WATER QUALITY AND FLOODPLAINS TECHNICAL REPORT

October 2008

Prepared for:

Federal Highway Administration
Federal Transit Administration
Colorado Department of Transportation

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1.0 INTRODUCTION

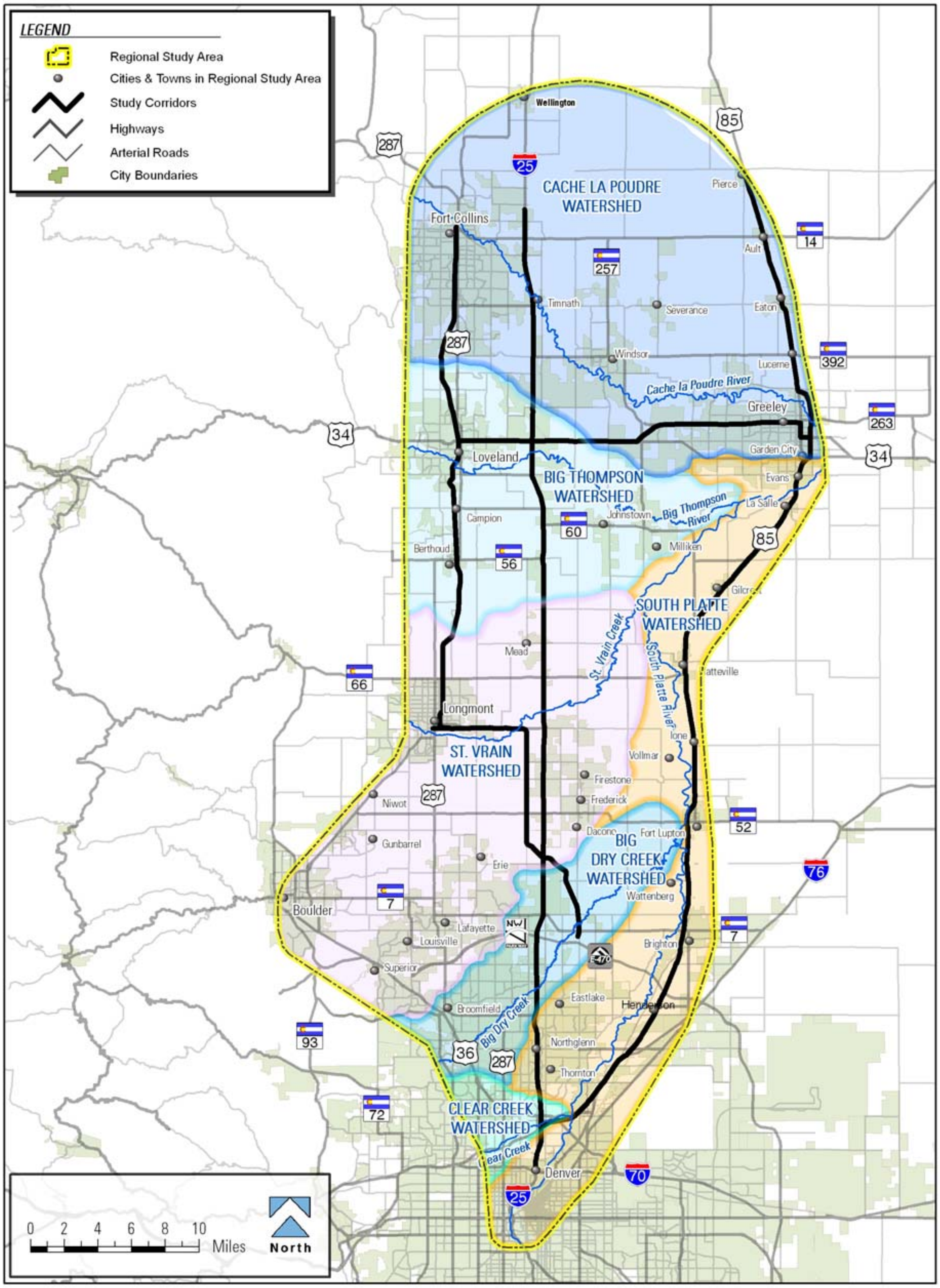
In accordance with the National Environmental Policy Act (NEPA) and its related regulations, the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), in cooperation with the Colorado Department of Transportation (CDOT), are preparing an Environmental Impact Statement (EIS) for the North Interstate 25 (I-25) project. This study identifies: 1) the existing water resource conditions; 2) the impacts from the proposed project activities; and 3) mitigation strategies to reduce impacts from the project alternatives.

1.1 PROJECT OVERVIEW

Transportation improvements are being considered along approximately 70 miles of the I-25 corridor, the BNSF railroad corridor to the west of I-25, and the US 85 corridor to the east of I-25. This is referred to as the regional study area, which is depicted in **Figure 1-1.** The regional study area spans portions of six counties: Adams, Boulder, Broomfield, Denver, Larimer, and Weld. In addition, more than 30 communities, two metropolitan planning organizations (the Denver Regional Council of Governments and the North Front Range Metropolitan Planning Organization), and the Upper Front Range Regional Planning Commission (UFRRPC) are included within the regional study area.

Three alternatives are being considered in the EIS. The first alternative is the No-Action Alternative (No-Action) where no new road or rail improvements will be made as part of this project, though changes to the system may be made by other projects. Additionally, there are two action alternatives (Package A and Package B) consisting of comprehensive system-wide road/rail improvements to the regional study area. The alternatives are described in detail in the EIS document (CDOT, 2007). There is overlap of the road corridors targeted for improvement by the two action alternatives, especially the I-25 corridor, but each action alternative is a unique set of road and/or rail improvements.

Figure 1-1 Regional Study Area



1.2 PURPOSE OF THE TECHNICAL DOCUMENT

Water is an important natural resource within the regional study area and throughout the State of Colorado. Streams, canals/ditches, lakes/reservoirs, and groundwater within the regional study area provide drinking and irrigation water supply, aquatic and riparian habitat, wetlands, recreation, and aesthetic value, all of which contribute to the quality of life for residents within the regional study area. The function of water resources within the regional study area, including the physical (e.g., stream channel structure), biological (e.g., aquatic habitat), and chemical (e.g., pH) characteristics could be affected by highway construction, operations, and maintenance activities associated with the project alternatives.

The purpose of this technical water resources analysis is to document existing water resource conditions (i.e., surface water, groundwater, and floodplains) within the project area. Water bodies that cross or are present within 100 feet of the existing I-25 or US 85 edges-of-pavement or the edge of the rail lines (BNSF, UPRR) were considered to be within the project area. Other objectives of the analysis are to evaluate the impact to water resources prior to the implementation of Best Management Practices (BMPs), and identify mitigation strategies for the project alternatives. The overall water resources goal for the North I-25 project is to develop a transportation system that meets the Purpose and Need of the project while maintaining or improving the aquatic systems within the project area and ensuring that the project complies with federal, state, and local laws that protect water resources. Specific goals for the water resources analysis include the:

- Establishment of baseline water quality, including physical, chemical, and biological conditions
- Identification of sensitive water resource areas for avoidance and impact minimization (i.e., waters on the Colorado Department of Public Health and Environment (CDPHE) 303(d) list and sensitive waters, as defined by the CDOT Municipal Separate Storm Sewer System (MS4) permit)
- Assessment of potential impacts to water resources from highway construction, operations, and maintenance activities associated with the build alternatives
- Identification of mitigation strategies to protect water quality

Watershed and municipal stakeholders were an important informational resource to develop the existing environmental conditions for this water resources analysis. CDOT and the project team conducted numerous stakeholder meetings to educate the attendees about the transportation project, identify existing watershed water quality documentation, identify existing water quality challenges, and initiate technical dialog about how the transportation improvements may affect local water resources. Stakeholders included all known watershed planning groups and local municipalities in the project area, CDPHE, United States Fish and Wildlife Service (USFWS), United States Environmental Protection Agency (EPA), the FHWA, and Colorado Division of Wildlife (CDOW). Stakeholder involvement is an on-going process and will be critical to the identification and development of water resource mitigation strategies within the affected watersheds.

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2.0 WATER RESOURCES REGULATIONS

Water resources within the project area are managed through federal, state, and local regulations that establish the standards and management actions necessary to protect their physical, chemical, and biological integrity. The primary regulations governing surface water and groundwater resources in the project area are the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA). The Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Commission (WQCC) has the authority to establish and enforce water quality standards within the state.

The primary water quality concern associated with the project results from the discharge of stormwater to receiving waters (see **Section 4.0**). As part of the CWA, entities with stormwater discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) permit program. MS4s that are owned and maintained by municipalities and CDOT are required to obtain Colorado Discharge Permit System (CDPS) permits for stormwater discharges. The permit requires CDOT to develop and implement a stormwater management program to maintain and protect water quality conditions from their stormwater discharges.

The CDOT MS4 permit authorizes new or existing discharges composed entirely of stormwater (and allowable non-stormwater discharges) from CDOT's MS4. This permit covers only state and interstate highways and their right-of-ways within the jurisdictional boundary of CDOT served by, or otherwise contributing to discharges to state waters from, municipal separate storm sewers owned or operated by CDOT that are within the following areas:

- the cities of Aurora, Colorado Springs, Denver, and Lakewood, herein referred to as the Phase I permit coverage areas; and
- the urbanized and CDPHE-designated areas; and the Cherry Creek Watershed, including any permitted Non-Standard MS4s that are within the urbanized areas of the counties, municipalities, and the Cherry Creek watershed, herein referred to as the Phase II permit coverage areas.

While the entire project must comply with CDPHE-WQCC rules and regulations, the MS4 permit requirements are only applicable in areas described above. The CDOT MS4 requirements described below are generally only applicable in these MS4 areas. Because of the size of this project, the alternatives cross the following 11 MS4 areas in the North I-25 Project Area:

- Portions of Adams County
- Portions of Boulder County
- The City and County of Broomfield
- The City of Fort Collins
- The City of Loveland
- The City of Thornton
- The Town of Erie
- Portions of Larimer County
- Portions of Weld County
- The City of Brighton
- The City of Longmont
- The City of Northglenn
- The City of Westminster

An analysis was conducted using the 2000 census urbanized area boundaries. However, because the study area is rapidly growing, the projected 2030 population used traffic model was utilized to predict what areas would meet the population density requirement in 2030. Additionally, areas along US 85 were not considered to be under the MS4 permit because the hydraulic characteristics of US 85 are not being altered. In other words, no new lanes are planned. However, the impervious surface area of five small areas for bus queue jumps at intersections along US 85 have been included in the consideration for water quality best management practices (BMPs). The project should also comply with requirements of local municipalities MS4 programs.

Terms and conditions of the MS4 permit require CDOT to develop and implement six stormwater management programs to reduce the discharge of pollutants from the MS4 to the maximum extent practicable:

- Construction Sites Program
- New Development and Redevelopment Program (also known as Post-Construction)
- Illicit Discharges Program (also known as Illicit Discharge Detection and Elimination)
- Industrial Facilities Program
- Public Education and Public Involvement Program
- Pollution Prevention and Good Housekeeping Program

The New Development and Redevelopment Planning Program is the primary CDOT Stormwater Management Program element for a planning level document, such as the North I-25 EIS. According to the MS4 permit, CDOT has developed and implemented a program that ensures that new highway projects and significant modifications are reviewed for the need to include permanent stormwater BMPs (structural and non-structural) to protect surface water. A permanent structural BMP can be a detention pond, a grassy swale, or an artificial wetland. Permanent non-structural BMPs can be a designated work practice that protects water quality or other non-structural components (CDOT, 2004a).

Program elements that require evaluation of permanent stormwater BMPs include (CDOT, 2004a):

- Any project that requires an EIS
- Any project that requires an Environmental Assessment (EA)
- Projects that will disrupt greater than one acre, within CDOT's MS4 coverage area.
- Projects that result in water quality impacts affecting the chemical, biological, or physical integrity of any state water, especially sensitive waters

The MS4 permit defines a water body as sensitive if it meets any of the following criteria:

- Water quality segments listed on the most recent 303(d) list or for which a total maximum daily load (TMDL) has been developed that limits the amount of the specified pollutant that is likely to be present in discharges from CDOT activity;
- Water quality segments listed on the most recent CDPHE Monitoring and Evaluation (M and E) List for a pollutant that is likely to be present in discharges from CDOT activity;

- Water quality segments designated as Outstanding Waters (OW), including wetlands;
- Water quality segments classified as Aquatic Life Class 1;
- Water quality segments designated for Water Supply use where the potential exists for the CDOT discharge to impact this use; or,
- Water quality segments designated by federal or state agencies as a Threatened or Endangered Species Habitat

Following general guidance in the New Development and Redevelopment program (CDOT 2004c), the BMPs identified for the North I-25 EIS will offer collection and passive treatment of stormwater that is currently being directly discharged into existing untreated stormwater systems. In addition, the BMPs may also provide protection to receiving waters from chemical spills that may occur in the project area.

2.1 COLORADO BASIC STANDARDS FOR SURFACE WATER

CDPHE WQCC established two main regulations that identify the designated uses and water quality standards, including the Basic Standards and Methodologies for Surface Water (Regulation 31) and Classification and Numeric Standards for South Platte River Basin; Laramie River Basin; Republican River Basin; Smoky Hill River Basin (Regulation 38) (CDPHE, 2007a; CDPHE, 2007b). Colorado currently has four designated uses for surface water bodies, including:

- Agriculture – waters suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.
- Water Supply – waters suitable or intended to become suitable for potable water supplies.
- Recreational - waters suitable for human contact
  - Class 1a: Existing primary contact – waters in which primary contact uses have been documented or are presumed to be present.
  - Class 1b: Potential primary contact – waters where a reasonable level of inquiry has failed to identify any existing primary contact uses, but no use attainability analysis (UAA) has been completed demonstrating that a Class 2 designation is appropriate.
  - Class 2: Secondary contact – waters where a UAA has demonstrated that there is not a reasonable potential for primary contact uses to occur within the next 20-year period, but the waters are suitable or intended to become suitable for other recreational uses.
- Aquatic Life - waters capable of supporting cold or warm water life
  - Class 1: Cold Water Aquatic Life-capable of sustaining a wide variety of cold water biota including sensitive species or sustain such biota but for correctable water quality conditions.

- Class 2: Cold Water Aquatic Life-not capable of sustaining a wide variety of cold water biota including sensitive species due to habitat, water flow/levels or uncorrectable water quality conditions.
- Class 1: Warm Water Aquatic Life-capable of sustaining a wide variety of warm water biota including sensitive species or could sustain such biota but for correctable water quality conditions.
- Class 2: Warm Water Aquatic Life-not capable of sustaining a wide variety of warm water biota including sensitive species due to habitat, water flow/levels or uncorrectable water quality conditions.

The recreational use standards framework was recently modified (2005) in the State's Basic Standards and Methodologies for Surface Water (Regulation 31). According to this modification, there are four types of recreational use classifications:

- Class E - Exiting Primary Contact Use; used for primary contact recreation or have been since November 2, 1975.
- Class P - Potential Primary Contact Use: Potential for being used for primary contract recreation (no use attainability analysis performed).
- Class N - Not Primary Contact Use; not suitable or intended to become suitable for contact recreational uses.
- Class U - Undetermined Use; limited data to assess classification; the default if no use attainability analysis has been performed by WQCC.

The updated recreational use standards will be reviewed and updated in the South Platte River Basin Standards (Regulation 38) during 2009 (Hegeman, 2006).

These designated uses have their own unique water quality standards that are either numeric (quantitative thresholds) or narrative (visual/aesthetic). Numeric standards have a corresponding numeric limit (e.g., 10 milligrams/liter [mg/L]). Narrative standards are more subjective and are based upon visual and aesthetic observations. For example, algal blooms from nutrient inputs can cause the recreational resource to be impaired thus causing the narrative standards to be exceeded.

Streams that do not meet established water quality standards ("impaired streams") are placed on the Colorado 303 (d) List. CDPHE is required to establish a Total Maximum Daily Load (TMDL) assessment for water bodies on the 303 (d) list. The TMDL assessment establishes the total amount of pollutant loading that a surface water system can receive without exceeding water quality standards. This process involves managing pollutant loading from point sources (discharges from a specific conveyance/pipe) and nonpoint sources (diffuse overland discharges). Pollutants discharged above the surface water's assimilation capacity must be managed to reduce overall loading to the surface water system. When determined as a major loading contributor to the impairment, the parties responsible for contributing to the impairment must create a plan to reduce loading or potentially receive a numerically based limit from CDPHE.

When surface waters may be impaired but supporting documentation does not meet the standards for credible evidence, these waters are placed on the CDPHE Colorado 303(d) M and E List. Stream segments on this list require additional water quality monitoring and analysis to determine if water quality standards for streams classification designated uses are being met.

The designated uses for the surface water bodies within the project area, and segments on the 2006 303(d) or M and E Lists are discussed in **Section 4.0**.

There are numerous irrigation canals and ditches throughout the project area. Despite the important function of transporting irrigation and drinking water, canals/ditches are not subject to the same regulatory classifications and designated uses as natural watercourses (known as Unclassified Waters of the State). The irrigation canals in the project area are considered waters of the State of Colorado. Based on CRS 25-8-103 (19), state waters are defined to be any and all surface and subsurface waters that are contained in or flow through the state, including streams, rivers, lakes, drainage ditches, storm drains, ground water, and wetlands, but not including waters in sewage systems, waters in treatment works or disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed. Not all waters of the state have designated uses, which are used to develop water quality standards for determining compliance with the CWA. Despite the importance of the canals in the project area and the Colorado Front Range, irrigation canals do not have designated uses as do natural watercourses. According to State of Colorado code (C.R.S. § 25-8-203(2)(f)), "Waters in ditches and other man-made conveyance structures shall not be classified [with designated uses], and water quality standards shall not be applied to them but may be utilized for purposes of discharge permits" [CDPHE, 2003]).

Therefore, because canals/ditches and other man-made structures need to be protected as state waters they are included in our analysis of existing conditions.

2.2 SAFE DRINKING WATER ACT

Public drinking water supplies (systems serving more than 25 people) from both groundwater and surface water sources are regulated by the Safe Drinking Water Act. These sources include lakes, rivers, reservoirs, springs, and groundwater. Under the Safe Drinking Water Act, EPA and the Congress established national health-based standards for drinking water contaminants specified as having known adverse human health effects. As with the CWA, EPA has delegated regulatory authority of the Safe Drinking Water Act to the CDPHE Water Quality Control Division (WQCD). **Section 4.0** includes information about public water supply wells in the project area and how they might be affected by CDOT activities.

2.3 COLORADO BASIC STANDARDS FOR GROUNDWATER

The Colorado Basic Standards for Groundwater (Regulation No. 41) and Site-specific Water Quality Classifications and Standards for Groundwater (Regulation No. 42) were established pursuant to the Colorado Water Quality Control Act. Regulation No. 41 establishes statewide standards and a system for classifying groundwater to protect existing and potential beneficial uses of groundwater in the state, while Regulation No. 42 establishes site-specific classifications for groundwater areas throughout the state (CDPHE, 2004a; CDPHE, 2006a).

Groundwater throughout the state is expected to comply with the narrative and numeric established within Regulation No. 41. The narrative standards require waters to be free of toxic, carcinogenic chemicals that are a danger to the public health. Narrative standards apply to Domestic Use-Quality, Agricultural Use-Quality, Surface Water Quality Protection, and Potentially Usable Quality. Groundwater in selected areas of Colorado does not meet these standards due to natural and manmade conditions. These areas are identified under Regulation No. 42 and alternative uses and standards are specified.

2.4 SENATE BILL 40

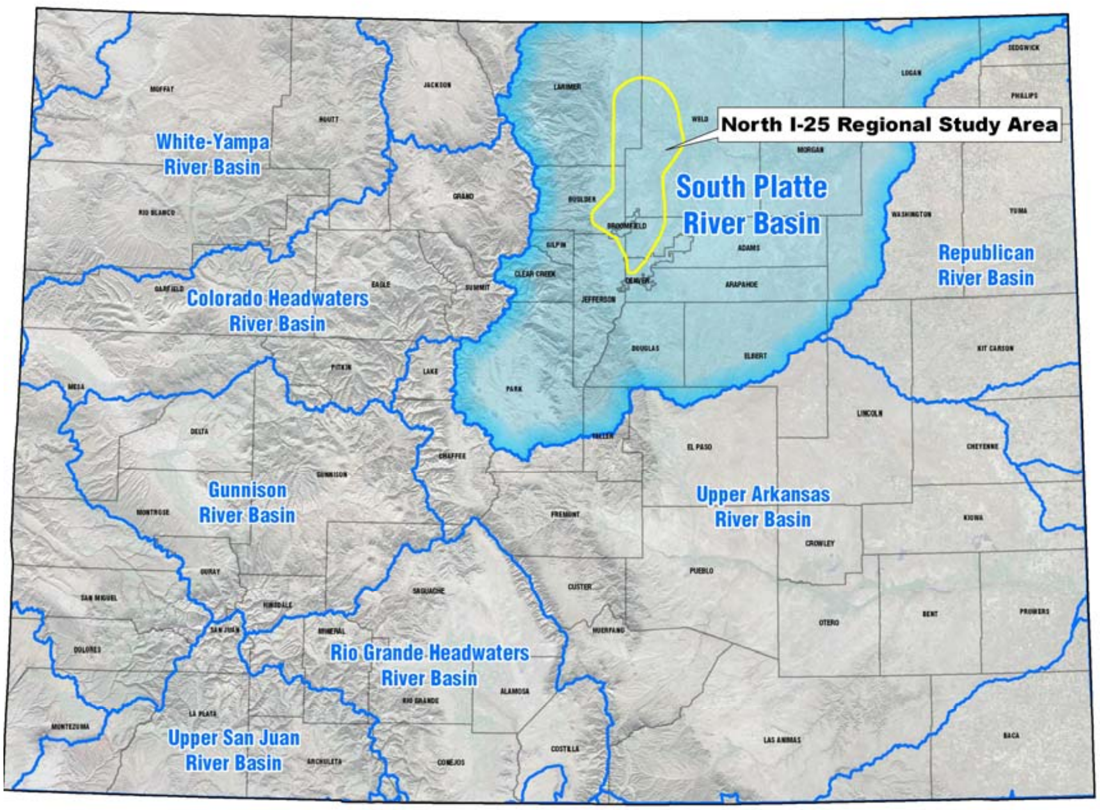
Colorado Senate Bill 40 (SB40) requires that projects that affect waters of the state and their associated riparian areas comply with its provisions. These provisions are aimed at preserving wildlife habitat in streams for fish and aquatic species and terrestrial species that rely upon riparian areas. Compliance with SB40 provisions is documented in a permit obtained through the Colorado Division of Wildlife. **Section 7.0** includes information about SB40 guidelines that will be followed in the project area.

3.0 REGIONAL STUDY AREA OVERVIEW

3.1 SOUTH PLATTE RIVER BASIN

The regional study area lies within the transition zone between the Rocky Mountain Front Range in central Colorado and the Great Plains of eastern Colorado and entirely within the South Platte River basin. The South Platte River basin is one of eight major river basins within Colorado, encompassing over 1.3 million acres in Colorado, Wyoming and Nebraska. Seventy-nine percent of the South Platte River basin (18,959 miles of streams) lies within the northeastern portion of Colorado (Colorado Water Conservation Board (CWCB), 2004; CDPHE, 2006d). The South Platte River eventually joins the North Platte River in Nebraska, which then flows into the Missouri and Mississippi Rivers. **Figure 3-1** shows the location of the South Platte River basin within the State of Colorado and relative to the regional study area.

Figure 3-1 South Platte River Basin



Approximately 70 percent of Colorado's population (nearly three million people) is concentrated within the major population centers along the Front Range and within the South Platte River basin (CDPHE, 2004b; CWCB, 2002). Within the past decade, population growth has increased rapidly within the region, with estimates indicating that nearly 2.4 million additional people will be settling along the Front Range within the next 25 years (CWCB, 2004). With the increased population growth, urbanization within the regional study area and project area are progressively contributing to degraded water quality.

3.1.1 Hydrology

There are six main watersheds within the South Platte River basin and within the project area: the South Platte River, Clear Creek, Big Dry Creek, St. Vrain Creek, Big Thompson River, and Cache la Poudre River. Within these associated watersheds, there are numerous surface water bodies, including intermittent and perennial streams, lakes, and reservoirs (see **Section 4.0)**. Numerous man-made surface water drainage features are also present within the project area and include culverts, inlets, and open channels. Most of the existing drainage structures in the project area were built during the 1960s. At that time, the adjacent areas were rural, and flood damage was limited to agricultural land. The sizes of many of these drainage structures were based on limited rainfall data for what was estimated to be a 25- or 50-year storm event. The 100-year storm is now used for drainage design in urbanized areas and for floodplains under the jurisdiction of the Federal Emergency Management Agency (FEMA). Many of the existing drainage structures constrict stormwater flows, cause flooding, and overtopping of the adjacent highways. In order to conform to newer criteria and control flooding, most drainage structures in the project area should be replaced with a larger structure.

Human activities have extensively altered the natural hydrologic conditions within the South Platte River basin. The majority of streams within the regional study area and project area have water flows that originate as snowmelt, creating high-flow conditions from May to July, with peak flows in June, and lower flows from October to March. High-intensity precipitation events also greatly affect these streams during the spring and summer months. Alterations to the natural hydrologic regime of the surface water systems within the entire basin affect the quality of aquatic habitat and the species that are dependent on that habitat. Water withdrawals within the basin have also affected the natural potential for streams to dilute contaminants entering from outside sources (USGS, 1998).

On an annual basis, over 3 million acre-feet of water are withdrawn from the South Platte River watershed, 400,000 acre-feet of water are imported into the watershed, and over 2 million acre-feet of water are stored in reservoirs within the watershed (USGS, 1998). The removal of water due to diversions, at times, depletes the amount of surface water flow from the hydrologic system, which has generally resulted in lower peak flows during the spring (USGS, 1998).

The high demand for water resources along the Front Range has lead to the over-appropriation of the existing water supply within the South Platte River basin. In general, the legal allocation of water (i.e., water rights) exceeds the amount of water that the South Platte River can physically supply (USGS, 1998). Several basin-wide issues are prevalent due to this high demand for water resources, including:

- Allocating water between multiple uses (predominantly urban and agricultural)
- Maintaining growth without impairing important water resources
- Protecting and restoring riparian habitats
- Developing future water supplies
- Protecting existing drinking-water supplies and the integrity of water resources as a whole (USGS, 1998)

With such a high demand for water resources along the Front Range, approximately 370,000 acre-feet of supplemental water are delivered each year via the Colorado-Big Thompson (CBT) project. The supplemental water accounts for approximately 34 percent of the total surface runoff in the upper reaches of the South Platte River basin (Wohl, 2001). Water from the CBT project is delivered to over 100 ditch, reservoir, and irrigation companies and 32 municipalities, supplying nearly 750,000 residential customers and irrigating approximately 620,000 acres of agricultural land along the Front Range. Water from the CBT project is also used to harness power for the cities of Longmont, Loveland, Boulder, Fort Collins, Greeley, Fort Morgan, and Sterling (Autobee, 1996; NCWCD, 2005).

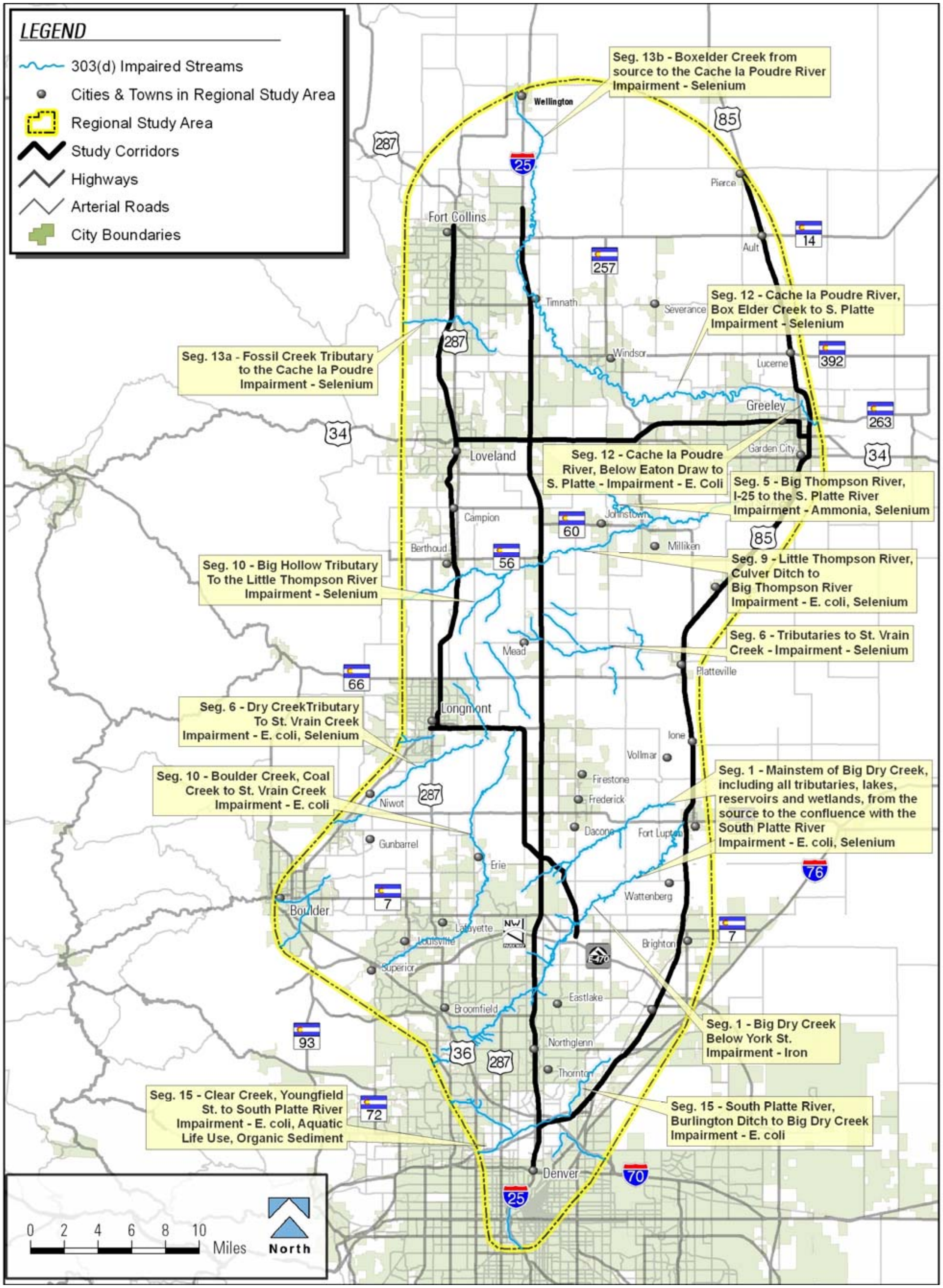
3.1.2 Surface Water Quality

The quality of surface water resources within the South Platte River basin watersheds is influenced by factors such as climate, geology, topography, land use patterns, natural water chemistry, stream flow characteristics, stream morphology, and riparian vegetation. Most of the surface water bodies within the South Platte River basin face similar water quality issues primarily due to human activities. These activities include extensive urbanization, flood control activities (e.g., channelization, cementing of banks, grade control structures), extensive in-basin and trans-basin diversions, reservoir construction, and pollutant-laden discharges (e.g., point and nonpoint) from multiple sources. Point sources of pollution can include POTW and stormwater sewer discharges, while nonpoint sources of pollution can include runoff from croplands, livestock, urban areas, roads, or construction sites (USGS, 1998).

During 2004-2005, 12,439 miles of stream surface water and 10,911 acres of lake surface water were fully supporting of all designated uses within the entire South Platte River basin. During this same time period, an estimated 3,134 miles of stream surface water and 4,763 acres of lake surface water were found to be impaired (CDPHE, 2006d). The surface waters within the project area that currently do not meet water quality standards are discussed in **Section 4.0**. Impaired stream segments and stream segments on CDPHE's M and E List for potential highway-related constituents are included in **Figure 3-2.**

In summary, the majority of the impairments in the project area are associated with Escherichia coli (*E. coli*) and selenium. *E. coli* impairments in Colorado streams are generally derived from animal waste, while the source of selenium impairments in Colorado streams are more ubiquitous (CDPHE, 2006c). However, in general, accelerated selenium mobilization can be associated with subsurface irrigation drainage systems that are incorporated in agricultural fields to prevent excess salt-build-up in soils. These systems can leach natural selenium from soils, which then drain into surrounding aquatic environments, such as ponds or creeks, which in turn empty into larger rivers, or wetland ecosystems. Although selenium is a naturally-occurring element that is found in rocks, soils, and water, it can be harmful to certain aquatic fish and wildlife species when concentrations are only slightly elevated above normal levels (Lemly, 2002).

Figure 3-2 Impaired Streams in the Project Area



3.2 GROUNDWATER

The regional study area is situated above the consolidated bedrock aquifers of the Denver basin and Dakota-Cheyenne group (aka South Platte Formation) and the unconsolidated shallow alluvial aquifers associated with the South Platte River and its tributaries (Colorado Geological Survey, 2003). Numerous groundwater wells associated with these aquifers are located within the project area. Groundwater from the aquifers is brought to the surface with wells and provide water supply for multiple uses.

3.2.1 Shallow Aquifers

Within the Front Range urban corridor, shallow aquifers are generally present within Quarternary age (2 – 1.8 Million Years Ago [MYA]) unconsolidated deposits (20 to 100 feet in thickness) and floodplain alluvium along the South Platte River and its tributaries. These shallow aquifers are generally present between 20 to 40 feet below the land surface and are recharged via precipitation, irrigation return flows, streams, canals, and ponds. Ninety percent of alluvial aquifer recharge results from infiltration of precipitation and irrigation water flows, while stream, canal and pond inflows are less influential (USGS, 2002b). Water infiltrates in a downward direction through alluvial deposits until it intercepts less permeable bedrock layers. Once the bedrock layer is reached, groundwater accumulates within the alluvium, thus forming the water table (USGS, 1996).

