencies required for roadside swales, cross drains, storm sewer networks and side drains vary by facility and roadway classification type and are discussed in more detail in the following sections.

3.2 Hydrologic Methodology

Drainage basins were delineated using project ground survey provided by CDOT and supplemental survey completed by the Farnsworth Group and/or Woolpert. The basin discharge points were taken to coincide with the upstream ends of existing and/or proposed culverts, inlets, swales, ponds, etc., and any other points at which it became necessary to determine flow rates for preliminary design purposes. The hydrology tabulation utilizes a Basin ID naming convention that designates whether the basin conveys flows from offsite (O) areas or areas within the project (onsite), and the station number of the associated drainage facility. Flows that originate away from the highway and drain towards the proposed improvements are considered offsite flows. Onsite flows are flows that pertain to the direct runoff associated with the roadway improvements themselves, or medians between the new travel lanes.

Drainage basins for this project vary in size from less than 1 acre to 132 acres. Therefore, Rational Method was used to calculate peak flows since it is considered applicable to smaller basins, typically less than 160 acres. Although the Rational Method is most applicable to urbanized areas with high impervious values, it is generally considered a valid, conservative approach to determining flow rates for the small basin sizes typically associated with roadway drainage systems, regardless of imperviousness. Regression equations are generally not applicable for drainage basins in this size category.

Rainfall data was obtained from the La Plata Drainage Criteria Manual for the Connection segment and from NOAA Atlas 14 for the 302 North segment. Runoff coefficients were based on percent imperviousness for each basin and CDOT Drainage Criteria Table 7.4: *Recommended Runoff Coefficients for Use in Rational Equation* as a function of Percent Impervious Area and Land Use Types.

3.3 Hydraulic Design Criteria

Multiple drainage facilities will be utilized to collect, convey, and route storm runoff as well as irrigation flows. The *CDOT Drainage Design Manual* specifies the drainage criteria to be used for the project. Below are the requirements that must be adhered to utilize a specific drainage method. In the *CDOT Drainage Design Manual* minimum pipe sizes are specified in Table 9.4: *Minimum Culvert Diameters*. This table is replicated below in **Table 3-2**.

Table 3-2: Minimum Culvert Diameters

Application	Minimum Diameter, Inches
Cross Drain	36 in.
Side Drain	18 in.
Median Drain	18 in.
Storm Drain Trunk Line Connections	18 in.
Median Drain to Cross Culvert	15 in.
Curb inlet to trunk line	15 in.
Irrigation Crossing	18 in.

Cross drains must be sized to convey a 50-year storm event or have a 36-inch diameter, whichever is larger. Side drains are sized to convey the 10-year storm event unless the side drain's size has the propensity to impact the highway by causing flooding. In this case the side drain shall be designed to meet the spread criteria and not cause overtopping of the highway in the major storm event. Storm sewer networks are not routinely suggested in rural areas due to the increased maintenance but are necessary in some locations on this project due to a closed median and water quality facilities. Storm sewer networks were designed in accordance with CDOT drainage design criteria; the criterion has been summarized in **Table 3-4.**

Table 3-3: CDOT Storm Drain Design Criteria Summary Table

Road Classification	DESIGN CRITERIA	CDOT
All	Minor Storm Design	2 to 10-year
	Major Storm Design	100-year
Arterials	Minor Storm Max. Spread Width	Width of roadway shoulder
	Design at Sag	50-year
	Maximum Spread Width at Sag	Width of roadway shoulder + 3 feet
Collectors	Minor Storm Max. Spread Width	Width of roadway shoulder
	Design at Sag	10-year
	Maximum Spread Width at Sag	½ of Driving Lane
Local	Minor Storm, Max. Spread Width	10-yr, ½ of Driving Lane
	Design at Sag	2 to 10-year
	Maximum Spread Width at Sag	½ of Driving Lane

Roadside ditches are defined as "*an open channel usually paralleling the highway embankment and within the limits of the highway right of way"* in the *CDOT Drainage Design Manual*. In rural areas, roadside ditches are commonly referred to or used as roadside channels primarily utilized to route flows. For roadside ditches along roadways, the design water surface profile shall have a minimum of 1 foot of freeboard, measured from the bottom of the base course to the water surface elevation, for the 10-year storm frequency peak discharge and shall not exceed edge of pavement for the 100-year storm frequency peak discharge.

Along with the criteria presented in the above table, the following list summarizes other design constraints set forth in the *CDOT Drainage Design Manual*.

- No roadway overtopping shall occur.
- Major and minor storm drainage on bridges shall not spread into thru lanes.
- Maximum headwater depth to structure depth ratio (HW/D) for cross culverts are displayed in **Table** 3-4.