Within the regional study area, the South Platte River Valley-Fill aquifer is comprised of unconsolidated deposits consisting of sand, gravel, silt, and clay from the South Platte River and its' major tributaries. Within this aquifer, the saturated thickness of fluvial deposits ranges from 0 to 120 feet, with the lower saturation present in upland areas and the higher saturation present in stream valleys and paleo-valleys (USGS, 2002b). Water yields from this aquifer range from 500-1,000 gallons per minute (gpm) and are primarily used for irrigation and domestic water supply (Colorado Groundwater Association, 2000; Colorado Geological Survey, 2003).

Locally, groundwater flows downstream and toward drainages (Colorado Geological Survey, 2003). Groundwater flow direction within the Denver basin aquifers is generally expected to occur toward or in the same direction of the surface flow (parallel) of the South Platte River; however, this flow direction likely varies due to the influence of local water table elevations and variations in soil and rock permeability, and therefore may not be consistent with the direction of flow for surface water (Colorado Groundwater Association, 2000; Colorado Geological Survey, 2003).

3.2.2 Bedrock Aquifers

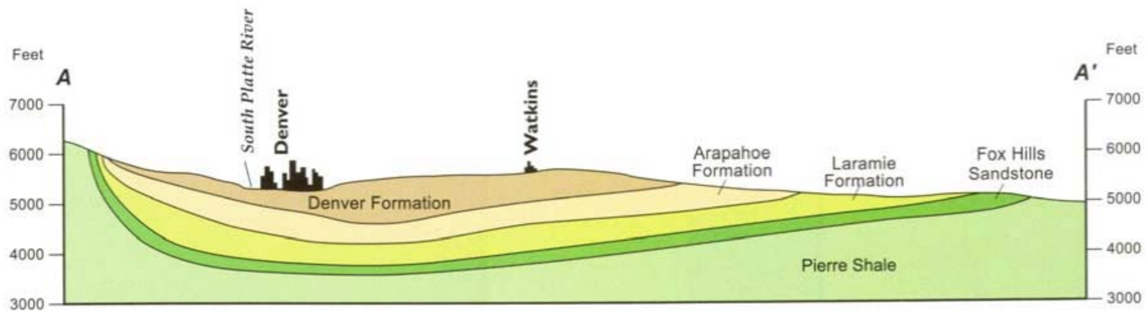
3.2.2.1 DENVER BASIN

The sedimentary rock geologic layers that make up the Denver basin include the Fox-Hills Sandstone, Laramie, Arapahoe, and Denver formations. The water-yielding portion of the Denver basin is approximately 6,700 square miles in area, and underlies a large portion of the project area, from just north of Denver to approximately the Greeley area. Groundwater from the Denver basin aquifers supplies a mix of domestic, commercial, industrial, and agricultural uses (Colorado Geological Survey, 2003;USGS, 2003b).

It is estimated that combined, the bedrock aquifers of the Denver basin store approximately 470-million acre-feet of water, with approximately 270 million acre-feet being recoverable (Colorado Groundwater Association, 2000). Saturated thickness within these aquifers ranges from 0 to 400 feet (USGS, 2002b).

The Denver basin consists of four principal sedimentary rock aquifers (each named after their corresponding geologic formation), with three that underlie a portion of the project area, including the Denver, Arapahoe, and the Laramie-Fox Hills aquifers (see **Figure 3-2**).

Figure 3-3 Bedrock Aquifers in the Regional Study Area



Source: Colorado Geological Survey, 2003, Fig. 6-1, p. 86

The Laramie-Fox Hills aquifer is the oldest and deepest of the three bedrock aquifers in the project area. This aquifer is generally confined, moderately permeable, with a water-yielding material thickness range of up to 300 feet (Colorado Groundwater Association, 2000). The aquifer consists mainly of sandstone and siltstone interbedded with shale from the Fox-Hill sandstone and Laramie formations. Water supply from this bedrock aquifer is mainly for domestic and municipal water uses and yields up to 350 gpm (Colorado Groundwater Association, 2000; Colorado Geological Survey, 2003).

- The Arapahoe aquifer is located above the Laramie-Fox Hills aquifer and is the most permeable and heavily used aquifer within the Denver basin. The Arapahoe aquifer is generally confined and consists of 400 to 700 feet of conglomerate, sandstone, siltstone, and shale (Colorado Groundwater Association, 2000). Water supplied by this aquifer is mainly for municipal purposes and yields up to 700 gpm (Colorado Groundwater Association, 2000; Colorado Geological Survey, 2003).
- The uppermost sedimentary rock aquifer underneath the project area is the Denver aquifer, which consists of 800 to1,000 feet of shale, silty claystone, and sandstone (Colorado Geological Survey, 2003). This aquifer is generally confined and the least permeable of the Denver basin aquifers, yielding up to 200 gpm and supplying groundwater mainly for domestic and municipal uses (Colorado Groundwater Association, 2000; Colorado Geological Survey, 2003).

The primary groundwater contaminants identified within Colorado's major aquifers, including the Denver basin are: nitrate, fluoride, selenium, iron, manganese, alpha radiation, and uranium. Fluoride, selenium, iron, manganese, alpha radiation, and uranium are all naturally-occurring constituents. Total dissolved solids (TDS), hardness, sulfate, and sodium are also identified as groundwater quality issues in Colorado's major aquifers.

The major sources of groundwater contamination in Colorado' major aquifers, including the Denver basin are: animal feedlots, leaking underground storage tanks (LUSTs), surface impoundments, landfills, septic systems, hazardous waste sites, large industrial facilities, oil and gas exploration, spills, small-scale manufacturing, and repair shops (CDPHE, 2002). Land-use activities have large impacts on alluvial aquifers in particular, due to their shallow water tables and high permeability.

The Dakota-Cheyenne group (aka South Platte Formation) is north of the Denver basin. This formation consists of an artesian aquifer system that underlies a northern portion of the project area, extending from approximately Greeley north to the Fort Collins-Wellington area. The Dakota-Cheyenne artesian aquifer system lies within the complex and extensive Dakota-Cheyenne group, which consists of two hydro-geologic units of sandstone layers separated by shale in many locations. Water from this aquifer is used primarily for domestic, municipal, industrial, and irrigation purposes (Colorado Groundwater Association, 2000; Colorado Geological Survey, 2003).

In areas with high oil and gas yields, groundwater quality in the Dakota-Cheyenne aquifer has relatively high levels of TDS, ranging from 200 to 25,000 mg/L. High TDS levels can be limiting for both domestic and industrial uses (Colorado Geological Survey, 2003).

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4.0 EXISTING CONDITIONS

This section describes the surface water designated uses and water quality impairments within the project area. Stream segments on CDPHE's M and E List for potential highway-related constituents are also included in this section. Water bodies that cross or are present within 100 feet of the existing I-25 or US 85 edges-of-pavement or the edge of the rail lines were considered to be within the project area. However, in certain cases, water bodies outside the project area were also included if they are: 1) downstream from the project area, 2) designated water supplies, or 3) impaired and close to the project area.

Existing contaminant loading from the current highway configuration for each watershed was estimated using an FHWA water quality model (Driscoll Model). This model is discussed later in this section. Five contaminants were modeled for the project area (chloride, copper, phosphorus, total suspended solids (TSS), and zinc) because of their water quality implications in the project area. They are assumed to be an indicator of overall contamination in runoff.

4.1 SOUTH PLATTE RIVER WATERSHED DESCRIPTION

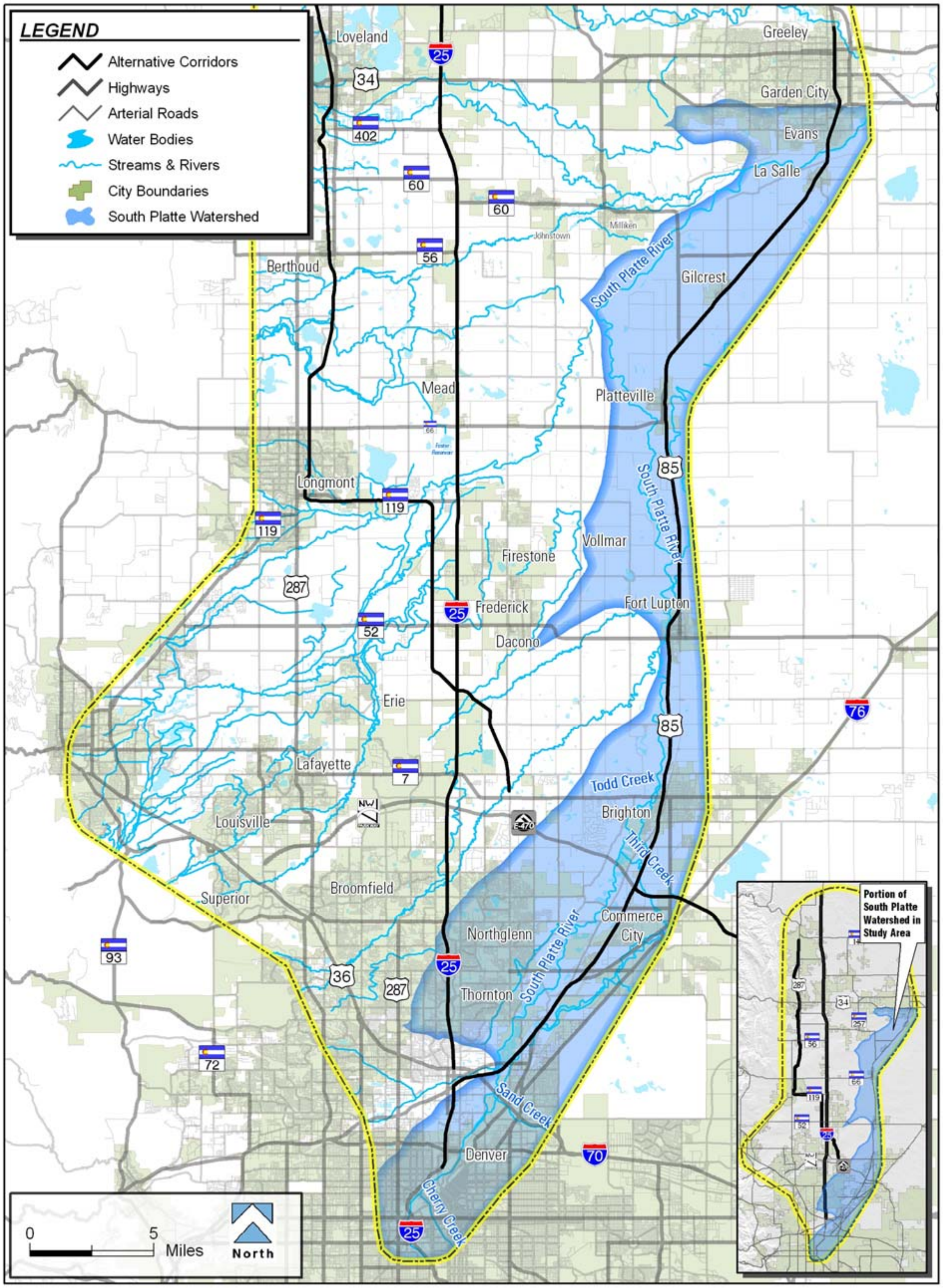
The South Platte River watershed occupies 45,560 acres in the southern portion of the regional study area (see **Figure 4-1**). Overall, within this watershed, I-25 accounts for approximately 110 acres of impervious surface within the project area (USGS, 2000). The E-470 to US 36 (H4) component crosses this watershed.

Natural surface waters originate at approximately 14,000 feet near the Continental Divide and flow in an easterly and northeasterly direction. The South Platte River drops nearly 11,000 feet in elevation while transitioning from a high alpine stream to an urban-dominated river and an irrigation-based and high plains stream system. All natural surface waters within the project area eventually flow into the South Platte River.

The landscape within the project area consists primarily of urban areas with large amounts of impervious surfaces. In all, approximately 29 percent (45,560 acres) of the watershed within the larger regional study area consists of impervious surfaces, with I-25 accounting for 110 acres of impervious surface area within this larger area (USGS, 2000). Other major cover types within the entire watershed include forest lands, rangeland, irrigated lands, dry land farming, and fallow farmland (USGS, 1998).

The hydrology and stream flow regime within the South Platte River watershed is typical of most watersheds along the Front Range (see **Section 3.1.1**). Stream flow within the watershed is heavily influenced by POTW discharges and the removal of water due to diversions. For nearly nine months of the year over 90 percent of the South Platte River's flow originates from wastewater effluent (CDM, 1994). Within the plains segment, surface water hydrology was historically characterized by intermittent flow, particularly during the summer and fall months. As a result of increased impervious surfaces, wastewater discharges, and increased irrigation demands on the South Platte River, it eventually became a perennial stream (CDM, 1994). However, the removal of water due to diversions creates nearly-dry to dry conditions within several downstream reaches of the South Platte River during different times of the year (CDM, 1994).

Figure 4-1 South Platte River Watershed



The South Platte River displays both urban and plains-type stream characteristics within the regional study area. Within the urban areas, the South Platte River exhibits a very linear, non-meandering character due to hydrologic modification from human activities. The entire length of the main stem of the South Platte River within the regional study area (69 miles) limits has been modified or channelized (USGS, 2006a). Physical modifications to the stream channel have occurred due to historic railroad development, flood prevention measures, and the construction of roads. Flood control activities, such as channelization, cementing of banks, and grade control structures (hard-lining) were designed along stretches of the South Platte River to facilitate the transport of stormwater.

The stream morphology changes as it flows northward past the Denver metropolitan area and into rural areas. The stream takes on a meandering characteristic and large width to depth ratios (i.e., wider and shallower), which are typical characteristics of plains type streams. Within these reaches, water temperatures are warmer, the floodplains are wider, water velocities decrease, and the channel begins to meander (CDM, 1994).

Ditches, streams, and water bodies in the regional study area, including the South Platte River, support a variety of aquatic insects, macroinvertebrates, and fish. In general, the quality of aquatic habitat within the South Platte River is moderately degraded throughout the watershed due to physical modifications to the stream channel, degradation of water quality from the addition of contaminants, and altered surface water flows (USGS, 1998). Species that are better able to tolerate these conditions, primarily suckers, dominate the urban reaches of the South Platte River. Further details regarding the current status of aquatic species in or the regional study area are provided within **Section 3.12** *Wildlife* in the EIS.

4.1.1 Surface Water Resources

The stream segments within the project area, their designated stream uses, and any water quality impairments are discussed in this section.

4.1.1.1 STREAMS

The streams within the project area are listed in **Table 4-1**. The main stem (Segments 15, 1a, and 1b) is also included because it has water supply designations and all streams within the project area eventually discharge into the South Platte River. It is important to consider downstream segments to ensure that upstream project activities do not adversely affect those receiving water bodies.

Table 4-1 South Platte River Watershed - Streams within the Project Area

I-25 Corridor	US 85 Corridor
Granger Hall Creek	South Platte River
Several unnamed tributaries to South Platte River	Second Creek
	Third Creek

These streams are classified as Upper South Platte River (Segments 15 and 16c) and South Platte (Segments 1a and 1b). According to the Colorado Regulation 38, Classifications and Numeric Standards for South Platte River Basin (Amended 4/9/2007, Effective 9/1/2007), the WQCC has established the following designated uses for the water bodies in the project area (CDPHE, 2007b):

- Segment 15: Recreation 1a, Class 2 warm water aquatic life, agriculture, and water supply
- Segment 16c: Recreation 1a, Class 2 warm water aquatic life, and agriculture
- Segment 1a: Recreation 1a, Class 2 warm water aquatic life, agriculture, and water supply
- Segment 1b: Recreation 1a, Class 2 warm water aquatic life, agriculture, and water supply

Some segments in this watershed are designated as water supply and anticipated constituents in the roadway runoff would not inhibit these segments from achieving this designated use. The water supply designated use implies that the water can be used for drinking water after normal treatment processes. Therefore, there are no sensitive waters, as defined by the CDOT MS4 permit, within the South Platte River watershed in the project area.

4.1.1.2 CANALS AND DITCHES

The Farmer's Highline Canal (0.079 acres) is present within the southern portion of the project area. The Farmer's Highline Canal, owned by the Farmer's Highline Canal and Reservoir Company, has been in use along the Front Range since 1886. Initially, the canal primarily served irrigation needs, but this slowly changed as agricultural land was converted to residential areas. Currently, Arvada, Westminster, Northglenn, and Thornton use approximately 85 percent of the water carried by the Farmer's Highline Canal, originating from Clear Creek, for both municipal and industrial purposes (Silkensen, 2000).

The ditches/canals in the South Platte River watershed that cross the US 85 corridor are:

- Platteville Ditch
- Platte Valley Canal
- Western Mutual Ditch
- Lateral of Fulton Ditch
- Union Ditch

4.1.1.3 LAKES AND RESERVOIRS

Approximately 0.551 acres of lake/reservoir surface water associated with the South Platte River watershed are within the southern portion of the project area. These surface water bodies are classified as Segment 16c (see **Section 4.1.1.1**).

4.1.1.4 IMPAIRMENTS

South Platte River Segments 16c, 1a, and 1b do not have any water quality impairments. Segment 15 has been placed on the 2006 303(d) List for an *E. Coli* impairment (CDPHE, 2006a). *E. coli* can be detected in stormwater runoff, but is not generally associated with highway activities.

4.1.1.5 DRISCOLL MODEL

Table 4-2 presents the estimated existing contaminant loading from a storm event from the existing I-25 conditions in the watersheds in the project area. These values are compared to the estimated loading for each alternative in the following section.

Table 4-2 Mean Contaminant Loading Per Storm Event From The Driscoll Model (Pounds per Event) in the South Platte River Watershed

Watershed	Chloride *(pounds/event)*	Copper *(pounds/event)*	Phosphorus *(pounds/event)*	Total Suspended Solids (TSS) *(pounds/event)*	Zinc *(pounds/event)*
South Platte River	78.4	0.058	3.7	2,600	0.52
Clear Creek	14.5	0.011	0.68	481	0.097
Big Dry Creek	125	0.093	5.8	4,150	0.83
St. Vrain Creek	265	0.20	12.4	8,800	1.8
Big Thompson River	181	0.13	8.4	6,000	1.2
Cache la Poudre River	266	0.20	12.4	8,800	1.8

4.1.2 Groundwater Resources

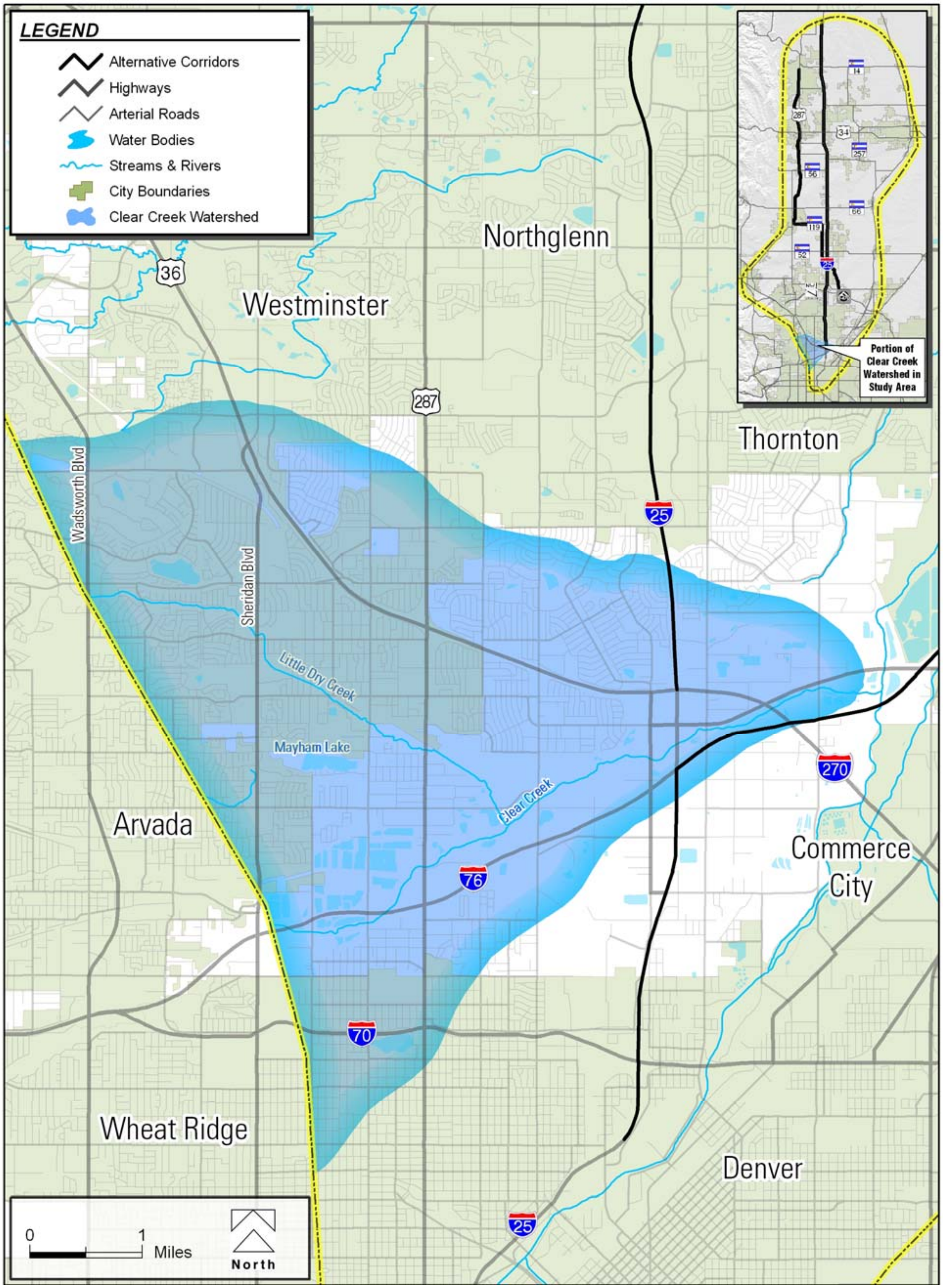
Within the project area and the South Platte River watershed, there are five potential drinking water wells (public and/or private) within 500 feet of the edge of existing I-25 corridor. The groundwater meets basic narrative and numeric water quality standards and no impairments have been identified by the WQCC.

4.2 CLEAR CREEK WATERSHED

The Clear Creek watershed occupies 14,787 acres in the southern portion of the regional study area (see **Figure 4-2**). Overall, within this watershed, I-25 accounts for approximately 20 acres of impervious surface within the project area (USGS, 2000). The E-470 to US 36 (H4) component crosses this watershed

Natural surface waters in the watershed originate at the Continental Divide, and flow in an easterly direction, emerging from the foothills at Golden, Colorado. Clear Creek then flows approximately 11 miles to the confluence with the South Platte River.

Figure 4-2 Clear Creek Watershed



The major land cover in the watershed includes evergreen forest lands, grasslands/herbaceous lands, shrublands, and low intensity residential development (USGS, 2000). The landscape within the project area, which lies with the lower portion of the watershed, consists primarily of urbanized areas with large amounts of impervious surfaces (EPA, 1997). Approximately 82 percent (12,173 acres) of the watershed within the regional study area consists of impervious surfaces, with I-25 accounting for 20 acres of impervious surface area (USGS, 2000).

The majority of surface water from Clear Creek (85 percent) is used as a primary drinking water source for approximately 350,000 people (USGS, 2002a).

The hydrology and stream flow regime within the Clear Creek watershed is typical of most watersheds along the Front Range (see **Section 3.1.1**). Clear Creek is a highly managed stream within the lower portion of the watershed. In this portion of the watershed diversions remove a significant amount of water from Clear Creek, while only about 20 percent of the water passing through Golden reaches the confluence with the South Platte River (USGS, 2002a; EPA, 1997).

The major factors affecting water quality within the lower portion of the Clear Creek watershed include (EPA, 1999):

- Urban development and runoff
- Hydrologic modification (gravel pits/water storage)
- Nutrient loading from septic tanks and municipal point sources
- Industrial discharges
- LUSTs

The main stem of Clear Creek is a characteristic urban type stream. The entire stretch of Clear Creek within the regional study area (six miles) has been modified or channelized (USGS, 2006a). The main channel is primarily linear, with low stream sinuosity and steep stream banks in several places, due to hydrologic modifications from human activities. Historically, the main stem exhibited a naturally meandering, sinuous, and braided character. The stream channel is very linear in shape near I-25. The natural riparian vegetation along Clear Creek has largely been eliminated by historic agricultural and grazing activities (USGS, 2002a).

Ditches, streams, and water bodies in the regional study area, including Clear Creek, support a variety of aquatic insects, macroinvertebrates, and fish. In general, the growth and function of in-stream aquatic habitat and riparian vegetation within the Clear Creek watershed have been affected by physical modifications, historic water quality issues, and altered surface water flows, which are causing impacts to native fish species and other aquatic organisms within the watershed. Non-native aquatic species, such as yellow perch, are becoming more prevalent within stretches of Clear Creek and are out-competing native species, such as green and orange-spotted sunfish (USGS, 2002a). Largemouth bass, green catfish, and creek chubs are also better able to adjust to the altered flow regime and degraded physical habitat conditions within the main stem of Clear Creek (EPA, 1997). Further details regarding the current status of aquatic species in or near the project area are provided within **Section 3.12** *Wildlife* in the EIS.

4.2.1 Surface Water Resources

The stream segments within the project area, their designated stream uses, and any impairments are discussed in this section.

4.2.1.1 Streams

The main stem of Clear Creek that crosses I-25 just south of the proposed improvements and downstream of the project area is classified as Segment 15. According to the Colorado Regulation 38, Classifications and Numeric Standards for South Platte River Basin (Amended 4/9/2007, Effective 9/1/2007), the WQCC has established the following designated uses for Segment 15: Class 1 warm water aquatic life, recreation 1a, water supply, and agriculture (CDPHE, 2007b). There are no sensitive waters, as defined by the CDOT MS4 permit, within the Clear Creek watershed in the project area.

The segment in this watershed is designated as water supply and anticipated constituents in the roadway runoff would not inhibit these segments from achieving this designated use. The water supply designated use implies that the water can be used for drinking water after normal treatment processes.

4.2.1.2 Canals and Ditches

A small portion of the Lower Clear Creek Canal is present in the southern portion of the project area. The Lower Clear Creek Canal is owned by the Lower Clear Creek Canal Company and the City of Thornton and used primarily for irrigation and municipal drinking water purposes.

4.2.1.3 Lakes and Reservoirs

There are no lakes or reservoirs associated with the Clear Creek watershed within the project area. However, there are lakes and reservoirs within the larger regional study area.

4.2.1.4 Impairments

Clear Creek Segment 15 fails to meet some of its stream classification designated uses and has been placed on the 2006 303(d) List for *E. coli*, aquatic life use, and organic sediment (CDPHE, 2006b) (see **Figure 3-2**). Segment 15 fails to meet water quality standards for recreation due to *E. coli* and aquatic life due to biological oxygen demand (BOD), sediment load (sediment oxygen demand), and aquatic life uses (CDPHE, 2006d). Aquatic life use impairments indicate that native fish species have declined in the stream system as compared to historical conditions. A TMDL analysis has not been completed for this segment (CDPHE, 2006d).

E. coli can be detected in stormwater runoff, but is not generally associated with highway activities (see **Table 5-2**).

4.2.1.5 Driscoll Model

Table 4-2 presents the estimated existing contaminant loading from a storm event from the existing I-25 conditions in the Clear Creek watershed. These values are compared to the estimated loading for each alternative in the following section.

4.2.2 Groundwater Resources

Within the project area and the Clear Creek watershed, there are five potential drinking water wells (public and/or private) within 500 feet of the existing I-25 corridor. The groundwater meets basic narrative and numeric water quality standards and no impairments have been identified by the WQCC.

4.3 BIG DRY CREEK WATERSHED

The Big Dry Creek watershed occupies 65,055 acres in the southern portion of the regional study area (see **Figure 4-3**). The watershed lies south of the St. Vrain Creek watershed and north of the South Platte River watershed. Overall, within this watershed, I-25 accounts for 171 acres of impervious surface area within the project area (USGS, 2000). The E-470 to US 36 (H4) component and the SH 60 to E-470 (H3) component cross this watershed.

Surface waters originate at approximately 8,000 feet in the foothills, approximately one-half mile west of SH 93 at the mouth of Coal Creek Canyon (WWE, 1998). Big Dry Creek surface waters flow in an easterly and northeasterly direction for nearly 42 miles before they join the South Platte River near Fort Lupton in Weld County.

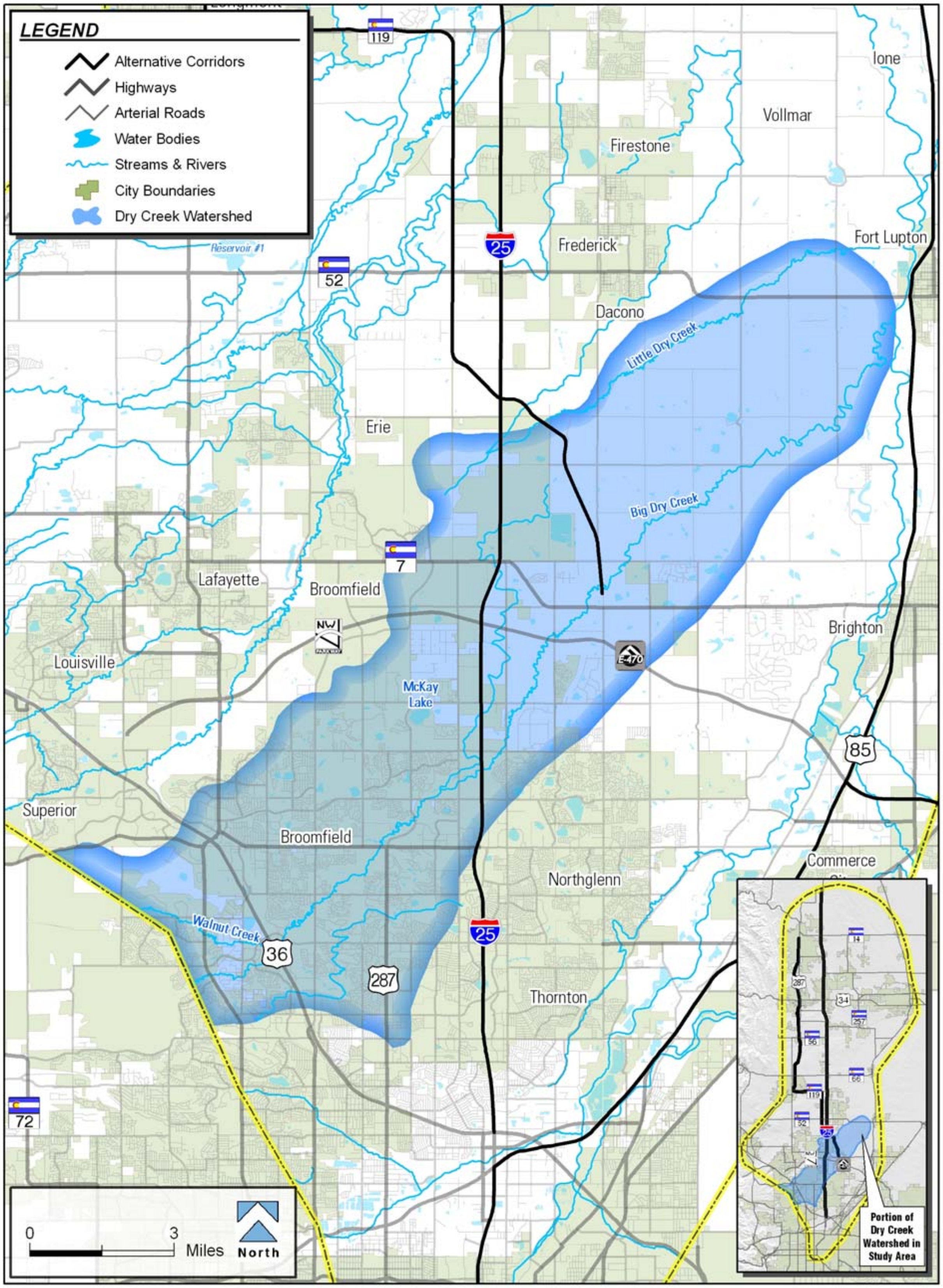
Land use within the watershed consists of a mixture of agricultural/rangeland, residential, commercial, and industrial uses. Within the entire watershed, the major land cover types include grasslands/herbaceous lands, low intensity residential development, and agricultural lands (pasture/hay and small grains) (USGS, 2000). Approximately 23 percent (15,139 acres) of the watershed within the larger regional study area consists of impervious surfaces, with I-25 accounting for 176 acres of impervious surface area within this larger regional study area (USGS, 2000).

East of I-25, the land use is primarily agricultural interspersed with some residential use. Within the past ten years, land use west of I-25 has changed from predominantly open space and rangeland to a mixture of residential and commercial uses. However, the preserved riparian corridor along Big Dry Creek still provides valuable wildlife habitat and a vital movement corridor for many species. Jefferson County Open Space and the City of Westminster are responsible for the corridor preservation along Big Dry Creek (WWE, 1998). More information on wildlife habitat and movement corridors is provided in **Section 3.12** *Wildlife* in the EIS.

The hydrology and stream flow regime within the Big Dry Creek watershed is typical of most watersheds along the Front Range (see **Section 3.1.1**). Stream flow within Big Dry Creek is heavily influenced by water releases from Standley Lake, which is managed for domestic water supply and agricultural activities, and the removal of water due to diversions. There are over 70 water right decrees for Big Dry Creek, with the majority of water rights being owned by the cities of Westminster and Thornton and several private landowners. Supplemental water is also imported into the Big Dry Creek watershed from both the Clear Creek and Coal Creek watersheds (WWE, 1998).

Physical modifications to the stream channel have occurred within the main stem of Big Dry Creek; however, unlike the other stream systems within the project area, the main stem below Standley Lake has not been highly channelized and retains much of the natural sinuosity and meandering characteristics common of prairie type streams (WWE, 1998). Within the regional study area, 0.3 percent (0.1 of 33.6 miles) of Big Dry Creek has been modified or channelized (USGS, 2006a). However, the stream channel exhibits a more linear form near I-25 and resumes a more natural meandering feature ½ mile east and downstream of I-25. Little Dry Creek exhibits similar stream channel characteristics.

Figure 4-3 Big Dry Creek Watershed



Agricultural areas and cattle grazing near stream banks have degraded water quality in the lower reaches of Big Dry Creek (WWE, 1998). In addition, natural sediment loads within the lower portion of Big Dry Creek have been altered due to an accumulation of sediment within Standley Lake. A lack of natural sediment within this portion of the watershed has resulted in some erosion and down cutting within the stream channel from Standley Lake to I-25 (WWE, 1998). Increased stream flow due to urbanization in the reaches of Big Dry Creek upstream of I-25 has caused water quality issues downstream of I-25, including alterations to the stream channel, stream bank instability, and flooding problems (WWE, 1998).

Temperature modifications due to POTW discharges and an increase in levels of TSS from upstream to downstream have also been identified as water quality issues within the watershed. Levels of TSS are highest within the watershed following storm events during the summer months (BDCWA, 2003; Clary, 2005).

Ditches, streams, and water bodies in the regional study area, including Big Dry Creek, support a variety of aquatic insects, macroinvertebrates, and fish. In general, the populations and diversity of aquatic species within the Big Dry Creek are limited due to a lack of suitable physical habitat caused mostly by alterations in natural surface water flows. In addition, temperature increases due to POTW discharges, polluted urban and agricultural runoff, and stream diversions are affecting the abundance and diversity of aquatic species within the watershed (WWE, 1998). Further details regarding the current status of aquatic species in the regional study area are provided within **Section 3.12** *Wildlife* in the EIS.

4.3.1 Surface Water Resources

The stream segments within the project area, their designated stream uses, and any impairments are discussed in this section.

4.3.1.1 Streams

Several perennial and intermittent streams within the Big Dry Creek watershed are present within the project area (see **Table 4-3**).

Table 4-3 Big Dry Creek Streams within the Project Area

I-25 Corridor	Rail Corridor
Tanglewood Creek	Big Dry Creek
Big Dry Creek	Unnamed tributary to Big Dry Creek
Little Dry Creek	
East Fork Preble Creek	
Several unnamed tributaries to Big Dry Creek	

These streams are classified as Big Dry Creek Segment 1. According to the Colorado Regulation 38, Classifications and Numeric Standards for South Platte River Basin (Amended 4/9/2007, Effective 9/1/2007), the WQCC has established the following designated uses for Big Dry Creek Segment 1: Class 2 warm water aquatic life, recreation 1b, and agriculture (CDPHE, 2007b). Segment 1 of Big Dry Creek, 2.5 miles downstream from the project area, is classified as a sensitive water, as defined by the CDOT MS4 permit, because it has been placed on the M and E List for a roadway related constituent (see **Section 4.3.1.4**).

The stream segment in this watershed is designated as water supply and anticipated constituents in the roadway runoff would not inhibit these segments from achieving this designated use. The water supply designated use implies that the water can be used for drinking water after normal treatment processes.

4.3.1.2 Canals and Ditches

Bull Canal and one unnamed irrigation canal/ditch are within the project area (see **Table 4-4**).

Table 4-4 Big Dry Creek Watershed Canals/Ditches within the Project Area

Canals/Ditches	Uses	Owner
I-25 Corridor		
Bull Canal	Municipal Water Supply	Farmer's Reservoir & Irrigation Co.
Unnamed	Irrigation	Unknown
Rail Corridor		
Bull Canal	Municipal Water Supply	Farmer's Reservoir & Irrigation Co.

4.3.1.3 Lakes and Reservoirs

There are no lakes or reservoirs associated with the Big Dry Creek watershed within the project area. However, there are lakes and reservoirs within the larger regional study area.

4.3.1.4 Impairments

Big Dry Creek Segment 1 fails to meet some of its stream classification designated uses and has been placed on the 2006 303(d) List (CDPHE, 2006b) (see **Figure 3-2**). Segment 1 fails to meet water quality standards for recreation 1b (due to *E. coli*) and warm water aquatic life (due to selenium) within the entire segment (CDPHE, 2006d). The WQCC has identified this segment as high priority (*E. coli*) and low priority (selenium) for TMDL analysis (CDPHE, 2006b). A TMDL analysis has not been completed for this segment (CDPHE, 2006d).

E. coli can be detected in stormwater runoff, but is not generally associated with highway activities. Selenium is not generally associated with highway activities (see **Table 5-2**).

A portion of Segment 1, below York Street, has also been placed on the 2006 M and E List for total recoverable iron; however this portion of Segment 1 is approximately 2.5 miles downstream of the project area (CDPHE, 2006c). Iron is with a constituent that can be associated with stormwater discharges from highway surfaces due to auto body rust, steel highway structures, and vehicle engine parts.

4.3.1.5 Driscoll Model

Table 4-2 presents the estimated existing contaminant loading from a storm event from the existing I-25 conditions in the Big Dry Creek watershed. These values are compared to the estimated loading for each alternative in the following section.

4.3.2 Groundwater Resources

Within the project area and the Big Dry Creek watershed, there are 14 potential drinking water wells (public and/or private) within 500 feet of the existing I-25 corridor. The groundwater meets basic narrative and numeric water quality standards and no impairments have been identified by the WQCC.

4.4 ST. VRAIN CREEK WATERSHED

The St. Vrain Creek watershed occupies 204,664 acres in the middle portion of the regional study area. The watershed lies north of the Big Dry Creek watershed and south of the Big Thompson River watershed (see **Figure 4-4**). Overall, within this watershed, I-25 accounts for 350 acres of impervious surface area within the project area (USGS, 2000). The SH 60 to E-470 (H3) component crosses this watershed.

Natural surface waters in the watershed originate at 13,520 feet near the Continental Divide in western Boulder County and generally flow from west to east. The St. Vrain Creek watershed is heavily influenced by the Boulder Creek watershed, which reaches the confluence with the St. Vrain Creek approximately two miles west of the project area (BCCF, 2006; USGS, 2006b).

The major land cover types in the entire watershed include evergreen forest lands, grasslands/herbaceous lands, agricultural lands (pasture/hay), and shrubland (USGS, 2000). The landscape within the project area, which lies within the lower portion of the watershed, consists mainly of grassland, agricultural land/pastures, open space, and developed/urbanized land (USGS, 2006b; USGS, 2003a). Approximately 17 percent (35,218 acres) of the watershed within the larger regional study area consists of impervious surfaces, with I-25 accounting for 354 acres of impervious surface area of this larger regional study area (USGS, 2000).

The riparian corridor along St. Vrain Creek continues to provide valuable wildlife habitat and is a vital movement corridor for many species. Portions of St. Vrain Creek are designated as Critical Wildlife Habitat and Significant Riparian Corridor in the Boulder County Comprehensive Plan, while the Colorado National Heritage Program has designated portions as Potential Conservation Areas (Trout Unlimited, 2005).

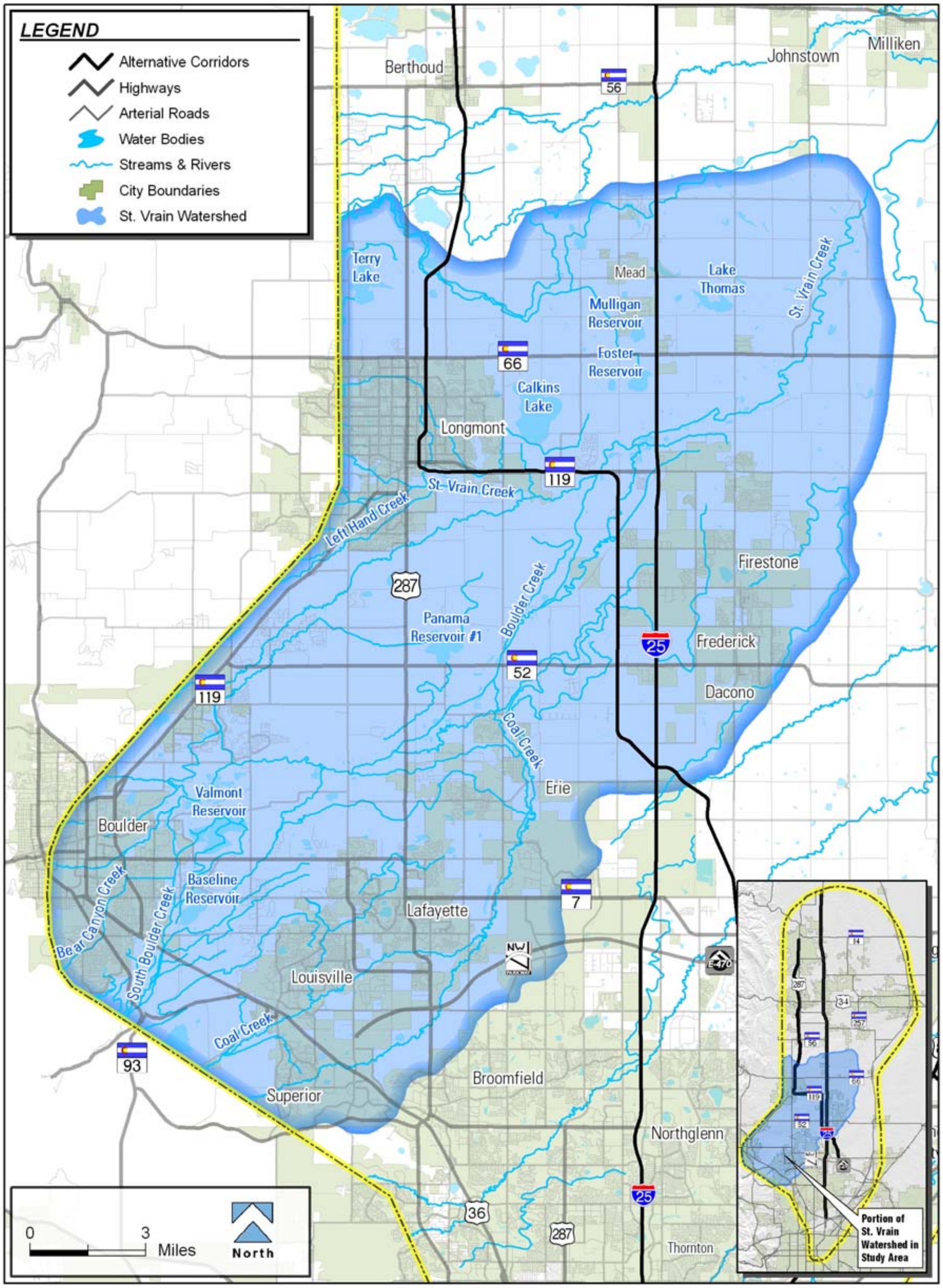
The hydrology and stream flow regime within the St. Vrain Creek watershed is typical of most watersheds along the Front Range (see **Section 3.1.1**). Stream flow within St. Vrain Creek is heavily influenced by the removal of water due to diversions for agricultural, domestic, and industrial activities (i.e., irrigation, drinking water, and wastewater processing). The removal of water due to diversions greatly depletes stream flow within the watershed between Lyons and Longmont (Trout Unlimited, 2005). Within the past 50 years, historic gravel mining activities have also depleted stream flow east of Lyons (Trout Unlimited, 2005). Stream flow is also influenced by trans-basin diversions, which import supplemental water from the west slope into the watershed at Lyons (Trout Unlimited, 2005).

Physical modifications to the stream channel have occurred along the main stem of St. Vrain Creek near the project area. Within the regional study area, all 23 miles of the main stream channel have been modified or channelized (USGS, 2006a). St. Vrain Creek has been channelized and exhibits a more linear shape as it approaches the bridge structure at I-25. The channel remains primarily linear until approximately ½ mile east of I-25 where it begins to regain the meandering characteristic of a plains-type stream. A hydrologic modification was constructed within the stream channel below the bridge just east of I-25.

The stream channel and banks are armored with cemented rock material, which creates an impediment to fish mobility due to increased stream gradient, velocity, and elevation drop. Upstream of the confluence with St. Vrain Creek, Boulder Creek has also been channelized (Murphy and Waterman, 2005).

Ditches, streams, and water bodies in the regional project area, including St. Vrain Creek, support a variety of aquatic insects, macroinvertebrates, and fish. In general, physical modifications to the stream channel have impacted native aquatic organisms within the lower reaches of Boulder Creek (BCCF, 2006). In the reaches of Boulder Creek upstream of the confluence with St. Vrain Creek, the lack of riparian vegetation has altered surface water temperatures, pH levels, and dissolved oxygen concentrations, which has caused uninhabitable conditions for many aquatic species. At times, rising levels of unionized ammonia have created toxic conditions for many fish species. Species that are better able to adjust to the degraded physical habitat conditions are prevalent within the lower portion of the watershed, including native white suckers, fathead minnows, as well as non-native common carp (USGS, 2003a; Murphy and Waterman, 2005). Further details regarding the current status of aquatic species in or near the project area are provided within **Section 3.12** *Wildlife* in the EIS.

Figure 4-4 St. Vrain Creek Watershed



4.4.1 Surface Water Resources

The stream segments within the project area, their designated stream uses, and any impairments are discussed in this section.

4.4.1.1 STREAMS

Several perennial and intermittent streams within the St. Vrain Creek watershed are present within in the project area (see **Table 4-5**).

Table 4-5 St. Vrain Creek Watershed Streams within the Project Area

I-25 Corridor	Rail Corridor
Rinn Valley Creek	Rinn Valley Creek
St. Vrain Creek	Unnamed tributary to St. Vrain Creek
Several unnamed tributaries to St. Vrain Creek	

The streams are classified as St. Vrain Creek Segments 3 and 6. According to the Colorado Regulation 38, Classifications and Numeric Standards for South Platte River Basin (Amended 4/9/2007, Effective 9/1/2007), the WQCC has established the following designated uses for the water bodies in the project area (CDPHE, 2007b): Boulder Creek Segment 10 is also included because it is located close to the project area, has a designated water supply designation, and has an impairment (CDPHE, 2006a).

- **Segment 3**: Class 1 warm water aquatic life, recreation 1a, and agriculture
- **Segment 6**: Class 2 warm water aquatic life, recreation 1a, and agriculture
- **Boulder Creek Segment 10**: Class 1 warm water aquatic life, recreation 1a, agriculture, and water supply

A stream segment in this watershed is designated as water supply and anticipated constituents in the roadway runoff would not inhibit these segments from achieving this designated use. The water supply designated use implies that the water can be used for drinking water after normal treatment processes.

4.4.1.2 CANALS AND DITCHES

Several irrigation canals/ditches within the St. Vrain Creek watershed are present within the project area (see **Table 4-6**).

Table 4-6 St. Vrain Creek Watershed Canals/Ditches within the Project Area

Canals/Ditches	Uses	Owner
I-25 Corridor		
Rural Ditch	Irrigation	Lower Boulder Reservoir & Ditch Co.
Last Chance Ditch	Irrigation	Last Chance Ditch Company
Sullivan Canal/Lower Boulder Ditch	Irrigation	Lower Boulder Reservoir & Ditch Co.
Boulder and Weld County Ditch	Irrigation	Boulder & Weld County Ditch Co.
Mead Lateral Ditch/Farmers Extension Ditch	Irrigation	Highland Ditch Co.
Unnamed Ditch near Motor Sports Park	Unknown	Unknown
Unnamed Ditch on Mulligan property	Unknown	Unknown
Highland Ditch	Unknown	Unknown
Unnamed Ditch exits Foster Reservoir	Unknown	Unknown
Flume Ditch	Unknown	Unknown
Unnamed Ditch on Haley property	Unknown	Unknown
Unnamed Ditch on Nelson property	Unknown	Unknown
Unnamed Ditch on McWilliams Property	Unknown	Unknown
Unnamed Ditch on Dacono Gateway Center property	Unknown	Unknown
Several Unnamed Ditches	Unknown	Unknown
Rail Corridor		
Bull Canal	Municipal Water Supply	Farmer's Reservoir & Irrigation Co.
The Slough	Unknown	Unknown
Oligarchy Ditch	Unknown	Unknown
Supply Ditch	Irrigation	Consolidated Home Supply Ditch and Reservoir Co.
Rough & Ready Ditch	Unknown	Unknown
Highland Ditch	Unknown	Unknown
Unnamed Irrigation Ditch	Unknown	Unknown

4.4.1.3 LAKES AND RESERVOIRS

Approximately 0.77 acres of lake/reservoir surface water associated with the St. Vrain Creek watershed are within the project area. These surface water bodies are classified as Segment 6 (see **Section 4.4.1.1**).

St. Vrain State Park lies within the lower portion of the watershed and within the project area. The park is just east of I-25 and north of the SH 119 interchange. There are currently over 80 acres of surface waters that exist within the park, including several fairly shallow man-made lakes (Finch, 2005). These lakes are stocked by the CDOW with trout and provide a recreational resource for fisherman. Many rough fish (i.e., carp, suckers) are also prevalent in surface waters within the park (Shapins Associates, 2004). Within the next two to five years, Colorado State Parks anticipates a major park expansion, including the addition of approximately 100 acres of new gravel ponds/lakes that will be filled and opened for public recreation. The expansion is taking place on both sides of I-25, near the project area (Finch, 2005).

4.4.1.4 IMPAIRMENTS

Boulder Creek (Segment 10) is also included because it is located close to the project area, has a designated water supply designation, and has an impairment for *E. Coli* (CDPHE, 2006a) (see **Figure 3-2**).

St. Vrain Creek Segment 6 does not meet some of its stream classification designated uses and has been placed on the 2006 303(d) List (CDPHE, 2006b) (see **Figure 3-2**). The entire portion of Segment 6 fails to meet water quality standards for Class 1 warm water aquatic life due to selenium, while Dry Creek also fails to meet water quality standards for Class 1 warm water aquatic life due to *E. coli* (CDPHE, 2006d). The WQCC has identified this segment as a high priority (*E. coli*) and low priority (selenium) for TMDL analysis (CDPHE, 2006b). A TMDL analysis has not been completed for this segment (CDPHE, 2006d).

Segment 3 has been placed on the 2006 303(d) List for aquatic life use and *E. Coli* (CDPHE, 2006a) (see **Figure 3-2**).

E. coli can be detected in stormwater runoff, but is not generally associated with highway activities. Selenium is not generally associated with highway activities (see **Table 5-2**).

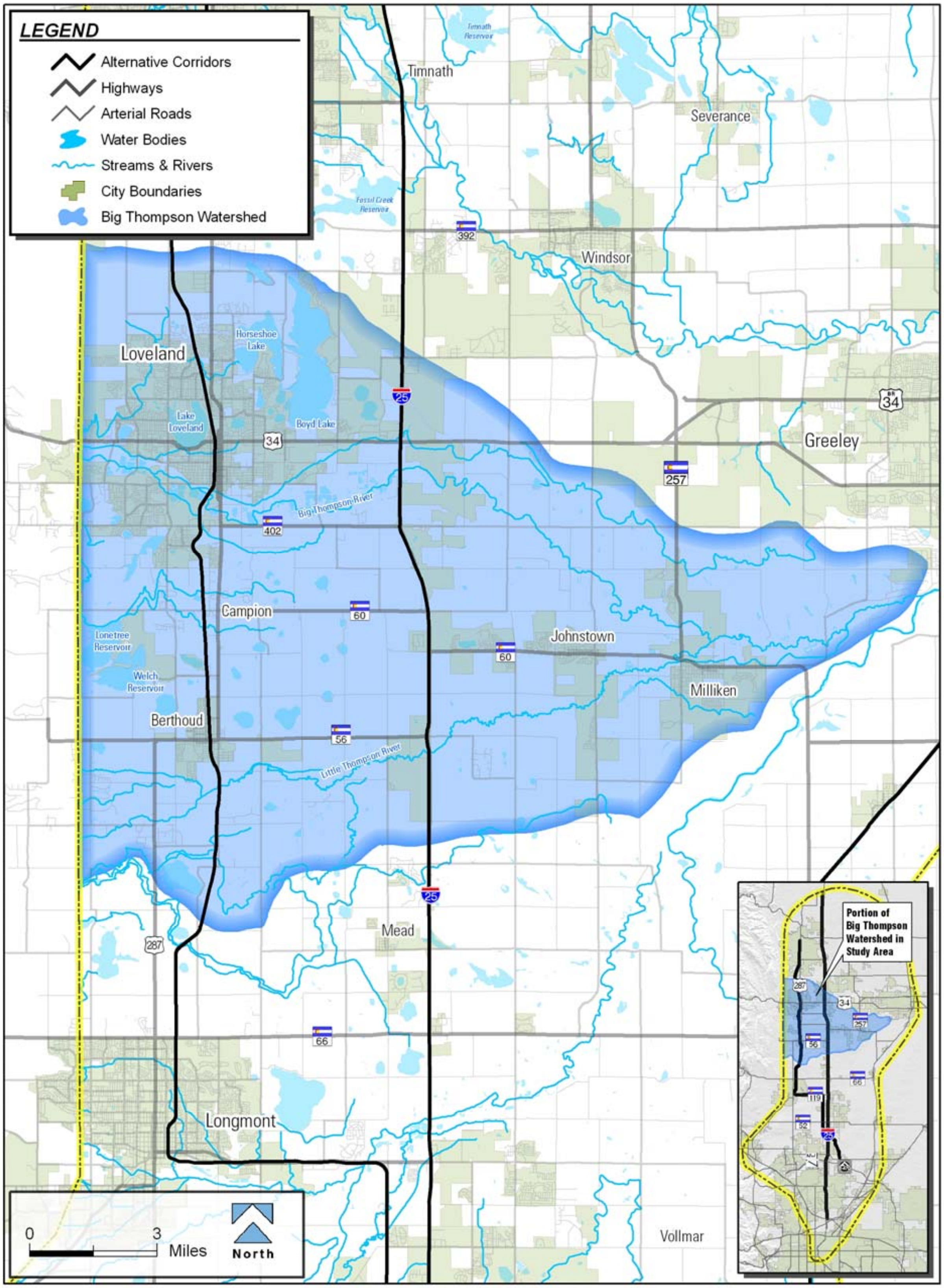
4.4.1.5 DRISCOLL MODEL

Table 4-2 presents the estimated existing contaminant loading from a storm event from the existing I-25 conditions in the St. Vrain Creek watershed. These values are compared to the estimated loading for each alternative in the following section.

4.4.2 Groundwater Resources

Within the project area and the St. Vrain Creek watershed, there are 11 potential drinking water wells (public and/or private) within 500 feet of the existing I-25 corridor. The groundwater meets basic narrative and numeric water quality standards and no impairments have been identified by the WQCC.

Figure 4-5 Big Thompson River Watershed



4.5 BIG THOMPSON RIVER WATERSHED

The Big Thompson watershed occupies 122,523 acres in the northern portion of the regional study area (see **Figure 4-5**). The watershed is located north of the St. Vrain Creek watershed and south of the Cache la Poudre River watershed. Overall, within this watershed, I-25 accounts for approximately 223 acres of impervious surfaces within the larger regional study area (USGS, 2000). The SH 14 to SH 60 (H2) component and SH 60 to E-470 (H3) component cross this watershedNatural surface waters originate east of the Continental Divide in Rocky Mountain National Park and flow primarily eastward, dropping nearly 9,500 feet in elevation while transitioning from a high mountain to a plains stream. The Big Thompson River eventually joins the South Platte River near Greeley (Bestgen and Fausch, 1993b).

Within the entire watershed, the major land cover types include evergreen forest lands, grasslands lands, and agricultural lands (pasture/hay and row crops) (USGS, 2000). Land use within the project area, which lies within the lower portion of the watershed, consists primarily of urban/developed and agricultural land uses (Brown and Caldwell, 2002). Approximately 11 percent (13,888 acres) of the watershed within the regional study area consists of impervious surfaces, with I-25 accounting for 198 acres of impervious surface area (USGS, 2000).

The hydrology and stream flow regime within the Big Thompson River watershed is typical of most watersheds along the Front Range (see **Section 3.1.1**). Stream flow conditions in the Big Thompson River are significantly influenced by the Colorado Big Thompson (CBT) project. This project is an elaborate system of pumps, dams, reservoirs, tunnels, and canals which stores, collects, and conveys water from the western slope into the Big Thompson River. At certain times of the year, the Big Thompson River is primarily supplied with water from the CBT project. Stream flow conditions within the Big Thompson River are also affected by numerous diversions, which at times, create low flow and intermittent flow conditions. In some instances, certain reaches of the stream have dried up completely (Bestgen and Fausch, 1993b).

Physical modifications to the stream channel, which are characteristic of urban type streams, have occurred along the main stem of the Big Thompson River within the project area. Within the regional study area, 2.6 percent (0.8 of 30.5 stream miles) of the river has been modified or channelized (USGS, 2006a). The main channel is confined and linear in shape as it approaches the existing I-25 area. The channel remains primarily linear until approximately 1 mile east of I-25 where it begins to regain the meandering characteristic of a plains-type stream.

Water quality concerns that have been identified within the watershed are associated with excess nutrients (i.e., nitrogen and phosphorus), sediment, and pathogens (i.e., *E. coli*) (Brown and Caldwell, 2002; BTWF, 2003/2004). High algal growth (i.e., eutrophication) and turbidity-related issues due to nutrient loading and sedimentation are affecting both the aquatic habitat and aesthetic characteristics within portions of the watershed (Brown and Caldwell, 2002). Other water quality concerns that have been identified within the watershed are associated with elevated water temperatures, toxics, organics, metals, and the presence of noxious species (Bestgen and Fausch, 1993b; BTWF, 2005; Brown and Caldwell, 2002).

Ditches, streams, and water bodies in the regional study area, including the Big Thompson River, potentially support a variety of aquatic insects, macroinvertebrates, and fish. In general, physical modifications to the stream channel, water quality issues, and fluctuating surface water flows have contributed to reduced aquatic habitat quality and connectivity within the Big Thompson River.

Long-term monitoring within a segment of river near Greeley identified a variety of native and non-native fish species, including minnows, suckers, and darters (native) and trout, minnows, and sunfishes (non-native) (Bestgen and Fausch, 1993b). The Little Thompson River at US 287 and the BNSF crossing has been designated by the Colorado Natural Heritage Program (CNHP) as a Proposed Conservation Area. This reach of the Little Thompson River provides habitat for a number of native fish and a greater diversity of mayflies, caddisflies, and stoneflies compared with other Front Range streams (CNHP, 2005). Further details regarding the current status of aquatic species in or near the project area are provided within **Section 3.12** *Wildlife* in the EIS.

4.5.1 Surface Water Resources

The stream segments within the project area, their designated stream uses, and any impairments are discussed in this section.

4.5.1.1 Streams

Several perennial and intermittent streams within the Big Thompson River watershed are present within the project area (see **Table 4-7).**

Table 4-7 Big Thompson River Watershed Streams within the Project Area

I-25 Corridor	Rail Corridor
Big Hollow Reservoir Drainage	Big Thompson River
Big Thompson River	Little Thompson River
Little Thompson River	Dry Creek
	Unnamed Tributary to Big Thompson River

These streams are classified as Big Thompson River Segments 4b, 4c, 5, 6, 9, and 10. According to Colorado Regulation 38, Classifications and Numeric Standards for South Platte River Basin (Amended 4/9/2007 Effective 9/1/2007), the WQCC has established the following designated uses for the water bodies in the project area (CDPHE, 2007b):

- Segments 5: Class 2 warm water aquatic life, recreation 1b (from 5/1-to 10/15 annually), recreation 2 (10/16 -4/30), and agriculture
- Segments 4b and 4c: Class 2 warm water aquatic life, recreation 1a (from 5/1-to 10/15 annually), and recreation 2 (10/16 – 4/30)
- Segment 6: Class 2 warm water aquatic life, recreation1a, and agriculture
- Segments 9 and 10: Class 2 warm water aquatic life, recreation 1a, and agriculture

4.5.1.2 Canals and Ditches

Several canals and ditches within the Big Thompson River watershed are present within the project area (see **Table 4-8).**

Table 4-8 Big Thompson River Watershed Canals/Ditches within the Project Area

Ditches & Canals	Uses	Owner
I-25 Corridor		
Loveland & Greeley Canal (aka Barnes Ditch Chubbock)	Irrigation	Greeley-Loveland Irrigation Co.
Farmers Ditch/Farmers Irrigation Canal	Irrigation	Harley Olson
Hillsboro Ditch	Irrigation	Hillsboro Ditch Co.
Home Supply Ditch	Irrigation	Consolidated Home Supply Ditch & Reservoir Co.
Handy Ditch	Irrigation	Consolidated Home Supply Ditch & Reservoir Co.
Rail Corridor		
Louden Ditch	Irrigation	Louden Irrigating Canal and Reservoir Company
Loveland & Greeley Canal (aka Barnes Ditch Chubbock)	Irrigation	Greeley-Loveland Irrigation Co.
Farmers Ditch/Farmers Irrigation Canal	Irrigation	Harley Olson
Big Thompson Ditch	Irrigation	Big Thompson Ditch and Manufacturing Company
Lake Ditch	Irrigation	Lake Canal Reservoir Co.
Home Supply Ditch	Irrigation	Consolidated Home Supply Ditch & Reservoir Co.
Handy Ditch	Irrigation	Consolidated Home Supply Ditch & Reservoir Co.
New Ish Ditch	Unknown	Unknown
Two unnamed	Unknown	Unknown

4.5.1.3 LAKES AND RESERVOIRS

Approximately 1.520 acres of lake/reservoir surface water associated with the Big Thompson River watershed are within the project area. These surface water bodies are classified as Segment 6 and are designated for Class 2 warm water aquatic life, recreation 1a, and agriculture (CDPHE, 2007b).

4.5.1.4 IMPAIRMENTS

Big Thompson River Segments 5, 9, and 10 do not meet some stream classification designated uses and have been placed on the 2006 303(d) List (CDPHE, 2006b) (see **Figure 3-2**). Segments 4b and 9 have been placed on the 2006 M and E List (CDPHE, 2006c).

- Segment 5 fails to meet water quality standards for warm water aquatic life 2 due to selenium in the entire segment and ammonia (CDPHE, 2006b; CDPHE, 2006d). The WQCC has identified this segment as a low priority for TMDL analysis (CDPHE, 2006b). A TMDL analysis has not been completed for this segment (CDPHE, 2006d).
- Segment 9 fails to meet water quality standards for selenium (aquatic life warm 2) and *E. coli* (recreation 1) in the entire segment (CDPHE, 2006b; CDPHE, 2006d). Segment 9 has also been placed on the 2006 M and E list for aquatic life use, indicating a decline in native fish species has occurred within the stream system as compared to historical conditions (CDPHE, 2006c). The WQCC has identified this segment as a low priority (selenium) and high priority (*E. coli*) for TMDL analysis (CDPHE 2006b). A TMDL analysis has not been completed for this segment (CDPHE, 2006d).

- Segment 10 fails to meet water quality standards for selenium (aquatic life warm 2) within the Big Hollow portion, which lies approximately 2.7 miles upstream of I-25 (CDPHE, 2006b; CDPHE, 2006d). The WQCC has identified this segment as a low priority (selenium) for TMDL analysis (CDPHE, 2006b). A TMDL analysis has not been completed for this segment (CDPHE, 2006d).
- Segment 4b has been placed on the 2006 M and E list for selenium (CDPHE, 2006c).

E. coli can be detected in stormwater runoff, but is not generally associated with highway activities. Selenium and ammonia are not generally associated with highway activities (see **Table 5-2**).

4.5.1.5 DRISCOLL MODEL

Table 4-2 presents the estimated existing contaminant loading from a storm event from the existing I-25 conditions in the Big Thompson River watershed. These values are compared to the estimated loading for each alternative in the following section.

4.5.2 Groundwater Resources

Within the project area and the Big Thompson River watershed there are seven potential drinking water wells (public and/or private) within 500 feet of the existing I-25 corridor. Groundwater within a small portion of the project area falls within an oil and gas field classified area in the vicinity of the I-25 and SH 52 (Dacono) area. Groundwater associated with oil and gas operations in the Sussex Sandstone formation (a subdivision of the aquifers discussed in **Section 3.2**) does not meet basic state groundwater standards and is classified as Limited Use and Quality classification (TDS concentrations greater than 10,000 mg/L).