Table 3-4: CDOT Headwater to Depth Ratio Table

Range of Diameter or Height or Rise, inches	Maximum HW/D
Less than 36 in.	2.0
36 in. to 60 in.	1.7
Larger than 60 in. but less than 84 in.	1.5
84 in. to less than 120 in.	1.2
120 in. or larger	1.0

- Inlets (Area, Type R, etc.) shall be designed for the 100-year event, less the allowable street capacity.
- Storm sewer velocities in the major storm (100-year) shall not be any greater than 22 feet per second (fps).

- Manhole spacing shall be in accordance to Table 13-5 from CDOT Drainage Manual as shown in **Table** 3-5.

Table 3-5: Manhole Spacing Criteria

Size of Pipe (in.)	Maximum Distance (ft.)
15 to 24	400
30 to 36	500
42 to 54	700
60 and up	1000

3.4 Bridge Drainage

Multiple bridges are proposed for the selected alignment. Bridge drains will be utilized and placed in locations that allow for the roadway on the bridge to meet the spread width criteria and minimize the bypass flows over the expansion joints. Flows on the bridge were calculated using the Rational Method and drains were placed in order to convey the minor drainage. To decrease the runoff passing over the bridge abutments, bridge abutment drains are also required.

3.5 Wildlife Crossings

In accordance with the mitigation commitment stated in the US 550 EA/FONSI and the US 550 and US 160 South Connection Supplemental FEIS/ROD, large animal crossings are required beneath US 550 near animal migration paths. The crossings shall accommodate large animals, deer and elk, to maintain historic herd migration paths. The crossings shall be sized at a minimum of 13 feet x 32 feet (height x width) with a natural substrate floor. The bridges over Gulch A and Gulch B function as additional large animal crossings. Additional criteria for the crossings can be found in Book 2, Section 5.

In addition to the large animal crossings, small mammal crossings shall be spaced approximately 500 ft to 1000 ft apart along US 550 and sized between 3 feet and 5 feet in diameter, with an average of 4 feet in diameter. Small mammal crossings shall have a minimum of 12 inches of native soil above the invert to promote use. Conveyance of runoff through the crossings should be minimized. Where feasible runoff should be routed around the crossings with the use of roadside ditches.

3.6 Stormwater Quality Management

Polluted stormwater runoff is commonly transported via municipal separate storm sewer systems (MS4s) into nearby rivers and streams. Under the 1987 Clean Water Act (CWA) Amendments, the Environmental Protection Agency (EPA) developed Stormwater Phase I and Phase II Regulations which established a MS4 program that manages and regulates stormwater impacts on water quality. The MS4 stormwater management program is intended to improve the Nation's waterways by reducing the quantity of pollutants that stormwater picks up and carries into the storm sewer systems. Among other requirements, the regulations require regulated entities to acquire a National Pollutant Discharge Elimination System (NPDES) Permit for their stormwater discharges.

In Colorado, these regulations are administered by the Colorado Department of Public Health and Environment's (CDPHE) Water Quality Control Commission (WQCC). The Colorado stormwater NPDES

permit program is referred to as the Colorado Discharge Permit System (CDPS). CDOT is regulated by a Phase I MS4 permit (COS-000005) that covers state and interstate highways and their right-of-ways within urbanized boundaries, as defined by CDPHE. As part of the permit, CDOT has several different programs in place to ensure the amount of pollutants entering Colorado's waterways is reduced. Two of the programs that are applicable to the design development process are the New Development and Redevelopment (NDRD) Program and the Construction Sites Program.

3.6.1 Permanent Water Quality

At inception, water quality features were required for roadway improvements associated with both segments of this project. With the release of CDOT's *Permanent Water Quality (PWQ) Manual*, dated March 1, 2017, CDOT's PWQ Program requirements were updated. Because the US 550/160 Connection South Design Build Project does not lie within CDOT's MS4 permit boundary, PWQ Program requirements no longer apply to this project. Due to the stage of design when the regulations were updated, it was determined not to remove all PWQ features from the design. Water quality measures remaining in the Connection design demonstrate the potential for water quality. Ditches conveying roadway runoff to water quality designed for the 302 N segment were left in the design, but water quality elements were removed.

3.6.2 Construction Stormwater Management

A Stormwater Management Plan and Erosion Control Plan are required as part of the General Permit for Stormwater Discharges Associated with Construction Activity. The plans need to identify BMP measures, non-structural (i.e., administrative measures, phasing, signs) and structural, which will be used throughout each phase of the construction project to minimize erosion and protect water quality. The Stormwater Management Plan and the Erosion Control Plans shall be included in the Construction documents prepared for this project.