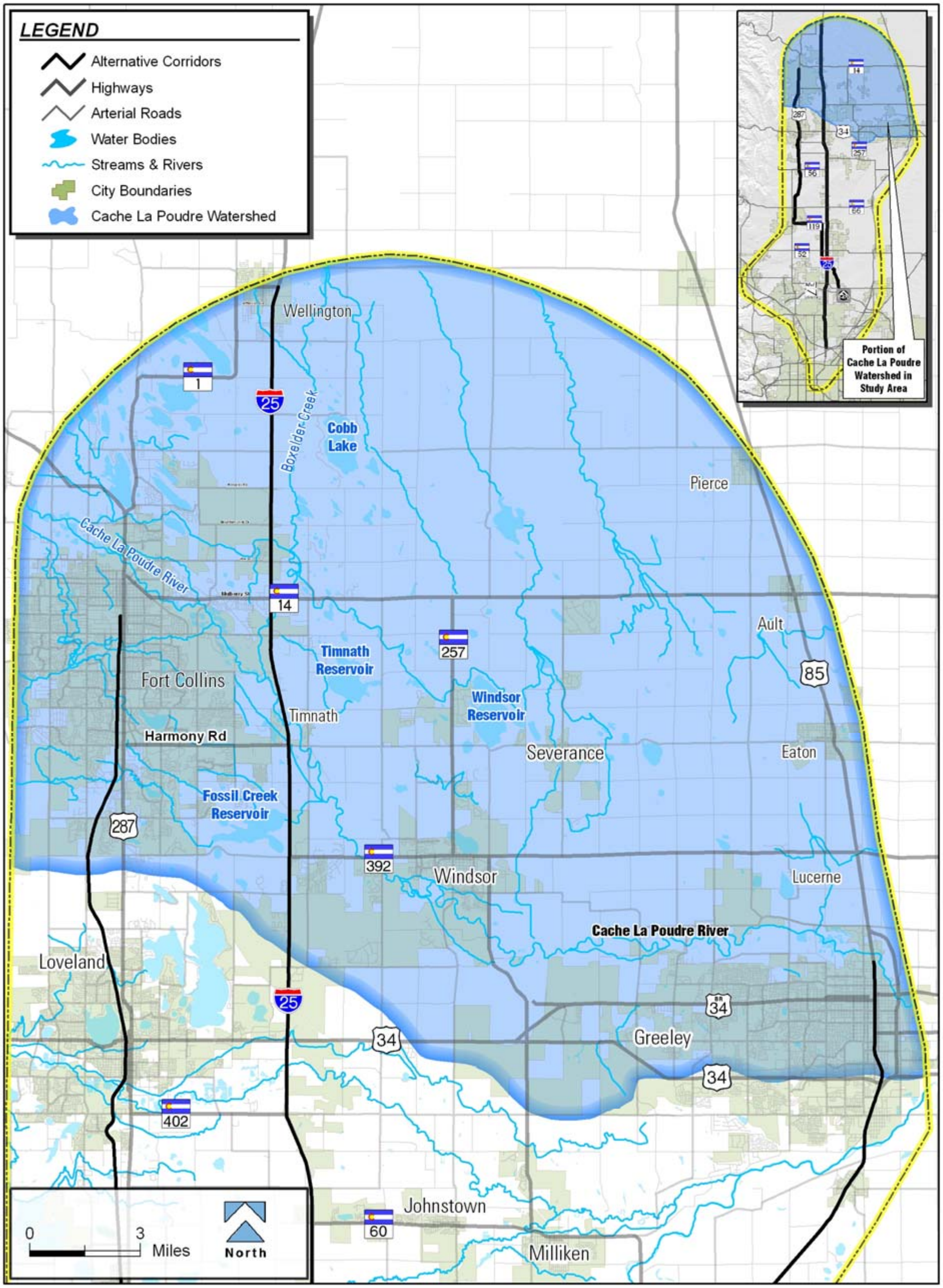
4.6 CACHE LA POUDRE RIVER WATERSHED

The Cache la Poudre River watershed occupies 264,736 acres in the northern portion of the project area. The watershed lies north of Big Thompson River watershed (see **Figure 4-6**). Overall, within this watershed, I-25 accounts for approximately 337 acres of impervious surfaces within the larger regional study area (USGS, 2000). The SH 1 to SH 14 (H1) component and SH 14 to SH 60 (H2) component cross this watershed.

Natural surface waters in the watershed originate east of the Continental Divide within Rocky Mountain National Park, approximately 42 miles west of the city of Fort Collins. Surface waters flow primarily eastward and southeastward while transitioning from a high mountain stream to a plains stream. The Cache la Poudre flows through the Fort Collins area and through the project area, eventually joining the South Platte River near Greeley.

Within the entire watershed, the major land cover types include evergreen forest, grasslands/herbaceous lands, and agricultural lands (pasture/hay and row crops) (USGS, 2000). The land use within the project area, which lies within the lower portion of the watershed, consists primarily of urban/developed and agricultural land. Although the floodplains of the Cache la Poudre River near Fort Collins are highly urbanized, a significant portion of the riparian corridor remains intact with parks and open space lands, providing a valuable natural resource to both humans and wildlife in the area. Approximately 14 percent (37,245 acres) of the total watershed within the regional study area consists of impervious surfaces, with I-25 accounting for 209 acres of impervious surface area (USGS, 2000).

Figure 4-6 Cache la Poudre River Watershed



The hydrology and stream flow regime within the Cache la Poudre River watershed is typical of most watersheds along the Front Range (see **Section 3.1.1**). Stream flow within the Cache la Poudre River is heavily influenced by the removal of water due to reservoir construction and diversions. There are at least nine canal/ditch diversions from Fort Collins to Greeley and eleven reservoirs within the mountain portion of the watershed (Bestgen and Fausch, 1993a; USGS, 2005; Evans and Evans, 1991).

Physical modifications to the stream channel have occurred in the vicinity of the project area primarily due to agricultural and urban land use activities that have caused channelization, stream bank erosion, and channel instability within the watershed. Within the regional project area, 70 percent (31 of 44 stream miles) of the Cache la Poudre River has been modified or channelized (USGS, 2006a). Boxelder Creek and Fossil Creek, tributaries to the Cache la Poudre River within the project area, have been particularly susceptible to these impacts (EDAW, 2003). From Fort Collins to I-25, the Cache la Poudre River exhibits a meandering shape, while Fossil Creek and Boxelder Creek exhibit a more linear character, especially as they approach the existing I-25 area. The main channels of Fossil Creek and Boxelder Creek begin to display a slight increase in meandering beyond I-25; although the channels are still being influenced by agricultural land use in this area.

Water quality concerns that have been identified within the watershed are associated with TDS and TSS, ortho-phosphate, ammonia, nitrate, dissolved oxygen, *E. coli*, and fecal coliform (Wohl, 2001). VOCs (i.e., acetone, benzene, and toluene), herbicides, dissolved organic chemicals, and wastewater chemicals have also been previously identified as contaminants of concern within the watershed (USGS, 2005). Of these contaminants, only TDS and TSS are pollutants related to highway runoff.

Ditches, streams, and water bodies in the regional study area, including the Cache la Poudre River, potentially support a variety of aquatic insects, macroinvertebrates, and fish. In general, physical modifications to the stream channel, water quality issues, and fluctuating surface water flows have contributed to reduced aquatic habitat quality and connectivity within the Cache la Poudre River. Long-term monitoring within the Cache la Poudre River, from Fort Collins to Greeley, identified a reduced occurrence of some fish species from 1970-1992, including the brassy minnow, common shiner, and creek chub. In general, native fish, including minnows, suckers, and darters were identified as the most common species within this stretch of the river. Non-native fish were also identified within this stretch of the river and included trout, minnows, and sunfishes (Bestgen and Fausch, 1993a). Further details regarding the current status of aquatic species in or near the project area are provided within **Section 3.12** *Wildlife* in the EIS.

4.6.1 Surface Water Resources

The stream segments within the project area, their designated stream uses, and any impairments are discussed in this section.

4.6.1.1 STREAMS

Several perennial and intermittent streams within the Cache la Poudre River watershed are present within the project area (see **Table 4-9).**

Table 4-9 Cache la Poudre Watershed Streams within the Project Area

I-25 Corridor	Rail Corridor	US 85 Corridor
Fossil Creek	Spring Creek	Cache la Poudre River
Mail Creek	Fossil Creek	
Cache la Poudre River	Two Unnamed Tributaries to Cache la Poudre River	
Boxelder Creek		
Unnamed Tributary to Cache la Poudre River		

These streams are classified as Cache la Poudre River Segments 11, 12, 13a, and 13b. According to Colorado Regulation 38, Classifications and Numeric Standards for South Platte River Basin (Amended 4/9/2007, Effective 9/1/2007), the WQCC has established the following designated uses for the water bodies in the project area (CDPHE, 2007b):

- Segment 11: Class 2 warm water aquatic life, recreation 1a, and agricultural uses
- Segment 12: Class 2 warm water aquatic life, recreation 1a, and agricultural uses
- Segment 13a: Class 2 warm water aquatic life, recreation 1a, and agricultural uses
- Segment 13b: Class 2 warm water aquatic life, recreation 1b (5/15-9/15), recreation 2 (9/16-5/14), and agricultural uses

4.6.1.2 CANALS AND DITCHES

Several canals and ditches are present within the project area (see **Table 4-10**).

Table 4-10 Cache la Poudre River Watershed Canals/Ditches within the Project Area

Canals/Ditches	Uses	Owner
I-25 Corridor		
Lake Canal	Irrigation	Lake Canal Reservoir Co.
Windsor Ditch	Unknown	Unknown
Unnamed Ditch on Lockman Property	Unknown	Unknown
Boxelder Ditch	Irrigation	Boxelder Ditch Co.
Larimer County Ditch	Irrigation	Water Supply and Storage
North Poudre Irrigation Co. Ditch	Irrigation	North Poudre Irrigation Co.
Cache la Poudre Reservoir Inlet	Storage	Cache la Poudre Reservoir Company
Fossil Creek Reservoir Outlet	Exchange Purposes	North Poudre Irrigation Co.
Louden Ditch	Irrigation	Louden Irrigating Canal & Reservoir Co.
Larimer and Weld Canal	Irrigation	Larimer & Weld Reservoir Co.
Several Unnamed Ditches/Canals	Unknown	Unknown
Rail Corridor		
Fort Collins Irrigation Ditch	Unknown	Unknown
Larimer County Canal No. 2	Water Supply and Storage	Irrigation
New Mercer Ditch	Unknown	Unknown
US 85 Corridor		
Greeley No. 3 Ditch	Unknown	Unknown

4.6.1.3 LAKES AND RESERVOIRS

Island Lake and one un-named lake/reservoir (2.127 acres) are present in the northern portion of the project area. These surface water bodies are classified as Cache la Poudre Segment 13a (see **Section 4.6.1.1**).

Although not within the project area, Fossil Creek Reservoir is a major reservoir within the regional study area. Fossil Creek Reservoir lies immediately west of I-25 and north of SH 392. Fossil Creek Reservoir provides vital open space and aquatic, wetland, and riparian habitat for a variety of species, including waterfowl, shorebirds, and bald eagles. Fossil Creek Reservoir provides recreational and outdoor educational opportunities to Front Range residents and also serves as a source of water for both domestic and agricultural uses (EDAW, 2003).

4.6.1.4 IMPAIRMENTS

Cache la Poudre Segments 12, 13a, and 13b do not meet some of their stream classification designated uses and therefore have been placed on the 2006 303(d) List (CDPHE, 2006b) (see **Figure 3-2**).

Segment 12

Cache la Poudre Segment 12 fails to meet water quality standards for recreation and warm water aquatic life 2 due to *E. coli* and selenium, respectively (CDPHE, 2006d). Selenium impairments are throughout the entire segment, while the *E. coli* impairment is restricted to the portion of Segment 12 below Eaton Draw (CDPHE, 2006b).

Segments 13a and 13b

Cache la Poudre Segments 13a and 13b also do not meet water quality standards for warm water aquatic life 2 due to selenium (CDPHE, 2006d). The selenium impairments identified in Segment 13a are within Fossil Creek for Segment 13a and Boxelder Creek for Segment 13b (CDPHE, 2006b).

E. coli can be detected in stormwater runoff, but is not generally associated with highway activities. Selenium is not generally associated with highway activities (see **Table 5-2**).

4.6.1.5 DRISCOLL MODEL

Table 4-2 presents the estimated existing contaminant loading from a storm event from the existing I-25 conditions in the Cache la Poudre River watershed These values are compared to the estimated loading for each alternative in the following section.

4.6.2 Groundwater Resources

Within the project area and the Cache la Poudre River watershed there are 22 potential drinking water wells (public and/or private) within 500 feet of the existing I-25 corridor. Groundwater within a portion of the project area falls within an oil and gas field classified area north of Fort Collins to Wellington. Groundwater associated with oil and gas operations in the Entrada and Muddy Sandstone formations, subdivisions within the Dakota-Cheyenne group is not meeting basic state groundwater standards because of its Limited Use and Quality classification (TDS concentrations greater than 10,000 mg/L).

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5.0 WATER QUALITY IMPACTS

This section describes the water quality consequences of the No-Action Alternative, Package A, and Package B. However, permanent BMPs have been incorporated into the project design. This was to ensure MS4 compliance in permit areas as required by CDOT's New Development and Redevelopment program document, 2004. BMPs are discussed in **Section 7.0**. Overall, the incorporation of BMPs throughout the project area would improve water quality conditions when compared to the No-Action Alternative.

In the absence of BMPs, the consequences of the alternatives on surface water quality are primarily the result of the addition of paved impervious surfaces. Paved impervious surfaces associated with the project include I-25 and the associated interchanges, transit stations, maintenance facilities, and carpool lots. Rail lines are not considered as impervious surfaces because rail ballast material is relatively permeable. The impacts common to all alternatives in the absence of BMPs and proposed mitigation are included in **Table 5-1**.

Impervious surfaces in the project area alter the characteristics of natural stormwater runoff, including the volume, velocity, and quality of runoff discharged into surface water bodies. Additional paved impervious surfaces will cover soils and vegetation that naturally absorb stormwater and decrease overland flow velocities. Stormwater runoff collects on impervious surfaces and causes increases in the volume and velocity of runoff discharged into nearby surface water bodies following snowmelt and rainfall events. As a result, in the absence of BMPs, these alterations could affect existing hydrologic flow patterns, such as peak discharges, stream channel characteristics, and aquatic habitat within surface water bodies within the project area. Greater velocities and volumes of stormwater runoff could result in streambed and bank erosion, especially near outlet structures, and deposition of excess sediment (i.e., sedimentation) into surrounding surface water bodies. Potential impacts associated with sediment are described briefly in **Table 5-1**.

If stormwater is left untreated, the project alternatives would cause indirect impacts later in time or at some distance downstream and upstream of the project area. These indirect impacts include alterations to natural channel movement processes (i.e. meandering, channel incision) and the continual degradation of aquatic habitat.

Table 5-1 Common Highway-Related Surface Water Quality Impacts

	Direct Impacts	Proposed Mitigation[1]
Sediment	**Harmful to aquatic life**. Sedimentation directly degrades aquatic habitat. Suspended sediment increases turbidity and reduces aquatic plant life productivity. Suspended sediment can be fatal to aquatic species by reducing dissolved oxygen levels (Trombulak and Frissell, 2000).	o **Water Quality Ponds** o **Riprap** o **Nonstructural BMPs** (continued decreasing use of salt and sanding)
Anti-Icing / De-Icing Chemicals (Salt-Based Deicers)	**Potentially harmful to aquatic species, including plants.** CDOT is conducting research to better understand the aquatic life effects.	o **Nonstructural BMPs** (continued decreasing use of salt and sanding)
Metals	**Toxic to aquatic life. Bio-accumulation.** Metals that bind to suspended solids and decaying organic matter can persist in the environment for long periods of time. **Contamination of drinking water supplies.**	o **Water Quality Ponds** o **Well Abandonment** o **Nonstructural BMPs** (Spill prevention plan during construction)
Nutrients	**Toxic to aquatic life.** Excessive nutrients, primarily nitrogen and phosphorus, can cause extreme algal growth, which is toxic to certain aquatic organisms. Algal blooms and die-off causes large swings in dissolved oxygen levels and in extreme cases fish kills. **Alters aesthetics. Can cause designated use impairments.**	o **Water Quality Ponds**
General Construction Activities	**Erosion. Harmful to aquatic life.** Vegetation removal at construction sites increases stormwater runoff velocity and volume causing accelerated erosion. Riparian vegetation removal reduces stream bank stability, accelerates erosion, alters aquatic habitat and shading, and causes in-stream temperature changes. Construction vehicles deposit sediment onto surrounding roads, which is later mobilized during storm events.	o **Construction BMPs**[2] ▪ Minimize in-stream activities ▪ Stormwater Management Plan (silt fence, inlet protection, containerization of wastes, etc.) ▪ Revegetation and replacement of site, including riparian areas ▪ Spill Prevention Plan ▪ Construction Phasing
Construction of new piers, culverts, etc.	**Erosion. Harmful to aquatic life**. Alters streamflow within channel. Erosion/sedimentation upstream and downstream of structures. Reduces quality and quantity of aquatic habitat.	o **Riprap** o **Construction Phasing**
Increased Stormwater Velocity & Volume	**Erosion. Harmful to aquatic life.** Increased stormwater runoff velocity and volume causes stream channelization (i.e., straightening). Channelization increases surface water velocity and exacerbates erosion and sedimentation. Reduces quality and quantity of aquatic habitat.	o **Water Quality Ponds** o **Riprap**

Notes:
1 – See Section 7.0 for a description of proposed mitigation measures.
2 – Activities CDOT currently undertake at construction sites and is required by permit.

The type and quantity of chemicals and other pollutants (e.g., sediment) that are deposited along roads in the project area, primarily I-25, would be affected by the project alternatives. **Table 5-2** includes pollutants that are often detected in highway stormwater runoff. Pollutants that collect on impervious surfaces are eventually mobilized within stormwater runoff and discharged directly into surrounding water bodies during snowmelt or rainfall events. However, pollutant levels in highway stormwater runoff vary based on factors such as surrounding land uses, automobile regulations, traffic characteristics, climate, stormwater maintenance practices, and the implementation of BMPs. In some cases, elevated stormwater pollutant discharges have the potential to cause violations in water quality standards. The primary pollutants associated with highway-related activities and the project alternatives include sediment, metals, and anti-icing / de-icing chemicals. Potential impacts associated with these constituents are described briefly in **Table 5-1**. Detailed information concerning anti-icing / de-icing chemicals within the project area is included in **Section 5.1**.

Table 5-2 Sources of Constituents in Highway Runoff

Constituent	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance, snow/ice abrasives, sediment disturbance.
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer use, sediment erosion.
Lead	Leaded gasoline, tire wear, lubricating oil and grease, bearing wear, atmospheric fallout.
Zinc	Tire wear, motor oil, grease.
Iron	Auto body rust, steel highway structures, engine parts.
Copper	Metal plating, bearing wear, engine parts, brake lining wear, fungicides and insecticides.
Cadmium	Tire wear, insecticide application.
Chromium	Metal plating, engine parts, brake lining wear.
Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, brake lining wear, asphalt paving.
Manganese	Engine parts.
Bromide	Exhaust.
Cyanide	Anticake compound used to keep deicing salt granular.
Sodium, Calcium	Deicing salts, grease.
Chloride	Deicing salts.
Sulphate	Roadway beds, fuel, deicing salts.
Petroleum	Spills, leaks, blow-by motor lubricants, antifreeze, hydraulic fluids, asphalt surface leachate.
PCBs, Pesticides	Spraying of highway right-of-ways, atmospheric deposition, and PCB catalyst in synthetic tires.
Pathogenic Bacteria	Soil litter, bird droppings, trucks hauling livestock/stockyard waste.
Rubber	Tire wear.
Asbestos*	Clutch and brake lining wear.

Note: No mineral asbestos has been identified in runoff; however some break-down products of asbestos have been measured.
Source: Evaluation and Management of Highway Runoff Water Quality, FHWA, 1996.

5.1 ANTI-ICING/DE-ICING CHEMICALS

Anti-icing/de-icing chemicals, such as magnesium chloride and other salt-based de-icing liquids, and traction sand are applied during and after winter storms. However, in recent years, CDOT significantly reduced the use of traction sand and increased the use of magnesium chloride for winter-time roadway maintenance activities. The increased reliance of chemical de-icers has resulted in reduced discharge of traction sand into surface water systems. However, the introduction of any salts, such as magnesium chloride, could affect natural ecosystems.

CDOT is currently undergoing multiple research projects to determine the environmental effects of magnesium chloride, as well as alternative de-icing compounds that may have fewer environmental impacts.

In the project area, CDOT Maintenance uses traction sand only when the chemical de-icers become ineffective due to snow pack depth or road surface temperatures. The application rates of chemicals and traction sand are tracked by CDOT Maintenance within a computer-based Maintenance Management System (MMS).

The composition of de-icing chemicals varies depending upon the manufacturer. CDOT has established de-icing chemical specifications for their vendors who supply these chemicals statewide. Possible by-products in the de-icing chemicals include low concentrations of metals, nutrients, and other salts. In general, the application rate for liquid de-icing chemicals is approximately 40 gallons per linear mile. Ice Slicer®, a solid complex chloride that is applied at the normal rate of about 40 pounds per linear mile, is sometimes used in combination with magnesium chloride.

Traction sand is composed of rock materials with specific angularity to increase tire contract and friction. Traction sand is composed of 5 -15 percent sodium chloride salt to avoid freezing and clumping during truck spreading applications. The common application rate of traction sand is approximately 120 pounds per linear mile. **Table 5-3** details the use of these materials in the project area for CDOT Region 4 fiscal years 2005 and 2006.

Table 5-3 Chemical De-Icer and Traction Sand Usage within the Project area (2005-2006)

Mile Post (I-25)	Traction Sand/Salt Mix (Ton/Year)	Magnesium Chloride (Gallon/Year)	Ice Slicer (Ton/Year)	Caliber 1000 (Gallon/Year)
Fiscal Year 2005				
229.11 to 250.24	2922	103,440	676	65,764
250.24 to 257.34	2218	107,940	380	56,993
257.34 to 271.41	2802	159,721	479	55,894
271.41 to 298.89	2538	4363	0	31,455
Fiscal Year 2006				
229.11 to 250.24	2248	137,266	1205	96,867
250.24 to 257.34	1790	70,423	430	29,586
257.34 to 271.41	3420	192,563	868	107,927
271.41 to 298.89	2336	4191	53	36,951

Reference: CDOT Region 4 Maintenance Management System

Chemical and traction sand usage will increase as impervious surfaces within the project area increase. Impervious surfaces for the No-Action Alternative and Packages A and B and included in **Table 5-4**.

5.2 WATER QUALITY METHODOLOGY

5.2.1 Surface Water

For each alternative, surface water quality impacts were determined by evaluating the total impervious surface area, estimating the total areas of roadway that will be treated by BMPs, by comparing projected traffic volumes, and applying the Driscoll model.

5.2.1.1 IMPERVIOUS SURFACES

The total impervious surface area of each alternative was evaluated as a way to estimate water quality impacts in the absence of BMPs. In addition, the impervious surface area treated by BMPs was also used to estimate overall water quality impacts from each build alternative and the No-Action alternative. Generally, if roadway runoff is passed through a BMP, the post-BMP runoff will have better quality than untreated runoff. This was quantified by comparing the impervious surface area associated with an alternative to the percent of that area being treated, or passed through, a BMP. Therefore, an alternative with a higher percentage of treatment will have a lesser impact to the water quality in the project area when compared to levels of existing BMP treatment (see **Table 5-4**). Areas of proposed water quality treatment were estimated based on current and future MS4 areas, the presence of sensitive waters, and the available area for BMPs within the right-of-way.

Table 5-4 Summary of Total and Treated Impervious Areas

Alternative	Total Impervious Area *(acres)*	Area Treated *(acres)*	% of Area Treated[1] *(acres)*
Existing	1,212	29	2.4%
No-Action	1,257	141	11.2%
Package A	1,946	1,765	90.7%
Package B	2,001	2,509	125%

1 – The percent of area treated through BMPs can be greater than 100 percent because the size of the ponds and/or depth of ponds are bigger/deeper to account for unknown constraints that may be identified in final engineering.

5.2.1.2 DRISCOLL MODEL

The Driscoll model, an FHWA-developed method, was applied as part of the impacts evaluation for the EIS (FHWA, 1990). The modeling approach described herein is consistent with FHWA guidance and is used as a screening tool to compare pollutant mass loading among Alternatives (No-Action, Package A, and Package B) and the individual Alternative Package components. The following summarizes the modeling approach.

The Driscoll Model was designed for, and is only applicable to highway runoff. Therefore, the model was only applied to the highway portions of the alternative packages and the No-Action. The constituents analyzed using the Driscoll methodology include dissolved zinc, dissolved copper, total phosphorus, chloride, and TSS. These constituents were selected because of their association with highway runoff, they are of concern in the project area, or have applicable stormwater runoff data. Sources of dissolved zinc and dissolved copper in roadway runoff are from brake and tire wear; while chloride and TSS are primarily a result of winter maintenance activities. Total phosphorus is a concern in the regional study area because of its potential impact to reservoirs.

The stormwater runoff concentration data for the constituents analyzed using the Driscoll model were obtained from the *I-70 Mountain Corridor Tier 1 Draft Programmatic Environmental Impact Statement (I-70 PEIS)* (CDOT 2004b). The I-70 PEIS study team conducted multiyear stormwater sampling events in an effort to characterize the stormwater discharged from I-70. Two types of runoff data were collected in the I-70 PEIS, including snowmelt and rainfall. The North I-25 project team determined that the rainfall data was the most appropriate and applicable data for this project. The rainfall data were considered to better represent the typical type and frequency of precipitation in the regional study area. The I-70 PEIS data is the most recent and accurate stormwater data from roadways in Colorado. Other stormwater data from roadways in Denver are available; however, these data are not representative of current conditions because they were collected more than 30 years ago. For example, the lead data is much higher than would be expected today, because when that data was collected, leaded gasoline was used. The runoff concentration data used in this analysis are presented in **Table 5-5.**

Table 5-5 Roadway Stormwater Runoff Concentrations for Analytes Evaluated

Constituent	Minimum (mg/l)	Maximum (mg/l)	Mean (mg/l)	Median (ug/l)	Number of Samples
Chloride	4.0	27.0	14.4	13.5	10
Copper	0.008	0.02	0.011	0.01	8
Total Phosphorus	0.21	2.1	0.79	0.625	10
Total Suspended Solids	38	1800	549	448	10
Zinc	0.069	0.25	0.12	0.09	8

Notes: All constituents are dissolved concentrations, unless otherwise noted.
Mg/l = milligrams per liter
Source: CDOT, 2004b.

Precipitation input parameters used in the Driscoll Model utilized data included in the model documentation for Denver, CO. Watersheds analyzed are Hydrologic Unit Component (HUC) 4. Impervious area, right-of-way area, and watershed area for each alternative were calculated via GIS. The input values for the Driscoll model are presented in Appendix A.

The Driscoll Model relates the parameters described above to estimate water quality impacts from roadway improvements. The project team determined that the model should be used to compare alternatives. The results of the Driscoll Model used for this analysis are event mass loading of each constituent, measured in pounds. This value represents an estimation of the pounds of each constituent that each watershed receives during a ‘typical’ storm event from roadway runoff.

This loading information can then be compared between alternatives, and the alternative with highest pounds of constituent is estimated to have a greater impact than other alternatives. The results of the Driscoll Model do not consider the application of BMPs, such as water quality (detention) ponds. These BMPs will keep portions of this calculated load from reaching a water body and thus lower the event load.

The results of the Driscoll model are presented in **Table 5-6** by component. The components typically cross several watersheds; therefore, a watershed could be affected by multiple components. **Figure 5-1** and **Figure 5-2** graphically presents the Driscoll model results by component and by watershed. **Figure 5-1** and **Figure 5-2** presents predicted dissolved copper loading by component and watershed, respectively, because aquatic organisms have a sensitivity to this roadway heavy metal pollutant. Constituent loading is measured in pounds of constituent leaving the roadway per a median rainfall event. The relationship between the alternative's loading is the same for every constituent analyzed in the Driscoll model, only the magnitude of the loading changes. The loads for the existing conditions are used as a "baseline" comparison for each build package. The No-Action Alternative has the lowest predicted constituent loading of all of the project alternatives.

Since the Driscoll model is a screening tool that differentiates impacts among alternatives, the results should not be used to determine if water quality standards are expected to be exceeded. The loading information from the Driscoll model is used to comparatively estimate which alternative may have more water quality impacts. It can be assumed that an alternative with a higher predicted load (i.e., a greater quantity of constituent leaving the road) would have more water quality impacts than another alternative. Alternative-specific discussion of the Driscoll model results are presented in the following sections.

Table 5-6 Driscoll Model Results for Each I-25 Highway Component

Contaminant	Alternative	Highway Component				
		SH 1 - SH 14 (Cache la Poudre River)	SH 14 - SH 60 (Cache la Poudre River, Big Thompson River)	SH 60 - E-470 (Big Thompson River, St. Vrain Creek, Big Dry Creek)	E-470 - US 36 (Big Dry Creek, South Platte River, Clear Creek)	Total Loading[1]
Chloride (pounds per event)	Existing	107	292	373	157	***930***
	No Action	107	292	413	157	***970***
	Package A	149	483	522	166	***1,320***
	Package B	149	568	537	183	***1,440***
Dissolved Copper (pounds per event)	Existing	0.079	0.22	0.28	0.12	***0.689***
	No Action	0.079	0.22	0.31	0.12	***0.718***
	Package A	0.11	0.36	0.39	0.12	***0.978***
	Package B	0.11	0.42	0.40	0.14	***1.07***
Total Phosphorous (pounds per event)	Existing	5.0	13.6	17.4	7.3	***43.4***
	No Action	5.0	13.6	19.3	7.3	***45.3***
	Package A	6.9	22.5	24.4	7.8	***61.6***
	Package B	7.0	26.5	25.1	8.6	***67.1***
Total Suspended Solids (pounds per event)	Existing	3,550	9,700	12,400	5,220	***30,900***
	No Action	3,550	9,700	13,700	5,220	***32,200***
	Package A	4,940	16,000	17,300	5,510	***43,800***
	Package B	4,960	18,900	17,800	6,080	***47,700***
Dissolved Zinc (pounds per event)	Existing	0.71	1.95	2.5	1.05	***6.20***
	No Action	0.71	1.95	2.8	1.05	***6.46***
	Package A	0.99	3.2	3.5	1.11	***8.80***
	Package B	1.0	3.8	3.6	1.22	***9.59***

Note: Results presented in this table indicate modeled total pounds of contaminant discharged per component per event.
1 Total loading values have been rounded to three significant figures.

Figure 5-1 Driscoll Model Results by I-25 Highway Component for Dissolved Copper

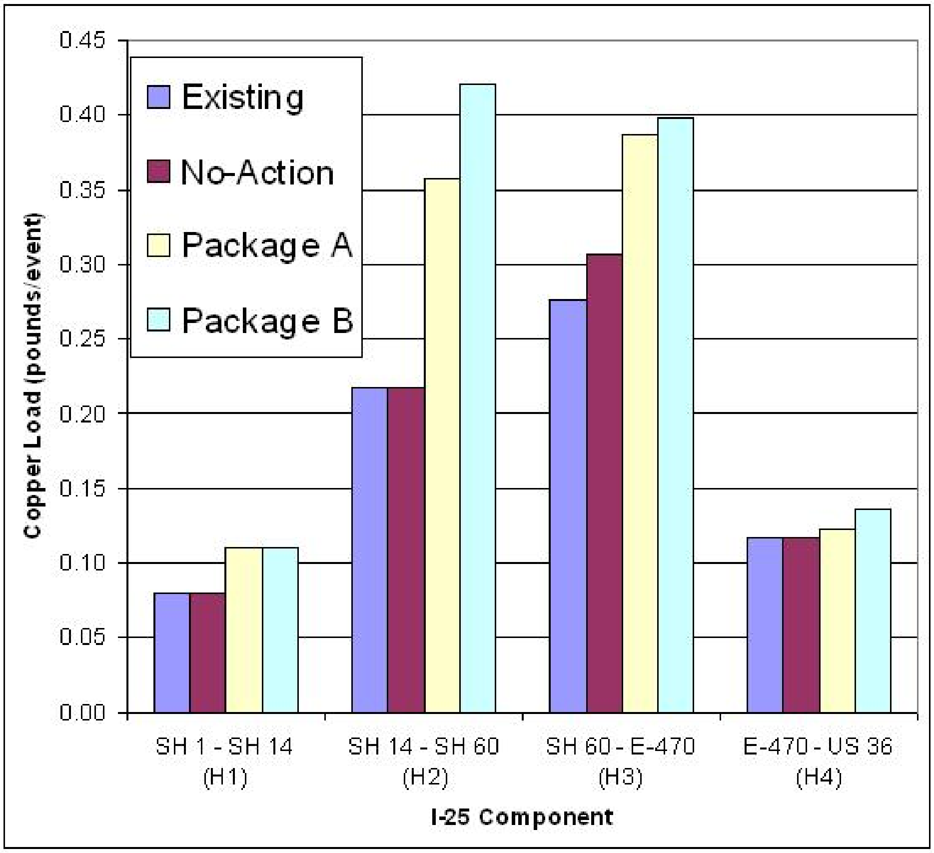
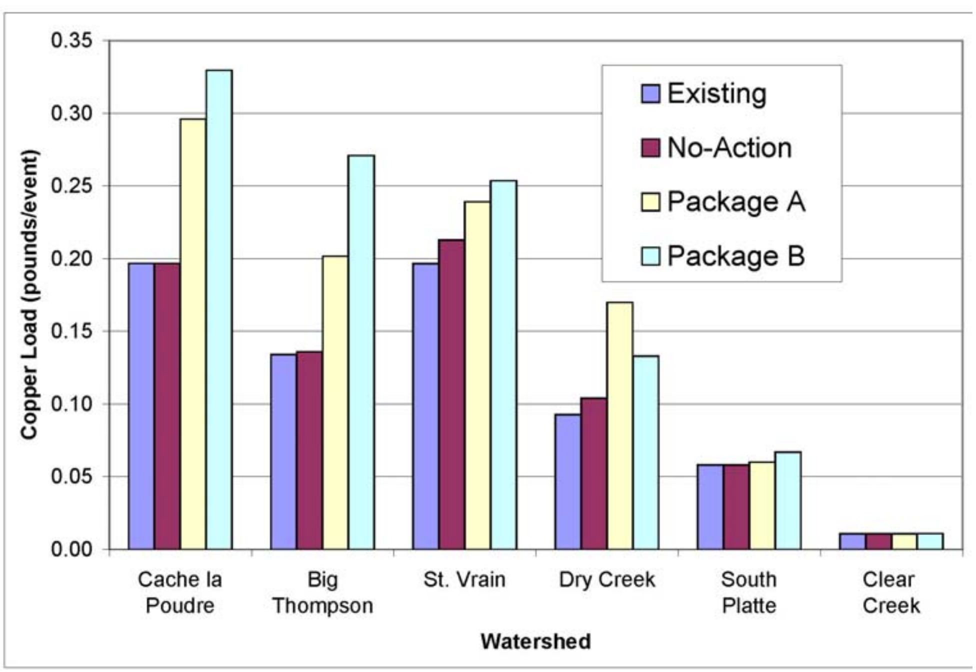


Figure 5-2 Driscoll Model Results by Watershed for Dissolved Copper



5.2.1.3 TRAFFIC

Water quality impacts were also assessed by comparing the projected annual average daily traffic (AADT) volumes. Several research studies have suggested that a correlation exists between stormwater runoff quality and annual average daily traffic (AADT) volumes (FHWA, 1990; Kayhanian and others, 2003). In general, urban areas with greater than 30,000 AADT have been shown to have higher pollutant concentrations of certain constituents when compared with nonurban areas with AADT less than 30,000. However, the correlation between AADT and pollutant concentrations is not consistent for all pollutants found in highway runoff. Pollutants related to transportation activities, such as zinc and copper, are expected to increase with AADT, while certain pollutants, such as total suspended solids, total dissolved solids, and ammonia, which are often found in highway runoff but generally associated with a nonurban setting are not expected to increase with AADT (FHWA, 1990; Kayhanian and others, 2003). Therefore, if left unmitigated, it can be assumed that an alternative with an AADT > 30,000 would have higher concentrations of certain constituents in runoff than an alternative with an AADT < 30,000.

Table 5-7 presents the projected traffic volumes for the alternative components on I-25. The majority of the existing traffic volumes and all of the proposed traffic volumes are greater than 30,000 AADT. However, traffic volumes can still be used to compare alternative from a water quality perspective. For example, an alternative with a higher traffic volume would be expected to have a higher amount of pollutants from vehicles being washed from the roadway; however the magnitude of difference may not be significant. In general, the projected traffic volumes are relatively similar between the project alternatives and range from nearly two to three times the existing traffic volumes. The greatest travel demand is generated in the southern portion of the project area between E-470 to US 36 (H4) followed by SH 60 to E-470 (H3), SH 14 to SH 60 (H2), and SH 1 to SH 14 (H1), all of which drains to the South Platte River.

Table 5-7 Projected Traffic Volumes (AADT) from the North I-25 Project Alternatives

Package	SH 1 to SH 14 *(H1)*	SH 14 to SH 60 *(H2)*	SH 60 to E-470 *(H3)*	E-470 to US 36 *(H4)*
Existing	19,100 – 40,800	40,800 – 65,100	65,000 – 96,700	87,200 – 180,700
No-Action	34,500 – 80,700	80,700 – 108,400	104,400 – 174,200	153,400 – 232,100
Package A	35,400 – 82,700	82,700 – 132,500	118,100 – 187,300	157,400 – 234,500
Package B	35,800 – 85,500	85,500 – 114,500	105,600 – 185,200	165,300 – 245,600

5.2.1.4 CONSTRUCTION AND DRAINAGE

Water quality impacts from construction activities are discussed qualitatively based upon the current state of practice for construction within CDOT. Impacts to the drainage system are briefly discussed in this section; however, the detailed analysis of the drainage system is presented in the **Section 6.0** *Floodplains*.

5.2.2 Groundwater

Groundwater quality impacts were evaluated by estimating the number of groundwater wells within the proposed right-of-way (see **Table 5-8**). The number of groundwater wells located within the proposed right-of-way was evaluated because active groundwater wells would need to be relocated, and existing wells would need to be plugged, sealed, and abandoned. For wells located within the proposed right-of-way, the status of groundwater well use will have to be determined prior to construction activities to identify the necessary course of action. For example, if a well is still active, the relocation would be required, while inactive wells can be abandoned.

Table 5-8 Summary of Groundwater Wells within the Project Area

Package		SH 1 to SH 14	SH 14 to SH 60	SH 60 to E-470	E-470 to US 36	Stations and Maintenance Facilities[1]	Total
Package A	**Wells within Proposed Right-of-way**	13	47	26	19	0	**105**
Package B	**Wells within Proposed Right-of-way**	13	47	28	21	2	**111**

Notes:
1– Includes all transit stations and associated parking lots and CDOT maintenance facilities and associated parking lots.

5.3 No-Action Alternative

The No-Action Alternative includes safety and maintenance improvements that would need to be constructed if the build packages were not implemented. Major and minor structure maintenance activities are expected to occur on I-25 from US 36 to SH 1. Safety improvements are anticipated at selected locations from WCR 34 to SH 1. The No-Action Alternative does not include transit components.

5.3.1 Surface Water

5.3.1.1 Impervious Surfaces

Direct effects on surface water quality from increases in impervious surface area would be negligible under the No-Action Alternative. This is because the No-Action Alternative has relatively minor contributions of impervious surface area from any structure upgrades, such as interchange improvements or bridge replacements.

The quality of stormwater runoff would be dependent on the implementation of BMPs associated with No-Action Alternative activities within MS4 areas. Projects over one acre in size associated with the No-Action Alternative that are located within MS4 areas will require BMPs, thereby reducing impacts from increased impervious surface area. The percentage of the impervious surface area treated by BMPs for the No-Action Alternative is substantially less than either of the package alternatives. This means that the majority of stormwater runoff from I-25 would continue to be untreated prior to discharging to water bodies.

Under the No-Action Alternative only 11.2% of the impervious surfaces within the project area are currently being treated. This area is within the SH 60 to E-470 (H3) component and the majority of increased pollutants deposited from vehicles would not pass through a BMP prior to discharge to receiving water bodies.

5.3.1.2 DRISCOLL MODEL

As previously mentioned, the results of the Driscoll model are presented as a screening tool to differentiate impacts among alternatives and not to determine if water quality standards are expected to be exceeded. The No-Action Alternative has the lowest estimated contaminant loading of the three alternatives (see **Table 5-6**). The only component with an increase in loading greater than the existing conditions is the SH60 to E470 component (H3). This component crosses the Big Thompson River, St. Vrain Creek, and Big Dry Creek watersheds. The remaining components have the same estimated loading as the existing conditions.

5.3.1.3 TRAFFIC

While the amount of impervious surfaces for the No-Action Alternative is approximately 689 to 744 acres less than the build package alternatives, the increase in future traffic volumes should also be considered. Chemicals and other pollutants deposited along I-25 within the project area and mobilized within stormwater runoff would continue to increase as traffic volumes continue to increase along the I-25 highway corridor over time. The largest potential increase on the upper range of number of vehicles would likely occur in the SH 60 to E-470 (H3) component. This component currently has the greatest impervious surface area (see **Table 5-7**) and crosses the Big Thompson River, St. Vrain Creek, and Big Dry Creek watersheds.

5.3.1.4 CONSTRUCTION AND DRAINAGE

Major and minor structure maintenance activities, such as demolition and construction of bridges and interchange improvements would have construction-related impacts at all stream crossings if left unmitigated. These impacts and the proposed mitigation to minimize these impacts are included in **Table 5-1.**

Major drainage impacts that result from cross drainage are addressed in **Section 6.0** *Floodplains*. Minor drainage features includes storm drainage pipes, inlets, open channels, and other facilities that are used to convey local storm drainage.

Drainage improvements associated with the No-Action Alternative would occur in several areas where roadway improvements are currently planned. Anticipated drainage improvements for the No-Action Alternative would include a more efficient storm drainage system of pipes, inlets, open channels, and water quality facilities. There would be no drainage improvements for the E-470 to US 36 (H4) component in the No-Action Alternative and impacts from an inadequate drainage system would occur in this area.

5.3.2 Groundwater

Groundwater impacts are not expected as a result of major and minor structure maintenance activities associated with the No-Action Alternative.

5.4 PACKAGE A

Package A contains four highway and four transit components. The package includes construction of additional general purpose lanes on I-25 and implementation of commuter rail and commuter bus service. Construction of associated elements, such as commuter rail and bus stations, carpool lots, bridges, interchanges, and queue jumps, also was considered in this analysis.

For purposes of this analysis, impervious surface areas include I-25 and associated interchanges, transit stations, maintenance facilities, and carpool lots. Rail lines were not included as impervious surfaces as part of this analysis because rail ballast material is relatively permeable.

5.4.1 Surface Water

5.4.1.1 Impervious Surfaces

Direct effects on surface water quality that are common to all Package A components would result from the addition of paved impervious surfaces, primarily from highway widening for additional general purpose lanes and associated interchanges, bridges, and carpool lots. Package A would result in more impervious surface area (1,946 acres) than the existing impervious area (1,212 acres), and the No-Action Alternative (1,257 acres). At the component level, impacts to water quality due to the addition of impervious surface area are expected to be the greatest as a result of highway widening from SH 14 to SH 60 (H2) (635 acres). This component crosses the Cache la Poudre River and Big Thompson River watershed.

To fully understand the impacts from impervious surface area for an alternative, it is important to consider the greater area surrounding the project. There are approximately 159,223 acres of total impervious surface area that exists within the regional study area from commercial and residential developments and other infrastructure. This gives context to the total impervious surface of Package A in relation to its surroundings that the impervious surface area associated with Package A is a small fraction (1.2 percent) of the overall impervious areas in the regional study area.

5.4.1.2 Driscoll Model

As previously mentioned, the results of the Driscoll model are presented as a screening tool to differentiate impacts among alternatives and not whether or not water quality standards are expected to be exceeded. The Package A estimated contaminant load for the northern and southern components (SH1 to SH 14 [H1] and E470 to US 36 [H4], respectively) are slightly greater than the existing conditions. The estimated loadings from the two middle components are considerably greater than the existing conditions. The Cache la Poudre and Big Thompson watersheds have the highest increased load from existing conditions, both approximately a 50 percent increase. These watersheds show the greatest increase in loading because of the SH14 to SH60 [H2] and SH60 to E470 [H3] components are within these watersheds. The Package A components estimated loadings are less than the Package B components.

5.4.1.3 TRAFFIC

In general, the projected traffic volumes are relatively similar between the project alternatives and range from nearly two to three times the existing traffic volumes (see **Table 5-7**). Therefore, Package A would cause an increase in the amount of pollutants being washed from the roadway due to increased traffic volumes. All of the proposed traffic volumes for the Package A components are greater than 30,000 AADT. The greatest predicted travel demand is generated in the southern portion of the project area between E-470 to US 36 (H4) followed by SH 60 to E-470 (H3), SH 14 to SH 60 (H2), and SH 1 to SH 14 (H1). However, the SH 1 to SH 14 (H1) component would be expected to have the most significant increase in pollutants because existing traffic in this segment is at times currently less than 30,000 AADT, which is generally characteristic of nonurban areas. Project activities in this segment would cause traffic to increase to levels characteristic of urban areas (i.e., greater than 30,000 AADT), which have higher pollutant concentrations of certain constituents when compared with nonurban areas with AADT less than 30,000 (see **Section 5.1.1.3)**.

If stormwater is left unmitigated, consequences from increased impervious surfaces and traffic would include an increase in water velocities and volumes, and an increase in the type and quantity of chemicals and other pollutants that are deposited along I-25 (see **Table 5-2)**. However, the incorporation of BMPs into the design will remove a large amount of the chemicals and sediment that could be deposited within surface water bodies within the project area. Under the Package A Alternative, water quality ponds will treat approximately 1,765 acres (90.7%) of the impervious surfaces within the project area. This is compared to the existing 2.4% of the impervious surfaces within the project area that are currently being treated. Consequently, it is anticipated that water quality conditions will improve with Package A when compared to the existing or the No-Action Alternative conditions.

5.4.1.4 CONSTRUCTION AND DRAINAGE

The implementation of the Package A Alternative would result in construction-related impacts at all stream/ditch/canal crossings if left unmitigated. Other water bodies that may not cross I-25, but are within the construction footprint (including staging areas) would also be affected. The majority of construction related impacts results from the demolition and/or construction of structures, rail lines, and highway lanes. Construction-related impacts and the proposed mitigation to minimize these impacts are included in **Table 5-1.** The proposed construction mitigation measures are summarized in **Section 7.0** and are required by permit and policy on CDOT projects.

Major drainage impacts that result from cross drainage are addressed in **Section 6.0** *Floodplains*. General purpose lanes on I-25 for the SH 14 to SH 60 (H2) component and for the SH 60 to E-470 (H3) component would require that modifications be made to existing drainage systems or that a new drainage conveyance system be installed. By installing new drainage structures (e.g., storm drainage pipes, inlets, open channels and other facilities conveying local storm drainage), no additional impacts to the drainage system are anticipated. These structures could actually improve the drainage system when compared to the current and No-Action Alternative conditions.

The Little Thompson River near the BNSF crossing has been designated by the CNHP as a Proposed Conservation Area (see **Section 4.4**). At this location, the existing bridge would be extended in kind, which will cause construction-related impacts (see **Table 5-1**). Mitigation measures to minimize these impacts are also included in **Table 5-1**.

5.4.2 Groundwater

The construction of the Package A Alternative could require addressing of up to 105 wells that are within the proposed right-of-way (see **Table 5-8**). The status of groundwater well use will have to be determined prior to construction activities to identify the necessary course of action for each well. Active wells would need to be relocated, and all active and non-active wells would need to be plugged, sealed, and abandoned.

5.5 PACKAGE B

Package B contains four highway components and three transit components. The package generally includes the construction of tolled express lanes on I-25 and implementation of bus rapid transit service. Construction of associated elements, such as bus stations, carpool lots, bridges, interchanges, and queue jumps, was also considered in the component-level analysis. For purposes of this analysis, impervious surface areas include I-25 and associated interchanges, transit station, maintenance facilities, and carpool lots.

5.5.1 Surface Water

5.5.1.1 IMPERVIOUS SURFACES

Direct effects on surface water quality that are common to all Package B components would result from the addition of paved impervious surfaces, primarily from highway widening for additional tolled express lanes and associated interchanges, bridges, and carpool lots. Package B would result in more impervious surface area (2,001 acres) than the existing impervious area (1,212 acres), and the No-Action Alternative (1,257 acres). At the component level, impacts to water quality due to the addition of impervious surface area are expected to be the greatest from highway widening from SH 14 to SH 60 (H2) (773 acres). This component crosses the Cache la Poudre River and Big Thompson River watershed.

To fully understanding the impacts from impervious surface area for an alternative, it is important to consider the greater area surrounding the project. There are approximately 159,223 acres of total impervious surface area that exist within the regional study area from commercial and residential developments and other infrastructure. This gives context to the total impervious surface of Package A in relation to its surroundings that the impervious surface area associated with Package A is a small fraction (1.3 percent) of the overall impervious areas in the regional study area.

5.5.1.2 DRISCOLL MODEL

As previously mentioned, the results of the Driscoll model are presented as a screening tool to differentiate impacts among alternatives and not whether or not water quality standards are expected to be exceeded. The Package B estimated contaminant load for the northern and southern components (SH1 to SH 14 [H1] and E470 to US 36 [H4], respectively) are slightly greater than the existing conditions. The estimated loadings from the two middle components (SH14 to SH60 [H2] and SH60 to E470 [H3]) are considerably greater than the existing conditions. The Cache la Poudre River and Big Thompson River watersheds have the highest increased load from existing conditions, approximately a 68 and102 percent increase, respectively.

Package B has the greatest estimated loadings of all alternatives.

5.5.1.3 TRAFFIC

In general, the projected traffic volumes are relatively similar between the project alternatives and range from nearly two to three times the existing traffic volumes (see **Table 5-7**). Therefore, Package B would cause an increase in the amount of pollutants being washed from the roadway due to increased traffic volumes. All of the proposed traffic volumes for the Package B components are greater than 30,000 AADT. The greatest predicted travel demand is generated in the southern portion of the project area between E-470 to US 36 (H4) followed by SH 60 to E-470 (H3), SH 14 to SH 60 (H2), and SH 1 to SH 14 (H1).

If stormwater is left unmitigated, consequences from increased impervious surfaces and traffic would include an increase in water velocities and volumes, and an increase in the type and quantity of chemicals and other pollutants, such as sediment, that are deposited within the project area (see **Table 5-2**). However, the incorporation of BMPs into the roadway design will remove a large amount of chemicals and sediment deposited within surface water bodies within the project area. Under the Package B Alternative, water quality ponds will provide a volume sufficient to treat approximately 2,509 acres treated (125%) of the impervious surfaces within the project area. This is compared to the existing 2.4% of the impervious surfaces within the project area that are currently being treated. Consequently, it is anticipated that water quality conditions will improve when compared to the existing and No-Action Alternative conditions.

5.5.1.4 CONSTRUCTION AND DRAINAGE

The implementation of the Package B Alternative would result in construction-related impacts at all stream/ditch/canal crossings if left unmitigated. Other water bodies that may not cross I-25, but are within the construction footprint (including staging areas) would also be affected. The majority of construction related impacts results from the demolition and/or construction of structures and highway lanes. Construction-related impacts and the proposed mitigation to minimize these impacts are included in **Table 5-1.** The proposed construction mitigation measures are summarized in **Section 7.0**.

Major drainage impacts that result from cross drainage are addressed in **Section 6.0** *Floodplains*. The roadway improvements associated with Package B would require existing drainage system modifications or a new drainage conveyance system. By installing new drainage structures (e.g., storm drainage pipes, inlets, open channels and other facilities conveying local storm drainage), no additional impacts to the drainage system are anticipated. These structures could actually improve the drainage system when compared to the No-Action Alternative.

5.6 GROUNDWATER

The construction of the Package B Alternative could require the relocation of up to 111 wells that are within the proposed right-of-way (see **Table 5-8**). The status of groundwater well use will have to be determined prior to construction activities to identify the necessary course of action. Active wells would need to be relocated, and all active and non-active wells would need to be plugged, sealed, and abandoned.

6.0 FLOODPLAINS

The project area includes many major and minor drainage crossings within six watersheds to the South Platte River. These watersheds include the Cache la Poudre River, Big Thompson River, St. Vrain Creek, Big Dry Creek, Clear Creek, and the South Platte River (see **Figure 6-1**). The following sections address important policies, recommended hydrologic and hydraulic methodologies, a description of floodplains and drainages within the regional study area, and a description of impacts to floodplains and the drainage system. The analysis includes the commuter rail route and US85 bus queue-jump locations in addition to the I-25 corridor.

Most of the existing drainage structures in the project area were built during the 1960s. At that time, the adjacent areas were rural, and flood damage was limited to agricultural land. The sizes of many of these drainage structures were based on limited rainfall data for what was estimated to be a 25- or 50-year storm event. The 100-year storm is now used for drainage design in urbanized areas and for floodplains under the jurisdiction of the Federal Emergency Management Agency (FEMA). Many of the existing drainage structures constrict stormwater flows, cause flooding, and overtopping of the adjacent highways. In order to conform to newer criteria and control flooding, most drainage structures in the project area would need to be replaced with a larger structure.

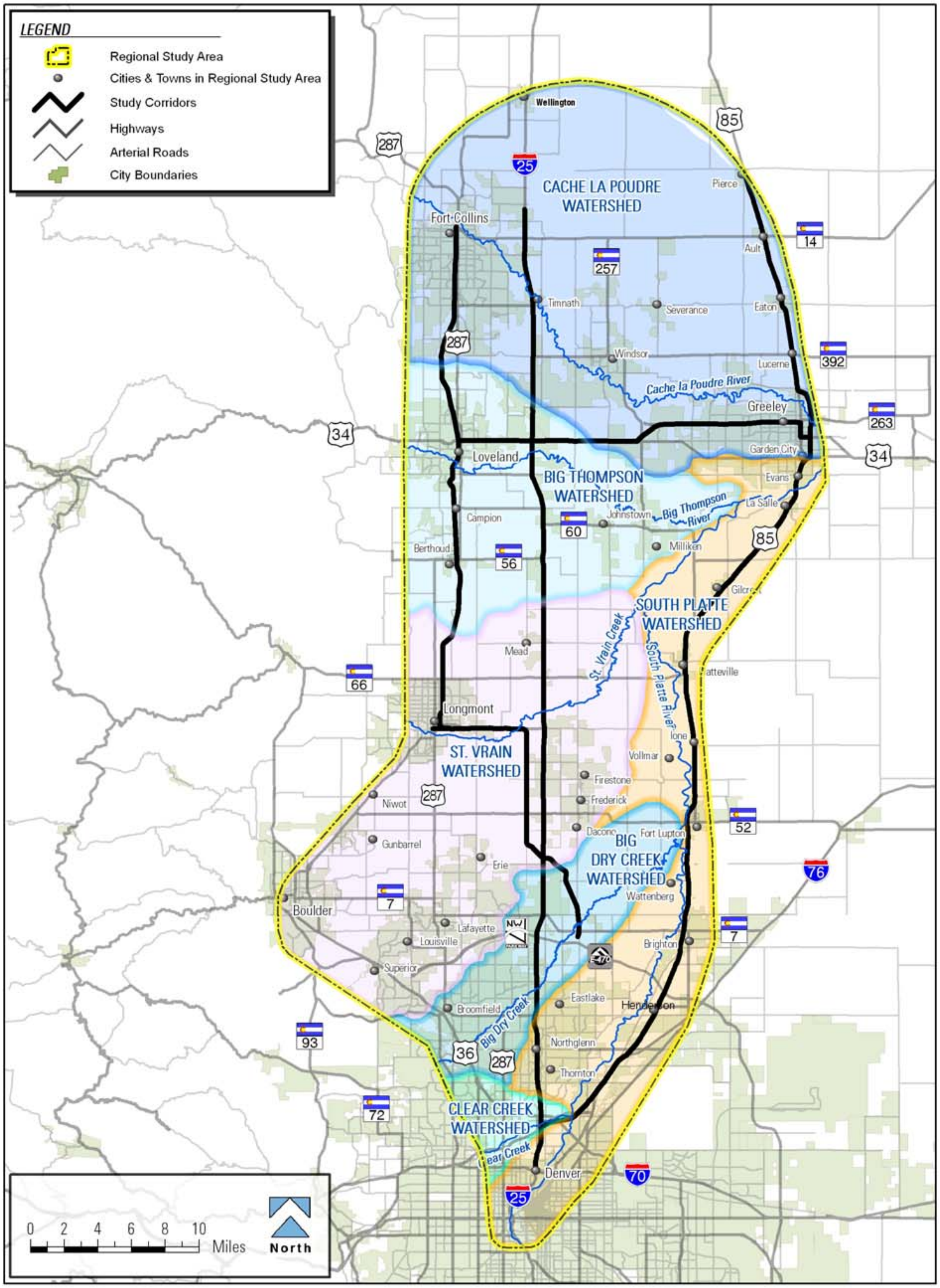
Currently, there are no facilities in place to treat runoff from paved areas, except for those planned between State Highway (SH) 119 and SH 66. This is because rior to 2001, CDOT, and many municipalities were not required to treat runoff from paved areas. CDOT now has an MS4 permit that requires CDOT to implement a program to reduce the discharge of pollutants by installing permanent facilities. A discussion of the CDOT MS4 permit is located in **Section 2.0**.

6.1 REGULATORY FRAMEWORK

Various governmental policies for floodplains and drainage will affect the project area. Important policies that will influence the study area include:

- *Executive Order 11988, Floodplain Management* -This order requires federal agencies to avoid, to the extent possible, long-term and short-term adverse impacts associated with the modification of floodplains and to avoid floodplain development wherever there is a practicable alternative. It states that federal agencies shall, *"take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains."* The agency shall further *"evaluate the potential effects of any actions it may take in a floodplain to ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management and to prescribe procedures to implement the policies and requirements of this Order."*
- Federal Highway Administration's 23 CFR 650, Subpart A- This code provides guidelines for floodplain and construction interaction, such as:
    - Avoid longitudinal and significant encroachments, where practicable
    - Minimize impacts of highway agency actions that adversely affect base floodplains

Figure 6-1 Watersheds in the Project Area



- Restore and preserve the natural and beneficial floodplain values that are adversely impacted by highway agency actions
- Natural and beneficial floodplain values shall include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge
- The base flood is defined as a flood that has a one percent or greater chance of occurrence in any given year (100-year flood)

- U.S. Department of Transportation Order 5650.2- This order, titled "Floodplain Management and Protection," prescribes "policies and procedures for ensuring that proper consideration is given to the avoidance and mitigation of adverse floodplain impacts in agency actions, planning programs and budget requests." The purpose of the Flood Disaster Protection Act (42 U.S.C. 4001-4128; DOT Order 5650.2, 23 C.F.R. 650 Subpart A; and 23 C.F.R. 771) is to identify flood-prone areas and provide insurance. The Act requires purchase of insurance for buildings in special flood-hazard areas. The Act is applicable to any federally assisted acquisition or construction project in an area identified as having special flood hazards. It directs projects to avoid construction in FEMA identified flood-hazard areas, or develop a design that is consistent with FEMA regulations.
- Denver, Adams, Weld and Larimer Counties, along with most cities and towns within the project area, are responsible for regulating development in FEMA designated floodplains and adhere to FEMA policy.
- CDOT policy per the CDOT Drainage Design Manual Section 3.2.1 states that the designer is to provide an adequate drainage structure, although all conceivable flows under all site conditions are not a requirement. This section also states that the 100-year flood be evaluated for drainage structures.
- The CDOT Drainage Design Manual Section 7.2.3 states that the 100-year storm is the design for urban areas, and the 50-year storm is the design frequency for interstate highways in rural areas. Many rural portions of the North I-25 project area are currently undergoing development. It is anticipated that by the year 2030, most of the project area will be urbanized. Due to this urbanization, it is appropriate to select the 100-year storm as the design storm for the entire project area.
- Colorado Senate Bill 116 addresses the requirements for facilities (including detention) to prevent storm waters in excess of historic 100-year rates from entering storm drainage conduits.
- FEMA Flood Zones- An inspection of the current FEMA flood insurance rate maps was completed for the project area. All of the major drainageways are within FEMA zones "AE", "A", or "X" which define boundaries of floodplains by varying degrees of detail. Smaller drainages are not defined by FEMA. Following is a description of each zone and a list of drainages within each specific zone.

- Zone "AE"- Zone "AE" is part of the FEMA 100-year flood hazard area where base flood elevations have been determined. Zone "AE" floodplain areas within the project area include the Boxelder Creek Overflows, Big Thompson River at the Burlington Northern Santa Fe Railway (BNSF), Big Dry Creek, Tanglewood Creek, the South Fork to Grange Hall Creek, Grange Hall Creek, and Clear Creek. The only "AE" Zone areas that also have a floodway delineated in addition to the floodplain are the Big Thompson River at the BNSF, Big Dry Creek, Tanglewood Creek, South Fork to Grange Hall Creek, and Grange Hall Creek. The new Cache la Poudre and Boxelder Creek Digital Flood Insurance Rate Map (DFIRM) has a delineated floodway. The floodway is the area of the floodplain that should be reserved (kept free of obstructions) to allow floodwaters to move downstream.
- Zone "A"- Zone "A" is part of the FEMA 100-year flood hazard area where base flood elevations have not been determined but a shaded, generalized floodplain is shown on the FEMA Flood Insurance Rate Maps (FIRM). Zone "A" areas within the project area include the Big Thompson River, Little Thompson River, St. Vrain Creek, South Fork of Preble Creek, Mustang Run, Sack Creek South, Shay Ditch, McKay Lake Drainageway, Quail Creek, and Niver Creek. US 85 Zone "A" areas include Second and Third Creeks. FEMA's publication "Managing Floodplain Development in Approximate Zone "A" Areas, April 1995" states that although base flood elevations are not shown in Zone "A" areas, the community is still responsible for ensuring that new developments within these areas are constructed using methods that will minimize flood damage. This often requires obtaining or calculating base flood elevations at the development site with the 100-year flood being FEMA's base flood.
- Zone "X"- Zone X is part of the FEMA 500-year flood area, 100-year flood area with average depths of less than 1 foot, or with drainage areas less than one square mile. This zone generally extends beyond the 100-year flood limits. Zone X areas within the project area include an unnamed tributary to Grange Hall Creek.

The study team determined that the 100-year design storm for all structures located in FEMA floodplain Zone's AE, A, and X should be used for this project. All minor crossings within the project area will also be assessed for the 100 year event.

6.2 METHODOLOGY

6.2.1 Hydrologic Methodology

The 100-year flows for the major and minor drainages crossing I-25 were obtained from written reports or were developed through the Colorado Urban Hydrograph Procedure (CUHP). Many of the larger crossings that were delineated as floodplain Zone "AE" had the 100-year flows listed in the Flood Insurance Study (FIS). The Urban Drainage and Flood Control District (UDFCD) has several Major Drainageway Planning Studies (MDPS) and Outfall Planning Studies (OPS) that provide 100-year flows near or at I-25. CUHP was used for drainages that had no documented 100-year flows. The CUHP input parameters are based on the basin geometry and runoff characteristics. The runoff characteristics that were input into the program were based on Urban Storm Drainage Criteria Manual published by the UDFCD and the CDOT Drainage Design Manual. These values may vary due to existing conditions or future development in the final design and will need to be adjusted in the future as better information becomes available.

Approximately 20 minor drainages have been identified in the project area. Peak flows for these drainages have been calculated using a percent imperviousness that is based upon the current land use, zoning, or anticipated future land use when known. In areas where the land use is unknown, 45 percent imperviousness was used. This is recommended by the UDFCD which is the generally accepted practice in Colorado. This percent impervious equates to about 80 percent residential, 10 percent commercial, and 10 percent open space. This is used to size drainage structures in order to allow upstream flows to pass through the project area.

6.2.2 Hydraulic Methodology

To assess the hydraulic adequacy of the I-25 structures, the water surface profiles in the FIS along with the MDPS and OPS were used. In the absence of an existing study, the capacity was analyzed using CDOT charts. Drainage structure capacities are based on a maximum headwater to diameter (or rise) ratio. The cutoff for recommending a reinforced concrete pipe (RCP) versus a concrete box culvert (CBC) was about 1400 cubic feet per second (cfs). which can be carried by 4-84 inch diameter RCP's. The cutoff for recommending a CBC versus a bridge was about 3000 cfs. For sizing bridges, FlowMaster™, developed by Haestad Methods, was used. In general the following criteria were used to model a new bridge:

- A trapezoidal channel was modeled with side slopes of 2:1
- Bottom widths were taken as the width (or diameter) of the existing structure unless inadequate
- Distance between the invert of the channel and the low cord of the proposed structure was estimated from pictures, existing cover, or any available contours
- Four feet of freeboard was assumed except where impractical. A minimum of two feet of freeboard was maintained for all bridges.

For some crossings a variety of crossing types and sizes are provided. This is to show the possible action in the future; however, more detailed information is needed for each crossing before a final recommendation of structure sizes can be made.

Both upstream and downstream impacts were assessed at each crossing. This includes assessing whether or not a railroad embankment, irrigation facility or other man-made feature that impacts drainage will be removed in the future. Coordination with local governments and entities is currently underway. This will continue as the EIS progresses toward the design phases.

6.3 EXISTING FLOODPLAINS AND DRAINAGE SYSTEM

The following section addresses flood history, floodplains, drainage, and floodplains functions in the six watersheds within the regional study area.

6.3.1 Cache la Poudre River Watershed

Flooding occurs within the I-25 right-of-way at the Cache la Poudre River, Boxelder Creek, Fossil Creek, Swede Lake Outlet and several minor crossings. During a 100-year flood event, Spring Creek overtops the BNSF in Fort Collins where the prospective commuter rail route will cross.

The Boxelder Creek and the Cache la Poudre River floodplains are complicated and interconnected in the I-25 area. Recently, portions of these drainages have been re-mapped by FEMA to better reflect the current extents of flooding. The updated FEMA Flood Insurance Rate Maps (FIRM) based on this re-mapping was approved during 2006. The following discussion details the existing drainage, and structures in this portion of I-25. Additional information on current studies, development and proposed floodplain modifications near I-25 are also discussed.

Cache la Poudre River - The Cache la Poudre River has experienced major flooding seven times since 1844. The most damage was caused by the 1904 flood. The 100-year flood width is about 1300 feet in the vicinity of I-25. The basin area of the Cache la Poudre River upstream of I-25 is 1,537 square miles. The Cache la Poudre River passes under a 4-span concrete on rolled I-beam bridge at the northbound I-25 lanes and a 4-span, welded girder bridge at the southbound I-25 lanes. This crossing is located at mile point 265.9. These I-25 bridges are not hydraulically sufficient and are constrained when passing the 10-year flows. CDOT has improved the crossing within the last 5-years by removing accumulated sediment. This was done to allow better conveyance of storm waters. These improvements were limited to areas within the I-25 right-of-way in anticipation that the improvements would be extended upstream and downstream so that the river system as a whole would function better. The Fort Collins Nature Conservancy owns land adjacent to the I-25 right-of-way at this crossing. This area has many trees, dense vegetation, and a viable wildlife habitat. For these reasons, the Conservancy would not allow the channel improvements to extend onto their property.

The 100-year discharge at I-25 is 17,400 cfs according to the Larimer County FIS. This 17,400 cfs splits at the I-25 Bridge. About 13,300 cfs passes under the existing I-25 bridge and the remaining 4,100 cfs passes south toward Harmony Road. The City of Fort Collins is requiring this split flow floodway to be kept intact. This is necessary because the entire 100-year flow cannot pass into the main channel without exceeding the allowable rise. The City of Fort Collins has future plans to raise Harmony Road and install an adequately sized culvert or bridge. South of Harmony Road these overflows spill back over I-25 and return to the Cache la Poudre River. The City of Fort Collins realizes that a future I-25 structure will be required here. In previous master plans, The City of Fort Collins looked at passing the entire 17,400 cfs under I-25 at the existing bridge location. They encountered physical limitations such as a large bridge span and sedimentation problems within the channel. The regulatory limitation of having no rise in the water surface elevations downstream of I-25 is an additional requirement. This rise would be in Larimer County and the Town of Timnath, so their mitigation rules would also apply. Raising the water surface elevations east of I-25 adds additional constraints, and further limits the feasibility of this option (Hayes 2006, Smith 2006).

According to the CDPHE, rivers in Colorado are given uses for which, under normal circumstances should attain. These uses include: agriculture, recreation, and warm water aquatic life. Additional floodplain uses include the conveyance of stormwater, riparian habitat, and water quality maintenance.

The surrounding area includes farmland and open space. The ground cover consists of native plants. There is no erosion and minimal debris in the channel and surrounding areas. There is riprap in the channel and under the bridges for slope stability. Low flows currently pass under the southern portion of the bridge.

Boxelder Creek - Boxelder Creek has a basin area of 265 square miles above I-25. It begins near Harriman, Wyoming and flows southeast toward Wellington. North of Larimer County Road 60, it crosses under I-25 at mile post 276.48 via a 3 cell concrete box culvert. It then flows southward along the east right-of-way of I-25. Many box culverts and pipes allow the Boxelder overflows to pass under I-25 in this area. Peak flows encroach onto I-25 for a 1500 foot segment south of the I-25 northbound off ramp to Prospect Road. North of Prospect Road, Boxelder Creek concentrates at I-25 mile post 268.81 at a 4-cell concrete box culvert. Two of these cells have been temporarily plugged until an adequately sized downstream channel is built. This will allow Boxelder Creek to pass westerly under I-25 in its original path and eventually to the Cache la Poudre River.

Two complimentary projects are being considered in order to better convey the peak Boxelder flows and control much of the flooding. They include a plan by the Boxelder Creek Regional Alliance and a second plan, Boxelder Creek at Prospect Road that was once sponsored by Fort Collins and the Commons Development. Below is a brief discussion of each of these plans.

The Boxelder Creek Regional Alliance (Alliance 2006) is a group that includes Fort Collins, Wellington, Windsor, Timnath, Larimer County, North Poudre Irrigation Company, Boxelder Sanitation District, New Cache la Poudre Irrigation Company, Colorado Water Conservation Board and impacted property owners. They are cooperating to limit flooding, allow better drainage, and provide more useable land in the Boxelder Creek floodplain. PBS&J has prepared a Regional Stormwater Management Plan that recommends drainage improvements and funding alternatives for Boxelder Creek between Wellington and the Cache la Poudre River. The preferred alternative lists the following proposed improvements:

- Pass Coal Creek flows (tributary to Boxelder Creek) to Clark Reservoir for 465 acre feet of detention
- Pass Indian Creek flows (tributary to Boxelder Creek) to Edson Reservoir for 9,901 acre feet of detention
- Improve culverts at road crossings
- Make overflow improvements to Prospect Road, Lake Canal, and the Cache la Poudre River
- Upgrade the Boxelder Creek channel for improved conveyance
- At the 4-cell box culverts under I-25 at mile post 268.81 the two plugged cells are to be opened so that all four cells can be utilized

At the 4-cell box culverts noted above, a 100-year flow of 1,490 cfs currently passes under I-25 via the two open cells and about 4,220 cfs pass to the south (out of the historic path) along the east side of I-25 toward Timnath. This causes several hundred acres to flood. Until channel improvements along the west side of I-25 are made and the two plugged cells can be opened and utilized, a new Boxelder Creek conveyance channel on the east side of I-25 will need to be constructed. This conveyance channel is planned by the Boxelder Creek Regional Alliance. It will parallel Interstate 25 about one-half mile to the east, and will be located near the new 60 inch Greeley water line. This water line crosses under I-25 and the east service road north of Prospect Road.

Boxelder Creek at Prospect Road - The once proposed Commons Project (Commons 2006) at the northwest quadrant of I25 and Prospect Road was impacted by the Boxelder Creek flooding downstream of the four box culverts described above. A plan that the City of Fort Collins and the Commons Development had, included passing Boxelder Creek flows in an improved channel, and splitting the flow near Prospect Road. Currently, Prospect Road is overtopped during moderate to large storms. Historically, the Boxelder Creek flows split at Prospect Road with about 2,129 cfs passing directly to the Cache la Poudre River and 1,571 cfs remaining in Boxelder Creek. The 100-year flow at Prospect Road has been changed due to updated hydrology in the area. A new flow of 4,600 cfs is accepted and will be used by Anderson Engineering to complete the revised storm water routing. This includes improving both the split flow channel and the Boxelder Creek channels and culverts at Prospect Road. South of Prospect Road, the split flow channel would require property acquisition. If this project were ever built, the conveyance channel that the Alliance project built would still be needed in order to pass localized storm waters from the areas north of Timnath along the east side of I-25. The Alliance improvements will occur sooner than the Fort Collins plan.

The surrounding area includes commercial, residential, farm land, and open space. The ground cover consists of native plants and grasses. There are no slope stability measures, and there is erosion along the banks. Minimal debris is present.

The commuter rail of Package A begins south of the Cache la Poudre River. The only major drainageway that the commuter rail crosses within this watershed is Spring Creek. Spring Creek has an upstream basin area of about eight square miles above the future commuter rail line which is part of the BNSF railway in this area. The Spring Creek floodplain at the BNSF has a width of 2,000 feet. The 100-year flow at this crossing is less than 1,944 cfs according to the Larimer County FIS. The current structure is a 14 foot by 12 foot by 37 foot concrete box culvert (CBC). This CBC is inadequate and the commuter rail will be overtopped by the 100-year flows just south of Prospect Street under current conditions.

Cache la Poudre River Tributary Drainages - Information regarding the drainages for the Swede Lake Outlet, Fossil Creek, and Fossil Creek Reservoir Outlet, are listed below. Many drainage culverts under I-25 are associated with the Boxelder Creek system. These include box culverts and smaller pipes. **Table 6-1** summarizes the floodplain and discharge information for the Cache la Poudre River watershed drainages.

Table 6-1 Cache la Poudre River Tributary Drainages

Mile Point	Name	Area (sq. mile)	Q100 (cfs)	Existing Structure	FEMA Zone	Comments
276.08 to 267.06	Boxelder Creek side drainage	-	-	4-2-cell CBC's, 2-3-cell CBC's, 1-48" CMP, 1-36" CMP, 4-30" CMP's, 10-24" CMP's	AE, A, A4 (with elev.)	Not Adequate (Alliance 2006)
268.813	Boxelder Creek	269	<11,700 (FEMA 1999)	2-span CBC	A	Not Adequate (Alliance 2006)
266.53 to 260.53	Local Minor Drainage	-	-	1-18" RCP 11-24" RCP 2-30" RCP 2-36" RCP 1-24" CMP 22"X37" CMPA	-	
265.846	Cache La Poudre River	1537	13,296 (FEMA 1999)	4-span Bridge, 4-span Bridge	A	Not Adequate (FlowMaster™)
263.27	Fossil Creek Reservoir Outlet	NA	400 (Poudre 2006)	12'x5' CBC	-	Adequate (Poudre 2006)
263.070	Fossil Creek	0.08 (48.6 ac)	Seasonal Flow	84" CMP	-	Not Adequate* (Poudre 2006)
262.55	Swede Lake Outlet	1.45	854 (FEMA 2003)	24" RCP	-	Not Adequate (CDOT 2004)

* Fossil Creek enters Fossil Creek Reservoir west of I-25. The old creek bed still exists downstream of the reservoir and is now an ephemeral stream. Overflows from the reservoir do release to the creek bed, however, and there has been at least one instance of flooding and I-25 overtopping in 1998 (Poudre 2006).

6.3.2 Big Thompson Watershed

Big Thompson River - The basin area of the Big Thompson River upstream of I-25 is 504 square miles. It has experienced major flooding eight times since 1864. The worst flooding occurred during 1976 when a cloudburst caused extensive flooding and took 139 lives. At I-25, the Big Thompson River has a 3100 foot wide floodplain. The Big Thompson River passes under 3-span, concrete slab and girder bridges at both the northbound and southbound I-25 lanes at mile post 256.60. These structures are in good condition. The river also passes under a 2-

span, concrete on rolled I-beam bridge at the frontage road. This bridge is in fair condition. The bridge at I-25 is not expected to be overtopped during the100-year storm. The 100-year flow at I-25 is 19,165 cfs according to the Larimer County FIS. I-25 is not expected to be overtopped, but the structures probably have inadequate freeboard. The Big Thompson River is in floodplain Zone "A" with a floodplain area defined without floodways. Flooding occurs at eight tributary crossings within this sub-watershed. The surrounding locale includes farm land and open space. The ground cover consists of native plants and Russian olive trees. There is no erosion and minimal debris. Riprap is present under the bridges.

According to the CDPHE, the rivers designated uses are for agriculture, and warm water aquatic life. Additional floodplain functions are for the conveyance of stormwater, riparian habitat, and water quality maintenance.

Little Thompson River - The Little Thompson River basin area upstream of I-25 is 182 square miles. It passes under I-25 at mile post 249.84 via a 3-span, concrete slab and girder bridge, which is in good condition. At I-25, the Little Thompson River has a 700-foot wide floodplain. The Little Thompson frontage road bridge on the east side of I-25 is a steel truss bridge that was built in 1938. It has been classified as a historic structure that will not be replaced. The 100-year flow is approximately 7,593 cfs according to the Boulder County FIS. I-25 will not be overtopped and the I-25 bridges are adequate. The frontage road bridge is marginally adequate. The Little Thompson River is in floodplain Zone "A" with a non-detailed floodplain area defined. There are no floodways in this area. The surrounding area includes farm land. The ground cover consists of native vegetation, thistle, and Russian olive trees. There is no debris or erosion at the I-25 bridges. The frontage road has significant erosion and some debris. There is riprap under the I-25 bridges and broken concrete under the frontage road bridge for slope stability.

US-34 Tributary to the Big Thompson River - An un-named tributary to the Big Thompson River crosses US-34 on the east side of I-25. A 30 inch reinforced concrete pipe originally passed less than 100 cfs of historic drainage. The Centerra Development at the northeast corner of this interchange has increased the flows to about 1,100 cfs (Northern 2004). A portion of Centerra's detention pond is located on CDOT right-of-way. Discussion between Centerra, their engineer, CDOT and the City of Loveland are currently under way in order to determine if this culvert is to be upsized or left in place with upstream detention. The detention area has served as inadvertent detention in the past. The developer's plan is to take advantage of this area for additional detention.

The commuter rail of Package A crosses both the Big and Little Thompson Rivers. The basin area of the Big Thompson River upstream of the commuter rail is approximately 470 square miles. The Big Thompson floodplain is 3600 feet wide at this crossing. The 100-year flow at the commuter rail is less than 1900 cfs according to the Larimer County FIS. The current structure at the Big Thompson crossing is a ballast deck, I-beam 30 foot bridge. The basin area of the Little Thompson River upstream of the commuter rail is approximately 170 square miles. The Little Thompson floodplain is 800 feet wide at this crossing. The 100-year flow at the commuter rail is less than 7,200 cfs according to the Boulder County FIS. The current structure at the Little Thompson crossing is a 109 foot ballast deck pile trestle wood bridge.

Big Thompson Tributary Drainages - Information regarding the drainages for several draws and tributaries, drainages to Little Thompson, and a draw at the service road is listed below. **Table 6-2** summarizes the floodplain and drainage information for the Big Thompson River watershed and drainages.

Table 6-2 Big Thompson River Tributary Drainages

Mile Point	Name	Area (sq. mile)	Q100 (cfs)	Existing Structure*	FEMA Zone	Comments
256.603	Big Thompson	504	19,165 (FEMA 1999)	3-span CSGC	A	Not Adequate (FlowMaster™)
254.890	Draw at SR	5.34	5,521 (CUHP)	3-span CI bridge	-	Not Adequate (FlowMaster™)
254.826	Draw	5.34	5,521 (CUHP)	CBC	-	Not Adequate (CDOT 2004)
253.86	Drainage	0.31	684 (CUHP)	58"X36" CMPA	-	Not Adequate (CDOT 2004)
252.670	Draw	0.75	1,731 (CUHP)	48" RCP	-	Not Adequate (CDOT 2004)
252.600	Trib. to Draw	0.14	200 (CUHP)	36" RCP (questionable)	-	Not Adequate (CDOT 2004)
249.841	Little Thompson	182	7,593 (FEMA 2002)	3-span CSG	A	Probably Adequate (FlowMaster™)
249.400	Draw	1.03	1944 (CUHP)	7'x2' CBC	-	Not Adequate (CDOT 2004)
US 34	Un-named Trib. to Big Thompson		1,100 (Centerra)	30" RCP	-	Not Adequate (CDOT 2004)
252.15 to 258.86	Minor Local Drainage	-	-	1-18" RCP 8-24" RCP 2-36" RCP 2-58"X36" CMPA 29"X18" CMPA	-	

* CSGC= Concrete Slab and Girder Continuous (poured in place), CI=Concrete on Rolled I-beam, CBC=Concrete Box Culvert., CMPA= Corrugated Metal Pipe Arch, RCP=Reinforced Concrete Pipe, CSG= Concrete Slab and Girder (Poured in place)

6.3.3 St. Vrain Watershed

St. Vrain Creek - The St. Vrain Creek basin area upstream of I-25 is approximately 344 square miles. The St. Vrain Creek has experienced major flooding 10 times since 1864. The worst flooding occurred during 1941 when a cloudburst and snowmelt combination caused extensive flooding. The 100-year flood width is about 3,700 feet in the vicinity of I-25. I-25 flooding also occurs at seven tributary crossings within this sub-watershed. The St. Vrain Creek passes under I-25 at Mile Post 241.13 via a 4-span concrete slab and girder bridge that is in good condition. The 100-year flow at I-25 for the St. Vrain Creek is approximately 17,209 cfs according to the Boulder County FIS. A riprap channel drop (grade control structure) was built near the east right-of-way lines of I-25 to lower channel the 100-year water surface. This allows the 100-year flood to pass within the existing I-25 and east frontage road bridges. Due to the grade control improvements, I-25 is not expected to be overtopped, and the structures are considered adequate. The Colorado Division of Wildlife has concerns regarding this grade control structure because they have slopes that are too steep for fish migration. The St. Vrain Creek is in the FEMA floodplain Zone "A" and has a generalized floodplain area defined. The surrounding area includes open space, abandoned gravel pits, farmland and the St. Vrain State Park. The ground cover consists of lush native vegetation and wetlands. There is no erosion or debris. Riprap has been placed under the bridge for slope stability.

The proposed commuter rail of Package A will cross the St. Vrain Creek. The basin area of the St. Vrain Creek upstream of the commuter rail is approximately 330 square miles. The100-year flow at the commuter rail is greater than 16,520 cfs according to the Boulder County FIS. There is no existing structure at this location.

About 7,000 feet of SH 119 is overtopped by the combined flooding from the St. Vrain Creek and Idaho Creek. Existing structures are absent adjacent to SH 119 where the prospective commuter rail route will cross these drainages.

According to the CDPHE, the rivers designated uses are for recreation, and warm water aquatic life. Additional floodplain functions are for the conveyance of stormwater, riparian habitat, and water quality maintenance.

Other St. Vrain Creek Tributary Drainages - Information regarding the drainages for the Draw at the Railroad, Draws at Service Roads, Draw above the Racetrack, and North Creek are listed below in **Table 6-3**.

Table 6-3 St. Vrain Creek Tributary Drainages

Mile Point	Name	Area (sq. mile)	Q100 (cfs)	Existing Structure*	FEMA Zone	Comments
246.96	Drainage	0.44	958 (CUHP)	60" RCP	-	Not Adequate (CDOT 2004)
245.67	Drainage	0.15	311 (CUHP)	8'X4' CBC	-	Adequate (CDOT 2004)
245.437	North Creek	6.48	2,995 (JR 2006)	23'x6' CBC	A	Not Adequate (CDOT 2004)
244.12	Drainage	1.61	2,772 (CUHP)	8'X4' CBC	-	Not Adequate (CDOT 2004)
241.127	St. Vrain Creek	344	17,209 (FEMA 2002)	4-span CSGC	A	Adequate
236.926	Drainage	0.89	1,424 (CUHP)	36" RCP	-	Not Adequate (CDOT 2004)
235.238	Drainage	0.68	1,150 (CUHP)	36" culvert	-	Not Adequate (CDOT 2004)
234.85	Draw above Racetrack	0.17	361 (CUHP)	97"x68" CBC	-	Adequate (CDOT 2004)
234.14	Drainage	0.07	104 (CUHP)	8'X8' CBC	-	Adequate (CDOT 2004)
233.570	Draw at SR	0.15	338 (CUHP)	2-36" RCP	-	Not Adequate (CDOT 2004)
233.299	Draw at SR	1.05	2,477 (CUHP)	22'x6' CBC	-	Not Adequate (CDOT 2004)
232.452	Draw at RR	0.65	1,290 (CUHP)	21'x5' CBC	-	Not Adequate (CDOT 2004)

* RCP=Reinforced Concrete Pipe, CBC=Concrete Box Culvert., CSGC= Concrete Slab and Girder Continuous (poured in place)

6.3.4 Big Dry Creek Watershed

Flooding occurs at tributaries to Little Dry Creek, Preble Creek, South Fork Preble Creek, Sack Creek South, Mustang Run, Shay Ditch, McKay Lake Drainageway, and Tanglewood Creek.

Big Dry Creek - Big Dry Creek has few records of flooding due to the numerous reservoirs and its recent agricultural past. The 100-year flood width is about 1,500 feet in the vicinity of I-25. The Big Dry Creek crossing at I-25 is marginally adequate for passing flood waters. The Big Dry Creek basin area upstream of I-25 is approximately 61 square miles. Big Dry Creek passes under I-25 at mile post 224.68 via a concrete on rolled I-beam, 2-span bridge. This bridge is in good condition. Previously, the west side of this bridge was improved by the City of Westminster to allow the 100-year flow to pass within the structure. Almost no freeboard exists under the current conditions. The 100-year flow at I-25 for Big Dry Creek is 8,839 cfs according to

the Adams County FIS. I-25 is not expected to overtop and the structure is considered marginally adequate hydraulically. Big Dry Creek is in the “AE” floodplain zone and has detailed water surface elevations. There is a floodway in this area that must be kept free from obstructions. The surrounding area consists of the City of Westminster sewage treatment facility, the Thorncreek Golf Course, residential, and open space. Ground cover includes native plants, Russian olive trees, and possible wetlands. There are no visible erosion or slope stability problems. There is some sedimentation under the bridge.

According to the CDPHE, the creeks designated uses are for recreation, and warm water aquatic life. Additional floodplain functions are for the conveyance of stormwater, riparian habitat, and water quality maintenance.

Quail Creek - Originally, Quail Creek passed under I-25 via a 24 inch culvert along the south side of 136th Avenue. Stormwaters continued flowing eastward and passed into Big Dry Creek near Washington Street. During 2002, Quail Creek was completely re-aligned and now passes directly into Big Dry Creek about 1,000 feet west of I-25. The original 24 inch Quail Creek culvert still conveys minor localized drainage under I-25. Quail Creek drainage is currently adequate at I-25. A Conditional Letter of Map Revision (CLOMR) is being prepared by ICON Engineering. It will remove the Quail Creek regulatory floodplain from this section of I-25.

McKay Lake Drainageway - The McKay Lake drainage basin area upstream of I-25 is 2.1 square miles. The 100-year flow is 1,600 cfs (Kiowa 2001). The McKay Lake Drainageway does not have a conduit under I-25 to pass storm waters. Stormwaters currently pond on the west side of I-25 and eventually overtop the highway median or spill south over the basin boundary into the Quail Creek and Big Dry Creek basins. A developer of the northwest quadrant of the 136th Avenue and I-25 intersection has built a retention pond in order to limit flooding in the area and protect the development. Potentially, I-25 can be overtopped by the 100-year storm event, so a drainage structure under I-25 is needed. The Cities of Westminster and Thornton have plans to construct three 84-inch culverts under I-25 to pass the McKay Lake Drainageway flows to the east. The McKay Lake Drainageway is in the floodplain Zone “A” with a generalized floodplain area defined. The surrounding areas include new commercial uses, farm land, and open space.

Preble Creek - The Preble Creek basin area upstream of I-25 is 3.3 square miles. Currently, Preble Creek passes under I-25 near mile post 229.48 via a 60 inch reinforced concrete pipe that is in fair condition. According to a hydraulics report prepared by JF Sato, the capacity of the 60 inch pipe is 200 cfs. Preble Creek has a 100-year flow of 2,317 cfs at the I-25 crossing. This flow was determined by the Urban Drainage and Flood Control District and has been accepted by CDOT and the City and County of Broomfield. Broomfield has directed the adjacent landowners to use this flow for their developments. The limited capacity of the existing 60-inch reinforced concrete pipe at I-25 will cause overtopping and flooding. This culvert needs to be replaced with a bridge, box culvert or multiple pipe system. CDOT is currently studying this area and will select a plan later in 2007 and construct a new structure in late 2008.

The Urban Drainage and Flood Control District also addressed the minor drainageways including Shay Ditch, Mustang Run, Sack Creek, and South Preble Creek. All of these drainages flow from west to east crossing I-25 and all have inadequate structures at I-25. Water quality and detention basins are recommended for these areas except Sack Creek. I-25 crosses Sack Creek at its headwaters and it was determined that a detention pond was not needed. These are only recommendations and a schedule for construction has not been addressed. These drainages are all within FEMA Zone A.

The commuter rail of package A crosses the Little Dry Creek. The basin area of Little Dry Creek upstream of the commuter rail is approximately 2.5 square miles. The 100-year flow at the commuter rail is greater than 3,700 cfs according to the Adams County FIS. The current structure at this crossing is a 14 foot bridge.

Other Big Dry Creek Tributary Drainages - Information regarding the drainages for Tanglewood Creek, Shay Ditch, Mustang Run, Sack Creek, Tributary to Little Dry Creek, Little Dry Creek, and drainage to Little Dry Creek are listed below. **Table 6-4** summarizes the floodplain and drainage information for the Big Dry Creek watershed.

Table 6-4 Big Dry Creek Tributary Drainages

Mile Point	Name	Area (sq. mile)	Q100 (cfs)	Existing Structure*	FEMA Zone	Comments
231.700	Minor Local Drainage	-	-	20" RCP	NA	
231.470	Little Dry Creek	2.27	3,384 (CUHP)	1-58" RCP 1-36" RCP	NA	Not Adequate (CDOT 2004)
230.636	Tributary to Little Dry Creek	0.23	503 (CUHP)	56" RCP	NA	Not Adequate (CDOT 2004)
229.480	Preble Creek	3.3	5,292 (WWE 2006)	60" RCP	NA	Not Adequate (WWE 2006)
228.546	S. Fork Preble Creek	0.6	1,139 (WWE 2006)	16'x6' CBC	A	Not Adequate (WWE 2006)
227.733	Sack Creek S.	0.3	658 (WWE 2006)	54" RCP	A	Not Adequate (WWE 2006)
227.335	Mustang Run	1.1	1,284 (WWE 2006)	18" CMP	A	Not Adequate (WWE 2006)
226.729	Shay Ditch	1.0	1,183 (WWE 2006)	48" RCP	A	Not Adequate (WWE 2006)
225.646	McKay Lake Drainageway	2.1	1,600 (Kiowa 2001)	None	A	Not Adequate
224.675	Big Dry Creek	61	8,839 (FEMA 1995)	2-span CIC	AE	Adequate
224.470	Tanglewood Creek	0.7	906 (CUHP)	50" RCP	AE	Not Adequate (CDOT 2004)

* RCP=Reinforced Concrete Pipe, CBC=Concrete Box Culvert., , CMP= Corrugated Metal Pipe, CIC=Concrete on Rolled I-beam continuous

6.3.5 Clear Creek

Clear Creek - The Clear Creek drainage basin has an approximate area of 567 square miles upstream of I-25. Clear Creek has experienced major flooding 12 times since 1864. The worst flooding occurred during 1965 when a cloudburst and snowmelt combination caused extensive damage. The 100-year flood width is about 3,700 feet in the vicinity of I-25. I-25 is not overtopped by Clear Creek. Clear Creek passes under I-25 at mile point 216.60 via concrete box girder bridges that are in good condition. The southbound on-ramp, I-25 lanes, northbound exit ramp, and the frontage road all have 3-span bridges, and the southbound exit ramp has a 4-span bridge. The 100-year flow at I-25 is about 14,520 cfs according to the Denver County FIS. I-25 is not expected to be overtopped at this location, and the current structures are considered adequate. FEMA has designated the Clear Creek area as Zone "AE" with detailed water surface elevations. There is a floodway that must be kept free from obstructions. The surrounding area consists of commercial properties and open space. Ground cover includes native plants and grasses, weeds, and Russian olive trees. There is some visible erosion on the banks of the channel and debris in the channel and banks. Riprap is present in the channel and under the bridge to provide slope stability.

According to the CDPHE, the creeks designated uses are for agriculture, and warm water aquatic life. Additional floodplain functions are for the conveyance of stormwater, riparian habitat, and water quality maintenance.

Clear Creek Minor Drainages - No minor tributaries to Clear Creek cross I-25 within the regional study area.

6.3.6 South Platte Watershed

Direct Flow Areas West of the South Platte River - A 1.3 square mile drainage basin concentrates at I-25 between 52nd and 55th Avenues. This area drains the highly impervious industrial areas west of I-25 between I-70 and 58th Avenue. Stormwaters concentrate along the west side of I-25 at Bannock Street and cause periodic flooding. **Table 6-5** presents information about the existing structures under I-25.

Table 6-5 South Platte River West Tributary Drainages

I-25 Mile Post	Description*	Notes
214.81 (Near 55th Avenue)	48" RCP	
214.78 (Near 54th Avenue)	48" RCP	Future 36" RCP to be jacked under I-25 here per OSP
214.52 (Near 52nd Avenue)	24" RCP	
214.51 (Near 52nd Avenue)	48" RCP	Plugged until outfall provided
214.33 (51st Avenue)	48" Brick	Historic status

* RCP=Reinforced Concrete Pipe

The brick pipe outlets east of I-25 where storm waters continue in an undersized storm drain system of streets, alleys and in one case, through a warehouse parking lot. The 48 inch concrete pipes were installed during the early 1990's when this segment of I-25 was improved. One of these pipes was plugged since there was no direct outfall for the storm waters and an increased possibility of property damage east of I-25 could occur. The pipe is to remain plugged until an outfall system to the South Platte River is constructed (Kiowa 2000, Washington 2004).

According to CDPHE, the creeks designated uses are for agriculture and warm-water aquatic life. Additional floodplain functions are for conveyance of stormwater, riparian habitat, and water quality maintenance.

Tributary Drainage Areas East of the South Platte River - Thirty intersections have been identified for proposed bus queue jumps. Thirteen locations are along the business route of US 34, and 17 are along US 85. Of these intersections, only two are in a floodplain according to available mapping from FEMA. They include the US 85/East 136th Avenue intersection at Second Creek and the US85/144th intersection at Third Creek. Second and Third Creeks have five recorded floods since 1948 when one death occurred. Most damage has been limited to crops and livestock. US 85 is overtopped by Second Creek at 136th Avenue, and Third Creek at 144th Avenue. The floodplains for these two drainages are interconnected and have a combined 6,800 foot width at US85. Both areas are in FEMA Zone "A".

Other South Platte River Tributary Drainages - Information regarding the drainages for Niver Creek, Niver Creek Tributary L, Grange Hall Creek, Grange Hall Creek South Fork, and Grange Hall Creek un-named Tributary are listed below. **Table 6-6** summarizes the floodplain and drainage information for the South Plate River watershed drainages.

Table 6-6 South Platte River East Tributary Drainages

Mile Point	Name	Area (sq. mile)	Q100 (cfs)	Existing Structure*	FEMA Zone	Comments
221.434	Un-named Trib. to Grange Hall Creek	0.35	796 (CUHP)	60" RCP	X	Not Adequate (CDOT2004)
221.228	Grange Hall Creek	0.5	1,508 (CUHP)	24" RCP	AE	Not Adequate (CDOT2004)
220.762	Grange Hall Creek, S. Fork	0.6	1,290 (Kiowa 1997)	48" RCP	AE	Not Adequate (CDOT2004)
218.943	Niver Creek	2.8	890 (Kiowa 1997)	8'X4' CBC	A	Not Adequate (Kiowa1997)
218.731	Niver Creek Tributary "L"	1.6	1,048 (Kiowa 1997)	8'X8' CBC	A	Not Adequate (Kiowa1997)

* RCP=Reinforced Concrete Pipe, CBC=Concrete Box Culvert

6.4 FLOODPLAINS AND DRAINAGE CONSEQUENCES

This section describes the consequences of the No-Action Alternative, and Packages A and B with regard to floodplains and the drainage system. This discussion provides a basis for comparison of the alternatives.

For Packages A and B, consequences are discussed by alternative component to allow for the possibility that the Preferred Alternative may include components from each of these alternative packages. Mitigation measures to address adverse impacts of the alternatives on this resource are discussed in **Section 7.0** *Mitigation Measures*.

6.4.1 No-Action Alternative

The No-Action Alternative (actions planned by others) would impact floodplains in areas where roadway improvements are currently planned. Existing conditions, described in **Section 6.3** would continue. Probable improvements in floodplain areas are shown in **Figure 6-2** and listed below.

- Improvements from SH 1 to SH14 (H1) will include the re-habilitation of one drainage structure.
- Improvements from SH 14 to SH60 (H2) will include the re-habilitation of three drainage structures.
- Improvements from SH 60 to E470 (H3) will include the re-habilitation of two drainage structures.
- Improvements from E470 to US36 (H4) include no plans to improve any drainage structures

6.4.2 Package A (General Purpose Lanes + Commuter Rail and Bus)

Package A includes construction of additional general purpose lanes on I-25, and the implementation of commuter rail and bus service. **Table 6-7** summarizes the consequences of each component of Alternative Package A, and provides a comparison with Package B.

Figure 6-2 Floodplain Impacts By Others for the No-Action Alternative

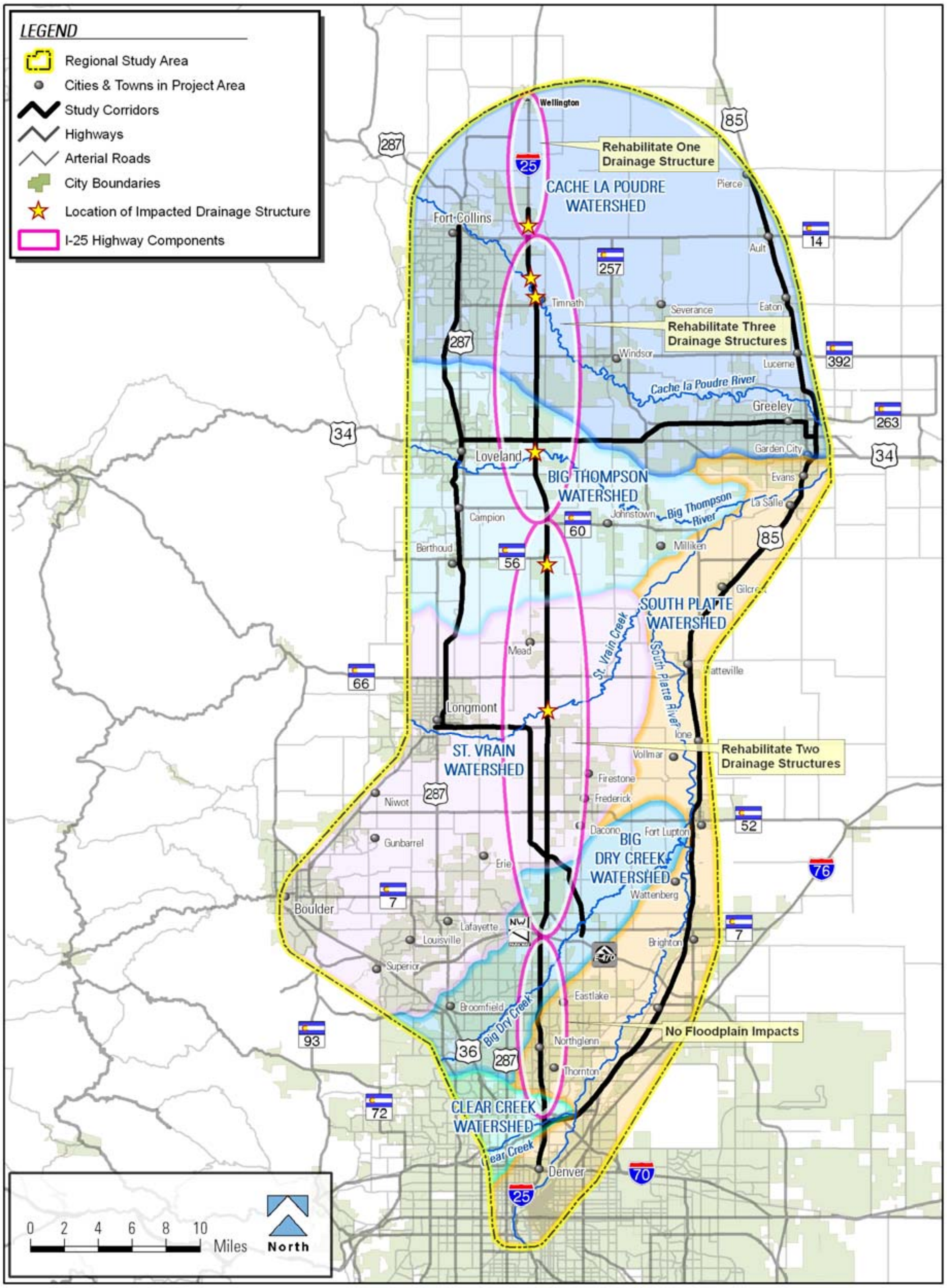


Table 6-7 Estimated Area of Impacts to Floodplains

Package A			Package B		
Component	**Component Description**	**Impacted Floodplain Area (acres)**	**Component**	**Component Description**	**Impacted Floodplain Area (acres)**
Package A Highway Components			**Package B Highway Components**		
AH-1	Safety Improvements: SH 1 to SH 14	1.3	B-H1	Safety Improvements: SH 1 to SH 14	1.3
AH-2	GPL Improvements: SH 14 to SH 60	4.9	B-H2	Tolled Express Lanes: SH 14 to SH 60	6.0
AH-3	GPL Improvements: SH 60 to E-470	4.6	B-H3	Tolled Express Lanes: SH 60 to E-470	5.0
AH-4	Structure Upgrades: E-470 to US 36	0	B-H4	Tolled Express Lanes: E-470 to US 36	1.2
Total Package A Highway Impacts:		*10.8*	*Total Package B Highway Impacts:*		*13.5*
Package A Transit Components			**Package B Transit Components**		
A-T1	Commuter Rail: Fort Collins to Longmont	1.7	B-T1	BRT: Fort Collins/Greeley to 120th	**0**
A-T2	Commuter Rail: Longmont to North Metro	0.2	B-T2	BRT: 120th to Denver	**0**
A-T3	Commuter Bus: Greeley to Denver	0.1	B-T3	BRT: Alternating to DIA	**0**
A-T4	Commuter Bus: Alternating to DIA	0			**0**
Total Package A Transit Impacts:		*2.0*	*Total Package B Transit Impacts:*		*0*
Total Package A Impacts:		**12.8**	**Total Package B Impacts:**		**13.5**

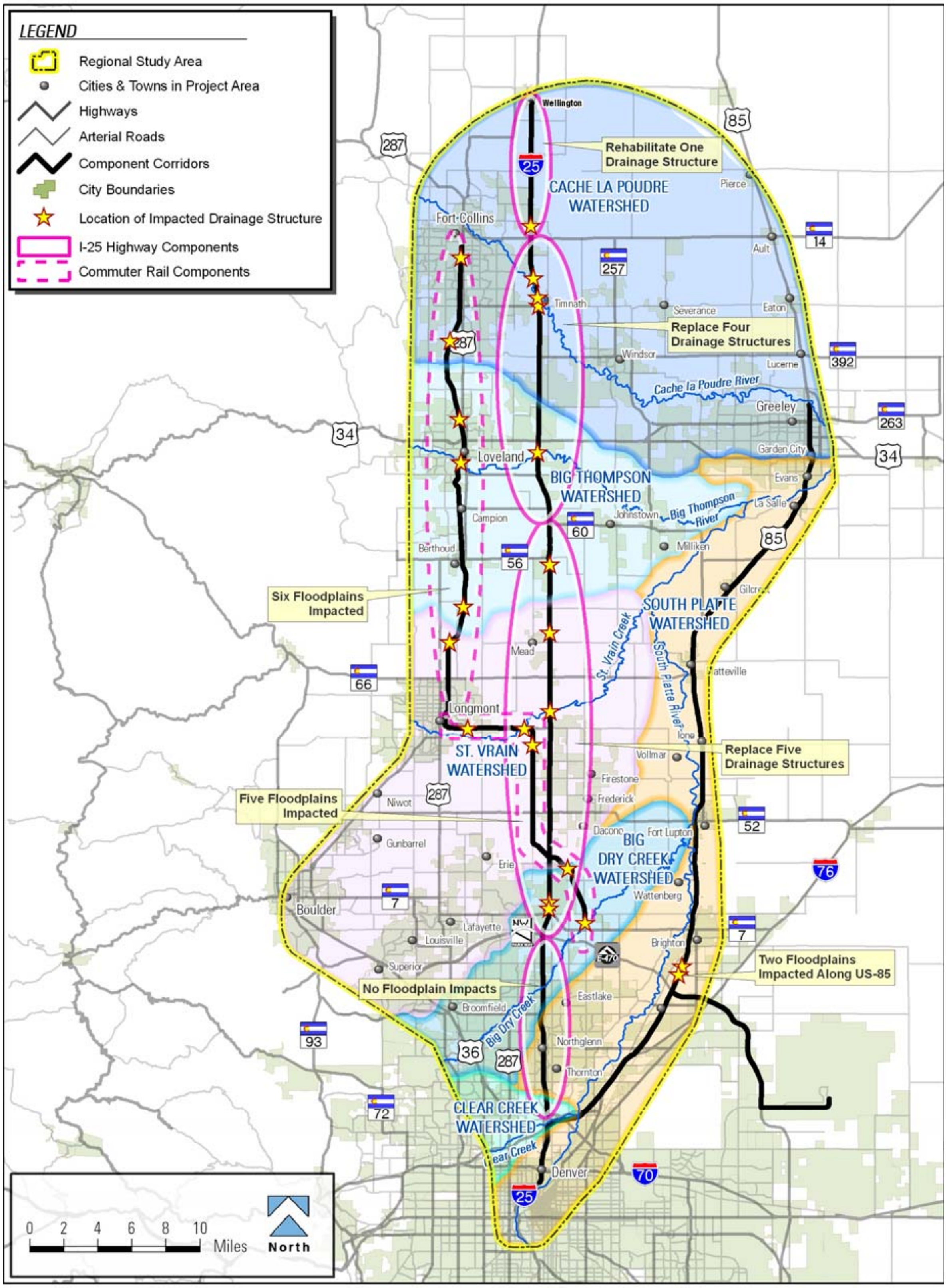
BRT – Bus Rapid Transit GPL – General Purpose Lane

Package A Highway Components

The highway components of Alternative Package A would impact floodplains. Most of the drainage crossings are too small to pass the required flows under I-25 and will need to be replaced. In areas where the structures are sufficient to pass the required flows, the increased width of I-25 will necessitate their being lengthened. Many areas along the commuter rail and bus routes will require new drainage structures. Any replacement or lengthening of a drainage structure, whether it is a bridge of culvert, will impact the floodplain. Specific consequences related to each highway component are shown on **Figure 6-3** and would be as follows.

- Safety improvements involving floodplains from SH 1 to SH14 (H1) will be limited to the No-Action Alternative that includes the re-habilitation of one drainage structure.
- GP Improvements from SH 14 to SH60 (H2) widening will encroach onto three floodplains and will require the replacement of four major drainage structures.
- GP Improvements from SH 60 to E470 (H3) widening will encroach onto four floodplains and will require the replacement of five major drainage structures.
- Structure upgrades from E470 to US36 (H4) will be limited to the No-Action Alternative and does not impact floodplains.

Figure 6-3 Package A Floodplain Impacts



Improvements would have the following floodplain impacts:

- Improving the capacity of the drainage structures would decrease the amount of ponding east of I-25 but could increase the chance of downstream flooding to the west of I-25.
- Natural vegetation around the drainage structures would be disturbed during construction.

Boxelder Creek crosses under I-25 near mile post 269, flowing from east to west. The current structure would be replaced in-kind. This improvement would have the following floodplain impacts:

- There should be minimal, or no changes to the floodplain limits. There may be local changes due to the new structure, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation around the drainage structure would be disturbed during construction.

The Cache la Poudre River crosses under I-25 near mile post 266, flowing from west to east. The current bridge would be replaced in-kind, but the new alignment of I-25 would shift the bridge. The bridge also would be widened to match the new typical section. These improvements would have the following impacts on the floodplain:

- There should be minimal or no changes to the floodplain limits. There may be local changes due to the new structure and new structure location, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation around the drainage structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and destroyed by the new structure location.

The Cache la Poudre River 100-year flows split just west of I-25. About two-thirds of the flow spills over I-25 and passes east under the existing bridge. The remaining flows pass to the south crossing Harmony Road before flooding I-25 at the I-25 and Kechter Road crossroads. There are no structures at this location currently. Four concrete box culverts (CBCs) would be added to this area, one in each quadrant of the crossroads. These improvements would have the following impacts to the floodplain:

- The floodplain limits would change with the new structures. I-25 would probably not be overtopped anymore and the flows would become more channelized. There could be an increase in downstream flooding due to the more concentrated flows.
- Natural vegetation surrounding the roadway would be disturbed during construction.
- Surrounding wetlands could be disturbed during construction.

The Big Thompson River crosses under I-25 near mile post 257, flowing from west to east. The current bridge would be replaced with a new wider bridge due to widening of I-25. This improvement would have the following floodplain impacts:

- There should be minimal or no changes to the floodplain limits. There may be local changes due to the widening of the bridge, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and destroyed due to the widening of the structure.

The Little Thompson River crosses under I-25 near mile post 250, flowing from west to east. The current bridge would be replaced with a new wider bridge and shifted to accommodate widening of I-25 and a new alignment. These improvements would have the following floodplain impacts:

- There should be minimal or no changes to the floodplain. There may be local changes due to the widening and shifting of the bridge, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and permanently disturbed due to the widening and shifting of the structure.

North Creek crosses under I-25 near mile post 245, flowing from west to east. The existing CBC would be replaced in-kind, but it would probably be extended due to the new alignment of the ramps and frontage road. This improvement would have the following floodplain impacts:

- There should be minimal or no changes to the floodplain limits. There could be local changes due to extending the CBC, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and destroyed due to extending the CBC.

Little Dry Creek crosses under I-25 near mile post 231, flowing from west to east. The existing CBC would be replaced in-kind. This improvement would have the following floodplain impacts:

- There should be minimal or no changes to the floodplain limits. There could be local changes due to replacing the CBC, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction.

Preble Creek crosses under I-25 near mile post 229, flowing from west to east. The existing 60 inch reinforced concrete pipe is inadequate for the 100-year flows. A bridge is needed to pass these flows. This improvement would have the following floodplain impacts:

- Improving the structure at I-25 would decrease the flooding west of I-25 where the flow backs up. This could increase the chance of flooding downstream because of the improved structure capacity. The floodplain would change in this area because of a new bridge.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction.

Package A Transit Components - The transit components of Alternative Package A would impact floodplains where crossings occur and where the Commuter Rail and Commuter Bus routes require widening that encroaches onto floodplains. The Commuter Rail route from Fort Collins to Longmont will cross six floodplains and from Longmont to North Metro will cross five floodplains. The Commuter Bus service in US 85 general purpose lanes and queue jumps will impact two floodplains between Greeley and Denver. The Commuter Bus, alternating to DIA will cross four floodplains. None of the bus stations, rail stations or associated parking facilities will impact a floodplain.

Spring Creek crosses under the BNSF railroad, the proposed alignment for the commuter rail, approximately 0.15 miles south of Prospect Road. The existing CBC is inadequate but adding two 60 inch reinforced concrete pipe (RCP) would help pass the full 100-year flows. These improvements would have the following impacts to the floodplain:

- The railroad is currently overtopped by the 100-year flows. Adding the pipes could alleviate this problem. However, there could be an increase in downstream flooding because the flows would be more concentrated through the pipes as opposed to spilling over the railroad.
- Natural vegetation around the drainage structures would be disturbed during construction.

Fossil Creek crosses under the BNSF railroad five times between Fossil Creek Drive and south of Trilby Road. The floodplain has been mapped by the City of Fort Collins in this area. At these crossings, three of the structures would be replaced with larger structures, and two new structures would be added. These improvements would have the following impacts to the floodplain:

- At three of the five crossings, Fossil Creek overtops the railroad. The new structures could alleviate this problem. They could also reduce ponding on the upstream sides of the railroad. Increasing the capacity of the crossing structures could cause more flooding downstream however. Because Fossil Creek snakes back and forth around the railroad, more detailed study would be needed to determine the full changes to the floodplain. Channel improvements and downstream studies may be needed in the future.
- Natural vegetation around the drainage structures would be disturbed during construction.
- Current mapping only shows wetlands at two locations. At both of these locations, the wetlands would be disturbed during construction.

Dry Creek crosses under the BNSF railroad near the Loveland Plaza Mobile Home Park. The existing CBC is inadequate. This could be solved by adding several 96 inch RCP or replacing the CBC with a larger structure. These improvements would have the following impacts to the floodplain:

- A larger structure or the added pipes could decrease ponding upstream of the railroad but could increase the chance of flooding downstream of the railroad.
- Natural vegetation around the drainage structures would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction.

The Big Thompson River crosses under the BNSF railroad approximately one-third of a mile south of West 1st Street. The existing bridge is not overtopped and would be extended in kind. This would have the following impacts to the floodplain:

- There should be minimal or no changes to the floodplain limits. There may be local changes due to extending the existing bridge, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation around the drainage structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and could possibly be destroyed due to the bridge extension.

The Little Thompson River crosses under the BNSF railroad approximately 1/3 of a mile south of County Road 6c. The existing bridge is not overtopped and would be extended in kind. This would have the following impacts to the floodplain:

- There should be minimal or no changes to the floodplain limits. There could be local changes due to extending the existing bridge, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation around the drainage structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and could possibly be destroyed due to the bridge extension.

Spring Gulch crosses under the BNSF railroad just south of 17th Avenue. The new commuter rail would cross Spring Gulch again along SH 119. The existing pipe at the railroad is inadequate. A bridge is needed to pass the 100-year flows. At the new crossing, a bridge is proposed as well. These improvements would have the following impacts to the floodplain:

- A larger structure at the railroad crossing and an adequately sized structure at the new commuter rail crossing should maintain or improve the floodplains at these locations. There could be a chance of increase flooding between these two bridges in Longmont, but this area is only mapped to a zone “X” level of detail currently.
- Natural vegetation around the drainage structures would be disturbed during construction.

The St. Vrain Creek would cross under the proposed commuter rail approximately 1.5 miles west of I-25 along SH 119. The proposed bridge would be very wide because of the wide, shallow floodplain in this area. This improvement would have the following impacts to the floodplain:

- The proposed bridge is designed to prevent overtopping of the proposed commuter rail, but the proximity to the SH 119 bridge, which is inadequate, could cause the flows to back up. The floodplain is so wide in this area that the proposed bridge would probably not make it worse.
- Natural vegetation around the drainage structures would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and destroyed due to the new bridge.

Idaho Creek would cross under the proposed commuter rail approximately 0.66 miles west of I-25 along SH 119. A wide bridge is proposed for this crossing as well, because the St. Vrain floodplain encompasses Idaho Creek. This improvement would have the following impacts to the floodplain:

- Adding a bridge at the commuter rail crossing at the St. Vrain floodplain and at Idaho Creek could change the floodplain upstream of SH 119. The current wide shallow floodplain may split into two flows that join together again downstream of SH 119. More detailed study would be needed in the future to determine the full extent of the changes to the floodplain. There would probably not be an increase in the flooding downstream of the proposed commuter rail due to the new bridges.
- Natural vegetation around the drainage structures would be disturbed during construction.

Little Dry Creek would cross under the proposed commuter rail approximately 0.15 miles south of Weld County Road 8 and 0.8 miles east of I-25. A new bridge is proposed at this crossing. This would have the following impacts to the floodplain:

- There should be minimal or no changes to the floodplain limits. There could be local changes due to the new structure, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation around the drainage structures would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and permanently disturbed due to the new bridge.

Big Dry Creek crosses under the Union Pacific (UP) Railway approximately 0.5 miles north of SH 7 and 2.33 miles east of I-25. The current bridge is not overtopped and it is recommended that this structure be extended in-kind. This would have the following impacts to the floodplain:

- There should be minimal or no changes to the floodplain limits. There may be local changes due to extending the existing structure, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation around the drainage structures would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and permanently disturbed due to the new bridge.

Second Creek has floodplains with designation zone “A” at the intersection of US 85 and East 136th Avenue. This is a location of a proposed queue jump for the commuter bus. Tapers and a shoulder would be added to northbound US 85 turn and to eastbound 136th. This would have the following impacts to the floodplain:

- The additional pavement could increase flows and cause some local changes to the floodplain limits.
- Vegetation will be disturbed and destroyed during construction.

First Creek has floodplains with designation zone “A” at the intersection of US 85 and East 104th Avenue. This is a location of a proposed queue jump for the commuter bus. Tapers and a shoulder would be added to southbound US 85 and to westbound 104th. This would have the following impacts to the floodplain:

- The additional pavement could increase flows and cause some local changes to the floodplain limits.
- Vegetation will be disturbed and destroyed during construction.

6.4.3 Package B (Tolled Express Lanes + Bus Rapid Transit)

Package B includes construction of Tolled Express lanes on I-25, and the implementation of bus rapid transit service. **Table 6-7** summarizes the consequences of each component of Package B, and provides a comparison with Package A.

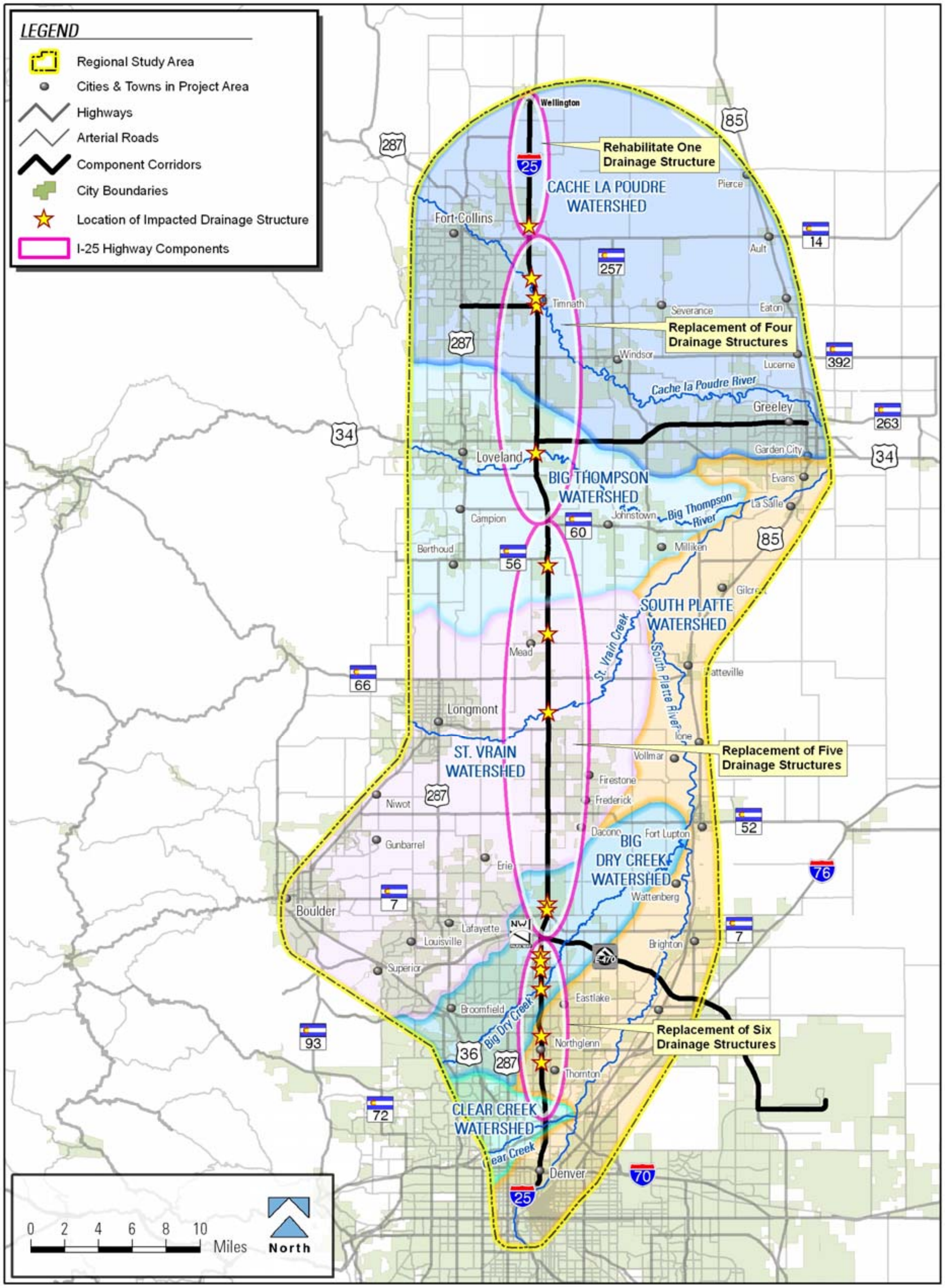
Package B Highway Components

The highway components of Package B would impact floodplains. Most of the drainage crossings are too small to pass the required flows under I-25 and will need to be replaced. In areas where the structures are sufficient to pass the required flows, the increased width of I-25 will necessitate their being lengthened. Areas along the bus routes will require new drainage structures. Any replacement or lengthening of a drainage structure, whether it is a bridge of culvert, will impact the floodplain. Specific consequences related to each highway component are shown on **Figure 6-4** and would be as follows.

- Safety improvements involving floodplains from SH 1 to SH14 (H1) will be limited to the No-Action Alternative that includes the re-habilitation of one drainage structure.
- Tolled Express Lanes from SH 14 to SH60 (H2) will encroach onto three floodplains and will require the replacement of four major drainage structures.
- Tolled Express Lanes from SH 60 to E470 (H3) will involve widening that will encroach onto four floodplains and will require the replacement of five major drainage structures.
- Tolled Express Lanes from E470 to US36 (H4) will involve widening that will encroach onto five floodplains and will require the replacement of six major drainage structures.

Floodplain impacts to the floodplains of Boxelder Creek, the Cache la Poudre River, the Big Thompson River, the Little Thompson River, North Creek, St. Vrain Creek, Little Dry Creek and Preble Creek would be similar to those identified in Package A.

Figure 6-4 Package B Floodplain Impacts



St. Vrain Creek crosses under I-25 near mile post 242. The existing bridge would be replaced with a new wider bridge to match the widening of I-25 in this area. This would have the following impacts to the floodplain:

- There should be minimal or no changes to the floodplain limits. There may be local changes due to the widening of the bridge, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and permanently disturbed due to the widening of the structure.

The South Fork of Preble Creek crosses under I-25 near mile post 229, flowing from west to east. The existing CBC would be replaced with a larger CBC. This would have the following floodplain impacts:

- A larger structure might eliminate some of the spreading of the floodplain upstream of I-25. Flooding could be increased downstream of I-25, however, due to the increased capacity of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.

Mustang Run crosses under I-25 near mile post 227, flowing from west to east. The existing structure is an 18 inch corrugated metal pipe that would be replaced with a CBC. This would have the following floodplain impacts:

- A larger structure would probably reduce upstream ponding behind I-25. Immediately downstream of the structure ponding could increase behind a levee at Bull Canal. It is unlikely that flooding would increase downstream of the Bull Canal levee.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands could be disturbed during construction.

Shay Ditch crosses under I-25 near mile post 227, flowing from west to east. The existing pipe would be replaced with a CBC. This would have the following floodplain impacts:

- Ponding upstream of I-25 would probably be reduced, but there could be an increased chance of flooding downstream of I-25.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands could be disturbed during construction.

Big Dry Creek crosses under I-25 near mile post 225, flowing from west to east. The existing bridge would be replaced in-kind and extended to match the widening of I-25. This would have the following floodplain impacts:

- There should be minimal or no changes to the floodplain limits. There could be local changes due to extending the bridge, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.

- Surrounding wetlands would be disturbed during construction and permanently disturbed due to the extension of the bridge.

Niver Creek crosses under I-25 near mile post 219, flowing from west to east. The existing CBC would be replaced and could be extended. This would have the following floodplain impacts:

- There should be minimal or no changes to the floodplain limits. There could be local changes due to possibly extending the structure, but this should not affect flooding upstream or downstream of the structure.
- Natural vegetation surrounding the structure would be disturbed during construction.
- Surrounding wetlands would be disturbed during construction and possibly permanently disturbed due to extending the CBC.

Package B Transit Components

Package B transit components would not have a floodplain impact that would be in addition to that described under highway components. None of the bus routes, bus stations, bus maintenance facilities, or associated parking facilities would impact a floodplain.

6.4.4 Indirect Effects To Floodplains

Improved structures at floodplain crossings can result in indirect effects to properties beyond the regional study area. Improved crossings convey floodwaters more efficiently because much of the original inadvertent detention caused by the highway embankment is removed. Greater flows pass through the new structure and are conveyed through downstream areas. These higher flows can cause increased flooding and potential damage to downstream properties. It is CDOT's policy that new structures are to be sized to pass the upstream flows through the highway right-of-way. The design flows are to be based on the current level of development, and are not to assume that any inadvertent detention facilities will lower them. Inadvertent detention facilities can include railroad embankments, irrigation canals, and ponds, which might be removed in the future.

6.4.5 Floodplain Impacts Summary

The No Action Alternative has the least floodplain impact and Alternative Package B has the highest floodplain impact. Alternative Package A is slightly lower in floodplain impacts than Package B. After mitigation, all of the impacts should restore the floodplains to an equal or better condition.

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7.0 MITIGATION MEASURES

This section summarizes the BMPs that have been incorporated as required water quality mitigation into the alternative packages.

7.1 SURFACE WATER QUALITY

If stormwater runoff is left unmitigated, the No-Action Alternative and Packages A and B would have water quality impacts due to changes in stormwater characteristics from the addition of impervious surface area and traffic levels. Other impacts would result from the demolition and construction of roadways and structures (e.g. bridges, culverts, piers, retaining walls) near surface water bodies. To reduce the impacts to water resources, a combination of mitigation measures consisting of permanent structural, nonstructural, and temporary construction BMPs will be implemented in the project area, in compliance with the Clean Water Act, CDPS permits, or areas of coverage by the CDOT's MS4 permit, discussed in more detail below. BMPs identified as part of Packages A and B will include water collection and passive treatment of stormwater. Under current conditions, 97.6 percent of the impervious surface area is being directly discharged into existing water systems (see **Table 5-4**)

7.1.1 Structural BMPs

Permanent structural BMPs have already been identified and sited for major stream systems in the project area. Permanent structural BMPs will remain in place and require routine maintenance to ensure their functionality. Water quality ponds and riprap outlet protection are examples of structural BMPs. Consistent with CDOT's MS4 design criteria identified in the New Development and Redevelopment Program (CDOT, 2004a), the performance criteria that have been selected for permanent structural BMPs within the project area are 100 percent water quality capture volume (WQCV) or 80 percent TSS removal. The removal efficiencies for these types of BMPs (e.g., extended detention basin) are 50 percent to 70 percent TSS, 10 percent to 20 percent (total phosphorus), and 30 percent to 60 percent (total zinc) (CDOT, 2004a).

The placement of extended detention ponds occur along the I-25 corridor. No roadway improvements are proposed along the US 85 corridor, with the exception of five very small areas for bus queue jumps at select intersections. The WQCV for these queue jumps is less than 0.1 acre-feet. To ensure 100 percent WQCV, the queue volume has been accounted for in the ponds along I-25. It is not practical to place detention ponds along the US 85 corridor because a new drainage system would be required to carry the water to a BMP.

Water Quality Ponds - Extended detention ponds were identified as the primary structural BMP for this project. Maintenance personnel have previously requested that subsurface vaults not be used. This is primarily because vaults may require special equipment in order to maintain them. Also, maintenance personnel are often required to obtain Occupational Safety and Health Administration (OSHA) confined space entry certification for vault maintenance activities.

The locations of water quality ponds have been identified throughout the project area for Packages A and B. The placement of these BMPs was determined using a rating system that was based on existing and future Phase I and Phase II MS4 areas, locations of sensitive surface water systems and/or irrigation canals, and physical design constraints, as follows:

Rating 1
Ponds identified with this rating are in MS4 areas based on the 2000 census. Approximately 92 water quality ponds were given this rating. The ponds are located between the I-25/I-76 interchange and continue to just north of SH 52. The next approximately 17 miles are not currently in an MS4 permitted area. Additional ponds have been placed between Larimer County Road 14 and SH 1.

Rating 2
Ponds identified with this rating are not in current or projected MS4 areas; however, they are in an area identified with sensitive waters. Sensitive waters defined in the CDOT MS4 permit applicable during project development as a water body as sensitive if it meets any of the following criteria:

- Listed on the TMDL/303d list impaired by potential highway-related pollutants
- Listed on the M and E List for potential highway-related pollutants
- Listed as Outstanding Waters of Colorado/United States or Gold Medal Fishery
- Aquatic Life Cold Water Class 1
- Segments designated for Water Supply use where the discharge of potential highway-related pollutants has potential to impact this use
- Containing Federally designated threatened & endangered species habitat

Two sensitive streams were identified in the project area, including the St. Vrain Creek and the Little Thompson Creek. These streams are not currently located within a MS4 permitted area; however, water quality mitigation measures will be included at these locations. Provisions were made to treat the surrounding roadway that discharges to these streams. Eight ponds were given this rating.

Rating 3
Ponds identified with this rating are in areas that are not currently in an MS4 municipality area; however by the year 2030, several areas may become regulated under the MS4 requirements. These estimations were based on population projections for the year 2030 used for the traffic analysis and the criteria for an MS4 permit. Consequently, by 2030, the area located between SH 52 to SH 66 and several small areas around SH 56 and SH 60 will most likely be regulated under MS4 permits. Based on this analysis, approximately 15 ponds were given this rating.

Rating 4
Ponds identified with this rating do not have any of the criteria listed above; however these areas contain convenient locations where existing right-of-way may be utilized for water quality ponds. These areas were identified as a conservative measure to address the need for additional water quality ponds in the case that the 2030 projected populations were underestimated. One stretch of I-25 was identified as an area that may not be covered under an MS4 permit by the year 2030 according to population projections. This area is located around SH 66 and extends north to approximately Weld County Road (WCR) 38. The infields of one interchange in this area were identified that may provide room for some

water quality ponds. However, this area may not be large enough to effectively treat the entire area from SH 66 to WCR 38. Four ponds were given this rating.

Figures 7-1 and 7-2 show the areas along the I-25 corridor where water quality ponds are proposed. They also show the reason why ponds were included in each particular stretch of the corridor. Areas of impervious transit infrastructure (e.g., park-n-Ride lots, stations, etc.) treated by water quality ponds has been enumerated on the figures. As previously discussed, Package A would provide ponds with a capacity to treat 90.7 percent of the total impervious surface area, while Package B would provide ponds with a capacity to treat 125 percent of the total impervious surface area. A percentage greater than 100 indicates that the volume provided is greater than the defined water quality capture volume, which is equal to one half inch of rainfall times the impervious area. Capture volumes greater than 100 percent can sometimes be used to offset other locations on the highway system where 100 percent capture cannot be achieved. These are dramatically greater than the existing conditions (2.4 percent) and the No-Action Alternative (11.2 percent).

The placement of water quality ponds occur along the I-25 corridor. No roadway improvements are proposed along the US 85 corridor, except for the addition of five very small impervious areas for bus queue jumps at select intersections. The Water Quality Capture Volume (WQCV) for these queue jumps is less than 0.1 acre-feet. To ensure 100 percent WQCV, the queue volume impervious surfaces area has been accounted for in the ponds along I-25. It is not practical to place water quality ponds along the US 85 corridor because a new drainage system would be required to carry the water to a BMP.

The application of water quality ponds as part of Package B is expected to reduce the amount of iron discharged from the roadway to Segment 1 of Big Dry Creek, which is on CDPHE's Monitoring and Evaluation list for Iron, by approximately 50 to 60 percent (FDEP, 1999). The improvements in the E-470 to US 36 (B-H4) segment of Package B, where Segment 1 of Big Dry Creek lies, are expected to increase all pollutant loadings—including iron—by approximately 30 percent (see **Table 5-6**). This demonstrates that the water quality ponds can improve the water quality conditions at Big Dry Creek over the existing conditions. However, Package A does not have any roadway improvements in the E-470 to US 36 (A-H4) component and therefore no water quality ponds would be provided to reduce the current iron loadings from the No-Action conditions.

Dissolved copper removal in water quality ponds is less than that of iron. Dissolved copper in Packages A and B are estimated to increase by 42 and 59 percent, respectively, over the existing conditions. Data from the USEPA shows that dissolved copper in extended dry detention basins ranges from 1.4 to 38 percent removal (USEPA 2008). While this is a wide range, it does show that there is potential for the proposed water quality ponds to remove dissolved copper to a level close to existing conditions.

As previously stated, removal efficiencies of 50 to 70 percent for TSS, 10 to 20 percent for total phosphorus, and 50 to 60 percent for iron are expected for the proposed water quality ponds.

The long-term functionality and effectiveness of the structural BMPs selected for this project is dependent on the availability of maintenance personnel, equipment, and access. Due to the large scale of the project, CDOT maintenance personnel will be provided the opportunity to review all BMP designs once an alternative has been selected.

Figure 7-1 Package A – Areas of Future Water Quality Treatments

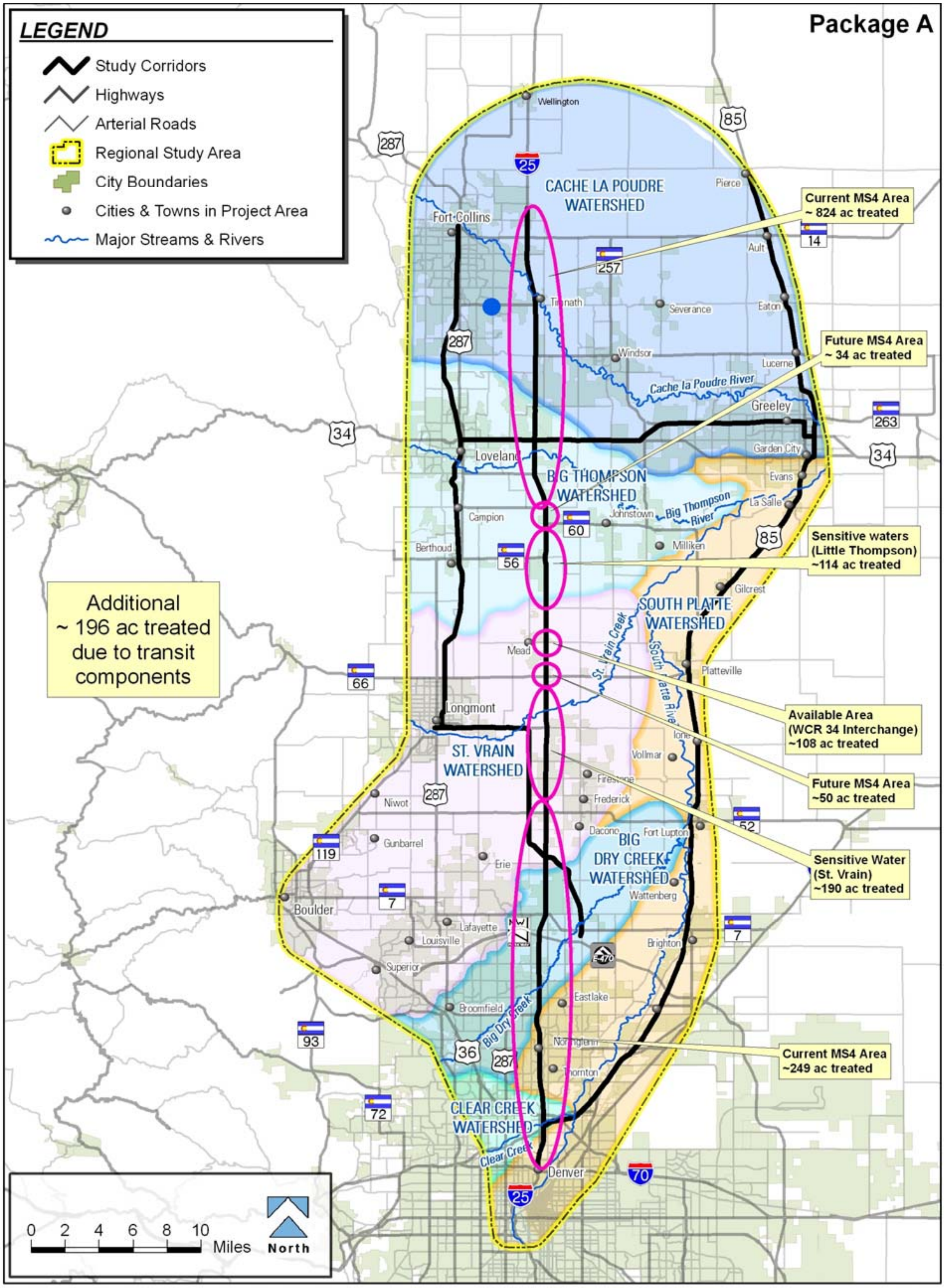
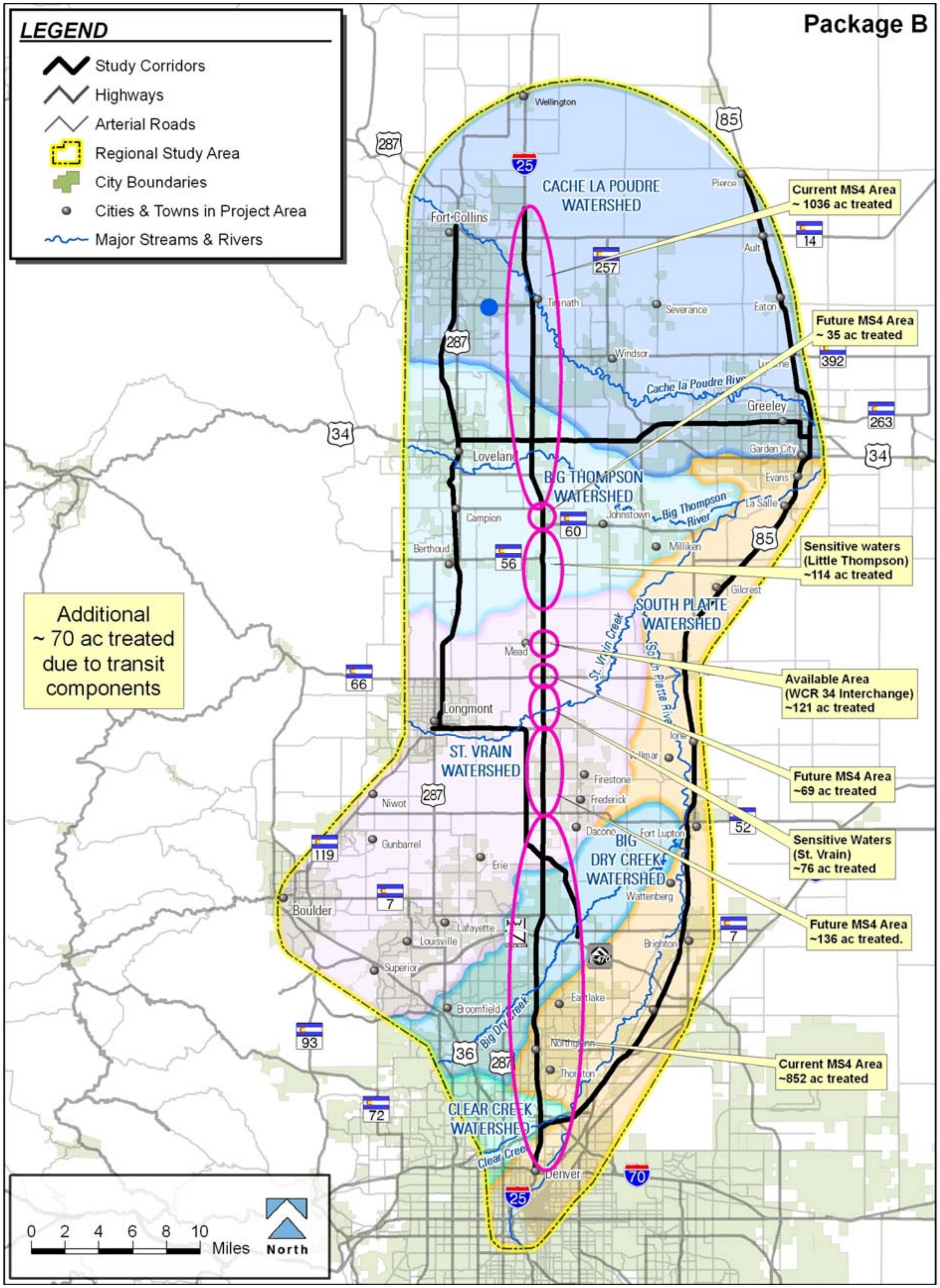


Figure 7-2 Package B – Areas of Future Water Quality Treatments



The No-Action Alternative has only 2 areas of BMPs (water quality ponds), which are associated with the No-Action improvements. The placement of water quality ponds incorporated into the design of Packages A and B were determined based on physical design constraints, adjacent property uses, and right-of-way requirements. It is anticipated that types and sizes of BMPs could be modified in the future. When possible, passive BMPs (e.g., grass swales or natural infiltration) will be used for ephemeral streams along the corridor that could reasonably discharge pollutants into perennial stream systems. The preliminary drainage design for Packages A and B is based on the CDOT Drainage Design Manual (CDOT, 2004a) and Volume 3 of the Urban Drainage and Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual (UDFCD, 2001).

Riprap - Riprap will be placed at bridge abutments, piers, and at critical portions of a channel or floodplain in order to avoid progressive or catastrophic failure of a structure. Riprap reduces water quality impacts by protecting stream systems from accelerated erosion and sedimentation processes that can occur from structures (see **Table 5-1**). The most effective method of stabilization at bridge abutments and piers is the use of riprap. Riprap that is correctly sized, is angular, and placed on a granular material or fabric, has a better record for erosion and scour protection than other methods such as vegetative cover. Despite its reliability, riprap must still be monitored and maintained. An energy dissipation device or material, such as riprap, will control post-construction erosion near bridges. If riprap is used above the ordinary high water level of the river, it must be covered with topsoil and vegetated. Stream systems within the project area may also be affected by the design and size of culverts and bridges, as well as the application of associated riprap. These impacts are listed in **Table 5-1**.

7.1.2 Nonstructural BMPs (Construction and Post-Construction)

Nonstructural BMPs reduce or eliminate pollutant mobilization within stormwater runoff. Street sweeping, and spill containment measures are examples of nonstructural BMPs. Project construction phasing is another nonstructural BMP to be implemented to minimize potential water quality impacts. Phasing construction activities minimizes the effects associated with large areas of exposed ground and with soil compaction from heavy machinery use, both of which are commonly associated with transportation projects.

7.1.3 Temporary Construction BMPs (Construction)

There is also potential for impacts to surface water bodies during the demolition and construction of roadways and structures (e.g.,, bridges, culverts, piers, retaining walls). Temporary construction BMPs are implemented to reduce erosion associated with areas of ground disturbance while these activities take place. These measures remain in place until soil stabilizing vegetation has been reestablished. Silt fences, straw bale barriers, and temporary check dams are examples of temporary construction BMPs.

CDOT's specifications for managing stormwater at a construction site (currently specifications 107.25 and 208) will be followed. When put into practice, the actions identified below will help avoid such impacts:

- If lead paint is present, this material must not be allowed to flake off and enter receiving waters. (Section 402, Clean Water Act, CDPHE Regulation 61).

- If cranes and other equipment are used for bridge demolition within a river or streambank area, the equipment will be kept out of the river to the greatest extent possible, and all work shall minimize temporary impacts to the river. The creation of a crane pad is necessary if cranes or other equipment cannot be kept out of the river.
- Sediment may enter the river from land disruption and subsequent erosion. Therefore, construction BMPs will be implemented and maintained in compliance with the CDPHE general construction permit. Construction plans must develop and adhere to a stormwater management plan (Section 402, Clean Water Act, CDPHE Regulation 61).
- Caissons used to create bridge piers may require groundwater dewatering. A discharge permit and a possible treatment strategy may be needed before dewatering activities can occur (see Section 8.2).Vegetation or other erosion control techniques (as indicated by CDOT erosion control practices) must be established to prevent sediment loading in compliance with the general stormwater construction permit.
- If other regulated materials are present within or on structures, they must be removed and appropriately recycled or disposed of prior to demolition activities. Typical materials include containerized regulated liquids such as paints, solvents, oil, grease, chemicals, pesticides, and herbicides, and chlorofluorocarbon (CFC) containing equipment (equipment must be emptied before equipment is removed) [Colorado Hazardous Waste Regulations (6 Colorado Code of Regulations [CCR] 1007-3)].
- A Senate Bill 40 (SB40) permit from the CDOW is required for the crossing of streams. This permit will include measures to protect existing riparian areas. In some cases, creation, restoration, or enhancement of riparian areas may be required by the CDOW.

Permanent structural BMPs, nonstructural BMPs, and temporary construction BMPs, permanent structural BMPs, and nonstructural BMPs must be regularly inspected and maintained to ensure functionality and efficiency. This includes inspections of proper BMP operation, outfall discharges and erosion protection, and detention pond sediment removal.

7.2 GROUNDWATER QUALITY

The status of groundwater well use will have to be determined prior to construction activities to identify if active wells are present. Active wells in the final right-of-way would need to be relocated and all wells would need to be plugged, sealed, and abandoned.

All wells that lie within the proposed right-of-way will be included in all project specifications and plan drawings. If any of these wells are affected by project activities, coordination with the Colorado Department of Labor and Employment, Division of Oil and Public Safety will be required. If necessary, wells must be plugged, sealed, and abandoned according to CDOT Section 202.02 Standard Specifications for Road and Bridge Construction and in conformance with the State Engineer well abandonment procedures.

If groundwater is encountered during activities associated with excavations for caisson/retaining walls, the discharge of groundwater is authorized if the following conditions are met.

- the source is groundwater and/or groundwater combined with stormwater that does not contain pollutants in concentrations exceeding the State groundwater standards in Regulations 5 CCR 1002-41 and 42;

- the source is identified in the SWMP;
- dewatering BMPs are included in the SWMP, and
- these discharges do not leave the site as surface runoff or to surface waters.

If these conditions are not met, then a separate Clean Water Act Section 402 Construction Dewatering Permit or Individual Construction Dewatering Permit will be required to be obtained from the CDPHE - WQCD. In addition, if dewatering is necessary, groundwater brought to the surface will be managed according to Section 107.25 of the CDOT *Standard Specifications for Road and Bridge Construction* (CDOT, 2005).

7.3 FLOODPLAINS

Package A and Package B will have varying impacts to floodplains. Many of the existing bridges are inadequate and can not pass the peak flows without overtopping I-25, the Commuter Bus routes or Commuter Rail lines. Impacts to floodplains occur with bridge construction or where roadway fill will encroach onto the flood fringe areas.

Floodplain mitigation should consider the following issues during the design phases:

- The 100-year FEMA design flows are to be used for freeboard determinations, scour design, and to ensure that flow velocities are acceptable.
- The 500-year design flows are to be used to further assess the scour design and set the depths of piles or caissons.
- The design is to consider the maximum allowable backwater.
- Degradation, aggregation and scour are to be determined. Adequate counter measures will be selected using criteria established by the National Cooperative Highway Research Program Report 568.
- The design is to be such that minimal disruption to the ecosystem will occur.
- The design will consider costs for construction and maintenance.
- A bridge deck drainage system that controls seepage at joints should be considered. If possible, bridge deck drains will be piped to a water quality feature prior to being discharged into a floodplain.
- The designs are to be coordinated with federal, state, and local agencies.

None of the crossings would have a significant encroachment on the floodplain. A significant encroachment is defined by FHWA as a transportation encroachment, and any direct support of a likely base floodplain development that would involve one or more of the following construction or flood related impacts:

- A significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route
- A significant risk
- A significant adverse impact on natural and beneficial flood-plain values

Floodplain impacts would include increasing the sizes of bridges, culverts, and other drainage facilities in order to better convey floodwaters. In most cases, larger drainage structures would not disturb the existing low flow channel areas where riparian habitat is located. The overbanks adjacent to the low flow channels will be generally expanded with the newer structures in order to pass the higher flows. Enlarged overbank areas will be generally revegetated with a diverse planting in order to enhance the habitat.

Upstream flood risks should decrease with an enlarged drainage structure. Downstream flood risks can increase due to the improved conveyance of the stormwaters. It is CDOT policy to size a drainage structure based on FEMA flows, or flows that are based on potential upstream land use. The standard flood for CDOT and FEMA is the 100-year flood. Impacts to downstream areas must be assessed at the time of preliminary and final design by using detailed hydraulic methods. All improvements are to follow the guidelines described in **Section 6.1** *Regulatory Framework*.

7.3.1 Package A

Boxelder Creek floodplains east of I-25 would be impacted. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows released downstream of I-25 would not be more than the present 100-year flows. Downstream capacity should be designed for the present 100-year flow conditions, in accordance with local, state, and federal regulations.
- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- If wetlands are disturbed, the mitigation approach described in **Section 3.8** *Wetlands* in the EIS would be followed.

Boxelder Creek floodplains at I-25 would be impacted. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

The Cache la Poudre floodplains at I-25 would be impacted. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would be conducted in accordance with the mitigation approach described in **Section 3.8** *Wetlands* in the EIS.

The Cache la Poudre River split flow floodplains at I-25 would be impacted. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows downstream of I-25 would not be more than the present condition 100-year split flows. Downstream capacity should be designed for the present flow conditions, in accordance with local, state, and federal regulations.

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- If wetlands are disturbed, the mitigation approach described in **Section 3.8** *Wetlands* in the EIS would be followed.

The Big Thompson River floodplains would be impacted at I-25.The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would be conducted in accordance with the mitigation approach described in **Section 3.8** *Wetlands* in the EIS*.*

The Little Thompson River floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS.

North Creek floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS.

Preble Creek floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows released downstream of I-25 would not be more than the present 100-year flows. Downstream capacity should be designed for the present 100-year flow conditions in accordance with local, state, and federal regulations
- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS.

Spring Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows released downstream of the railroad would not be more than the present 100-year flows. Downstream capacity should be designed for the present 100-year flow conditions, in accordance with local, state, and federal regulations.

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

Fossil Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows in this area would remain at the present 100-year flows. Downstream capacity should be designed for the present 100-year flows, in accordance with local, state, and federal regulations.
- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

Dry Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows in this area would remain at the present 100-year flows. Downstream capacity should be designed for the present 100-year flows, in accordance with local, state, and federal regulations
- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

The Big Thompson River floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

The Little Thompson River floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

Spring Gulch floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows in this area would remain the present 100-year flows. Downstream capacity should be designed for the present 100-year flows, in accordance with local, state, and federal regulations. Detailed study in the future would be needed between the two bridges to determine actual impacts.

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

The St. Vrain Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in the **Section 3.8** *Wetlands* in the EIS*.*

Idaho Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

Little Dry Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

Big Dry Creek floodplains would be impacted at the commuter rail corridor. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

Second Creek floodplains would be impacted at a commuter bus queue jump. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

First Creek floodplains would be impacted at a commuter bus queue jump. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

7.3.2 Package B

Floodplain impacts and mitigation measures to the floodplains of Boxelder Creek, the Cache la Poudre River, the Big Thompson River, the Little Thompson River, North Creek, Little Dry Creek, and Preble Creek would be identical to Package A.

The St. Vrain Creek floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

The South Fork of Preble Creek floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows released downstream of I-25 would not be more than the present 100-year flows. Downstream capacity should be designed for the present 100-year flow conditions, in accordance with local, state, and federal regulations.
- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.

Mustang Run floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- If wetlands are disturbed, wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

Shay Ditch floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- The flows released downstream of I-25 would not be more than the present 100-year flows. Downstream capacity should be designed for the present 100-year flow conditions, in accordance with local, state, and federal regulations.
- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- If wetlands are disturbed, wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS*.*

Big Dry Creek floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS***.***

Niver Creek floodplains would be impacted at I-25. The following measures would be taken to mitigate floodplain impacts to the extent practicable:

- Erosion control measures would be used during construction.
- Disturbed land would be seeded and re-vegetated after construction.
- Wetland mitigation would follow the approach described in **Section 3.8** *Wetlands* in the EIS.

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APPENDIX A – Model Input Files

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Existing - Right of Way

Component	Acres
SH 1 to SH 14	359.046
SH 14 to SH 60	975.633
SH 60 to E-470	1132.586
E470 to US 36	367.280

Watershed	Acres
Cache la Poudre	874.864
Big Thompson	638.362
St. Vrain	780.208
Dry Creek	324.199
Mid S. Platte	181.518
Clear Creek	35.394

Existing - Impervious Surface Areas

Component	Acres
SH 1 to SH 14	134.780
SH 14 to SH 60	368.530
SH 60 to E-470	487.150
E470 to US 36	220.790

Watershed	Acres
Cache la Poudre	336.650
Big Thompson	223.420
St. Vrain	349.580
Dry Creek	171.019
Mid S. Platte	110.260
Clear Creek	20.150

No Action - Right of Way

Component	Acres
SH 1 to SH 14	359.046
SH 14 to SH 60	975.633
SH 60 to E-470	1299.746
E470 to US 36	367.280

Watershed	Acres
Cache la Poudre	874.864
Big Thompson	638.362
St. Vrain	947.368
Dry Creek	324.199
Mid S. Platte	181.518
Clear Creek	35.394

No Action - Impervious Surface Areas

Component	Acres
SH 1 to SH 14	134.780
SH 14 to SH 60	368.530
SH 60 to E-470	532.400
E470 to US 36	220.790

Watershed	Acres
Cache la Poudre	336.650
Big Thompson	227.960
St. Vrain	363.900
Dry Creek	197.580
Mid S. Platte	110.260
Clear Creek	20.150

Package A - Right of Way

Component	Acres
SH 1 to SH 14	**434.640**
SH 14 to SH 60	**1429.772**
SH 60 to E-470	**1477.164**
E470 to US 36	**475.171**

Watershed	Acres
Cache la Poudre	**1189.235**
Big Thompson	**954.456**
St. Vrain	**894.419**
Dry Creek	**528.896**
Mid S. Platte	**214.367**
Clear Creek	**35.374**

Package A - Impervious Surface Areas

Component	Acres
SH 1 to SH 14	**196.596**
SH 14 to SH 60	**634.753**
SH 60 to E-470	**696.500**
E470 to US 36	**220.790**

Watershed	Acres
Cache la Poudre	**524.727**
Big Thompson	**336.900**
St. Vrain	**433.400**
Dry Creek	**323.199**
Mid S. Platte	**110.260**
Clear Creek	**20.150**

Package B - Right of Way

Component	Acres
SH 1 to SH 14	**435.125**
SH 14 to SH 60	**1503.958**
SH 60 to E-470	**1527.462**
E470 to US 36	**517.159**

Watershed	Acres
Cache la Poudre	**1237.224**
Big Thompson	**987.791**
St. Vrain	**913.656**
Dry Creek	**576.804**
Mid S. Platte	**228.901**
Clear Creek	**39.329**

Package B - Impervious Surface Areas

Component	Acres
SH 1 to SH 14	**197.546**
SH 14 to SH 60	**772.570**
SH 60 to E-470	**715.230**
E470 to US 36	**244.748**

Watershed	Acres
Cache la Poudre	**596.530**
Big Thompson	**494.601**
St. Vrain	**464.770**
Dry Creek	**229.835**
Mid S. Platte	**124.208**
Clear Creek	**20.150**

Driscoll Model Input Files

DRISCOLL Model--Cache la Poudre

Color	Meaning
Blue	= site-specific entry
Orange	= Driscoll Lookup
Green	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	874.86	874.86	1189.24	1237.224	acres
Paved Surface	AHWY	336.65	336.65	524.73	596.53	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	38.4802666	38.4802666	44.1230707	48.2151979	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.36936187	0.36936187	0.40886149	0.43750639	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	10.3405248	10.3405248	15.5594368	17.3213888	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	256887.719	256887.719	386540.171	430312.014	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	16158.07	11.97	754.04	536208.59	107.72
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	265.61	0.20	12.40	8814.39	1.77

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	16158.07	11.97	754.04	536208.59	107.72
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	265.61	0.20	12.40	8814.39	1.77

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	24313.13	18.01	1134.61	806835.62	162.09
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	399.67	0.30	18.65	13263.05	2.66

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	27066.35	20.05	1263.10	898201.75	180.44
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	444.93	0.33	20.76	14764.96	2.97

Driscoll Model Input Files

DRISCOLL Model--Big Thompson

(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	638.36	638.36	954.46	987.791	acres
Paved Surface	AHWY	223.42	227.96	336.90	494.601	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	34.9989504	35.7101457	35.2975936	50.071422	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.34499265	0.34997102	0.34708316	0.45049995	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	7.0473664	7.1490624	10.6008192	14.2399936	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	175076.402	177602.817	263354.164	353761.491	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	11012.19	8.16	513.90	365441.65	73.41
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	181.02	0.13	8.45	6007.26	1.21

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	11171.10	8.27	521.32	370715.10	74.47
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	183.63	0.14	8.57	6093.95	1.22

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	16564.81	12.27	773.02	549706.17	110.43
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	272.30	0.20	12.71	9036.27	1.82

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	22251.37	16.48	1038.40	738415.80	148.34
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	365.78	0.27	17.07	12138.34	2.44

Driscoll Model Input Files

DRISCOLL Model--St. Vrain

Legend	
(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	780.21	947.37	894.42	913.656	acres
Paved Surface	AHWY	349.58	363.90	433.40	464.77	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	44.8060005	38.4116837	48.4560368	50.8692549	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.413642	0.36888179	0.43919226	0.45608478	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	10.3272576	11.1829376	12.5703008	13.3345472	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	256558.124	277815.622	312281.626	331267.656	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	16137.34	11.95	753.08	535520.62	107.58
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	265.27	0.20	12.38	8803.08	1.77

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	17474.42	12.94	815.47	579891.96	116.50
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	287.25	0.21	13.41	9532.47	1.92

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	19642.31	14.55	916.64	651833.77	130.95
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	322.89	0.24	15.07	10715.08	2.15

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	20836.52	15.43	972.37	691463.82	138.91
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	342.52	0.25	15.98	11366.53	2.28

Driscoll Model Input Files

DRISCOLL Model--Dry Creek

(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	324.20	324.20	528.90	576.804	acres
Paved Surface	AHWY	171.02	197.58	323.20	229.835	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	52.7512423	60.9440498	61.108233	39.8462909	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.4692587	0.52660835	0.52775763	0.37892404	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	4.8682624	5.4632288	8.9321248	6.9940768	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	120941.33	135721.969	221899.102	173752.539	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	7607.13	5.63	355.00	252444.07	50.71
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	125.05	0.09	5.84	4149.77	0.83

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	8536.82	6.32	398.39	283296.09	56.91
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	140.33	0.10	6.55	4656.92	0.94

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	13957.31	10.34	651.34	463175.92	93.05
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	229.44	0.17	10.71	7613.85	1.53

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	10928.92	8.10	510.02	362678.31	72.86
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	179.65	0.13	8.38	5961.84	1.20

Driscoll Model Input Files

DRISCOLL Model--Mid S. Platte

Color	Meaning
Blue	= site-specific entry
Orange	= Driscoll Lookup
Green	= Calculation

Drainage Areas of Highway Segment	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	181.52	181.52	214.37	228.901	acres
Paved Surface	AHWY	110.26	110.26	110.26	124.208	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	60.7432872	60.7432872	51.4351556	54.2627599	%

Rainfall Characteristics	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration			
Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.52520301	0.52520301	0.46004609	0.47983932	ratio

Compute Runoff Flow Rates	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	3.0506816	3.0506816	3.1557984	3.5147424	cfs

Compute Runoff Volumes	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	75787.511	75787.511	78398.9079	87316.0864	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	4766.99	3.53	222.46	158193.29	31.78
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	78.36	0.06	3.66	2600.44	0.52

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	4766.99	3.53	222.46	158193.29	31.78
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	78.36	0.06	3.66	2600.44	0.52

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	4931.24	3.65	230.12	163644.13	32.87
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	81.06	0.06	3.78	2690.04	0.54

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	5492.13	4.07	256.30	182257.20	36.61
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	90.28	0.07	4.21	2996.01	0.60

Driscoll Model Input Files

DRISCOLL Model--Clear Creek

Color	Meaning
(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	35.39	35.39	35.37	39.329	acres
Paved Surface	AHWY	20.15	20.15	20.15	20.15	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	56.9305532	56.9305532	56.962741	51.234458	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.49851387	0.49851387	0.49873919	0.45864121	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	0.5646208	0.5646208	0.5645568	0.5772128	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	14026.7687	14026.7687	14025.1787	14339.5894	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	882.27	0.65	41.17	29278.45	5.88
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	14.50	0.01	0.68	481.29	0.10

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	882.27	0.65	41.17	29278.45	5.88
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	14.50	0.01	0.68	481.29	0.10

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	882.17	0.65	41.17	29275.13	5.88
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	14.50	0.01	0.68	481.24	0.10

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	901.95	0.67	42.09	29931.41	6.01
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	14.83	0.01	0.69	492.02	0.10

Driscoll Model Input Files

DRISCOLL Model--SH 1 to SH 14

Color	Meaning
(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	359.05	359.05	434.64	435.125	acres
Paved Surface	AHWY	134.78	134.78	196.60	197.546	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	37.5383656	37.5383656	45.2319161	45.3998276	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.36276856	0.36276856	0.41662341	0.41779879	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	4.1680192	4.1680192	5.7945984	5.8174304	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	103545.319	103545.319	143954.122	144521.333	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	6512.93	4.82	303.94	216132.91	43.42
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	107.06	0.08	5.00	3552.87	0.71

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	6512.93	4.82	303.94	216132.91	43.42
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	107.06	0.08	5.00	3552.87	0.71

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	9054.62	6.71	422.55	300479.28	60.36
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	148.84	0.11	6.95	4939.39	0.99

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	9090.30	6.73	424.21	301663.23	60.60
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	149.43	0.11	6.97	4958.85	1.00

Driscoll Model Input Files

DRISCOLL Model--SH 14 to SH 60

(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	975.63	975.63	1429.77	1503.958	acres
Paved Surface	AHWY	368.53	368.53	634.75	772.57	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	37.773425	37.773425	44.3954001	51.3691207	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.36441398	0.36441398	0.4107678	0.45958384	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	11.3770976	11.3770976	18.7937376	22.1182336	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	282639.102	282639.102	466889.299	549479.13	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	17777.82	13.17	829.63	589960.14	118.52
Mean event mass load *(= MCR * MVR *(0.00006245))*	M(mass)	pounds	292.24	0.22	13.64	9697.97	1.95

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	17777.82	13.17	829.63	589960.14	118.52
Mean event mass load *(= MCR * MVR *(0.00006245))*	M(mass)	pounds	292.24	0.22	13.64	9697.97	1.95

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	29367.04	21.75	1370.46	974550.50	195.78
Mean event mass load *(= MCR * MVR *(0.00006245))*	M(mass)	pounds	482.75	0.36	22.53	16020.01	3.22

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	34561.88	25.60	1612.89	1146942.45	230.41
Mean event mass load *(= MCR * MVR *(0.00006245))*	M(mass)	pounds	568.14	0.42	26.51	18853.85	3.79

Driscoll Model Input Files

DRISCOLL Model--SH 60 to E-470

Color	Meaning
(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment

	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	1132.59	1299.75	1477.16	1527.462	acres
Paved Surface	AHWY	487.15	532.40	696.50	715.23	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	43.0121863	40.9618495	47.1511626	46.8247328	%

Rainfall Characteristics

	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type

	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration

Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)

	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.4010853	0.38673295	0.43005814	0.42777313	ratio

Compute Runoff Flow Rates

	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	14.5364352	16.0849472	20.3285248	20.9090304	cfs

Compute Runoff Volumes

	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	361125.934	399595.327	505017.73	519439.122	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	22714.59	16.83	1060.01	753787.80	151.43
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	373.39	0.28	17.42	12391.03	2.49

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	25134.29	18.62	1172.93	834085.99	167.56
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	413.17	0.31	19.28	13711.00	2.75

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	31765.29	23.53	1482.38	1054136.99	211.77
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	522.17	0.39	24.37	17328.28	3.48

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	32672.38	24.20	1524.71	1084239.14	217.82
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	537.08	0.40	25.06	17823.11	3.58

Driscoll Model Input Files

DRISCOLL Model--E-470 to US 36

Color	Meaning
(blue)	= site-specific entry
(orange)	= Driscoll Lookup
(green)	= Calculation

Drainage Areas of Highway Segment	Title	Existing	No Action	Package A	Package B	Units
Total Right of Way	AROW	367.28	367.28	475.17	517.159	acres
Paved Surface	AHWY	220.79	220.79	220.79	244.748	acres
Percent Impervious (= 100 * AHWY/AROW)	IMP	60.1148987	60.1148987	46.4653777	47.325484	%

Rainfall Characteristics	Title	Value	
Volume--Mean	MVP	0.219	inch
Intensity--Mean	MIP	0.032	inch/hour
Duration--Mean	MDP	9.1	hour
Interval--Mean	MTP	144	hour
Number of Storms per year (= 24*365/MTP)	NST	60.8333333	no. events

Surrounding Area Type	Title	Value
Urban (> 30,000 ADT)	URBAN	X
Rural (<30,000 ADT)	RURAL	

Coefficient of Variance of Concentration			
Coef of Variance (0.71 Urban; 0.84 Rural)	CVCR	0.71	n/a

Compute runoff coefficient (Rv)	Title	Existing	No Action	Package A	Package B	Units
Runoff Coefficient (=0.007*IMP +0.1)	Rv	0.52080429	0.52080429	0.42525764	0.43127839	ratio

Compute Runoff Flow Rates	Title	Existing	No Action	Package A	Package B	Units
Flow Rate from mean storm (= Rv*MIP*AROW)	MQR	6.120992	6.120992	6.4662432	7.137264	cfs

Compute Runoff Volumes	Title	Existing	No Action	Package A	Package B	Units
Volume from mean storm (=Rv * MVP * AROW * 3630)	MVR	152062.657	152062.657	160639.667	177309.711	cubic ft

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Site Median Concentration	TCR	mg/l	13.5	0.01	0.63	448	0.09
Mean event concentration *(= TCR * sqrt(1 + CVCR^2))*	MCR	mg/l	16.56	0.01	0.77	549.44	0.11

Existing

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	9564.64	7.08	446.35	317404.44	63.76
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	157.23	0.12	7.34	5217.61	1.05

No Action

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	9564.64	7.08	446.35	317404.44	63.76
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	157.23	0.12	7.34	5217.61	1.05

Package A

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	10104.13	7.48	471.53	335307.47	67.36
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	166.10	0.12	7.75	5511.90	1.11

Package B

	Title	Units	Chloride	Copper	Phosphorus	TSS	Zinc
Annual Mass Load from Runoff *(= M(mass) * NST)*	ANMASS	pounds / year	11152.67	8.26	520.46	370103.29	74.35
Mean event mass load *(= MCR * MVR *(0.00006245)*	M(mass)	pounds	183.33	0.14	8.56	6083.89	1.22