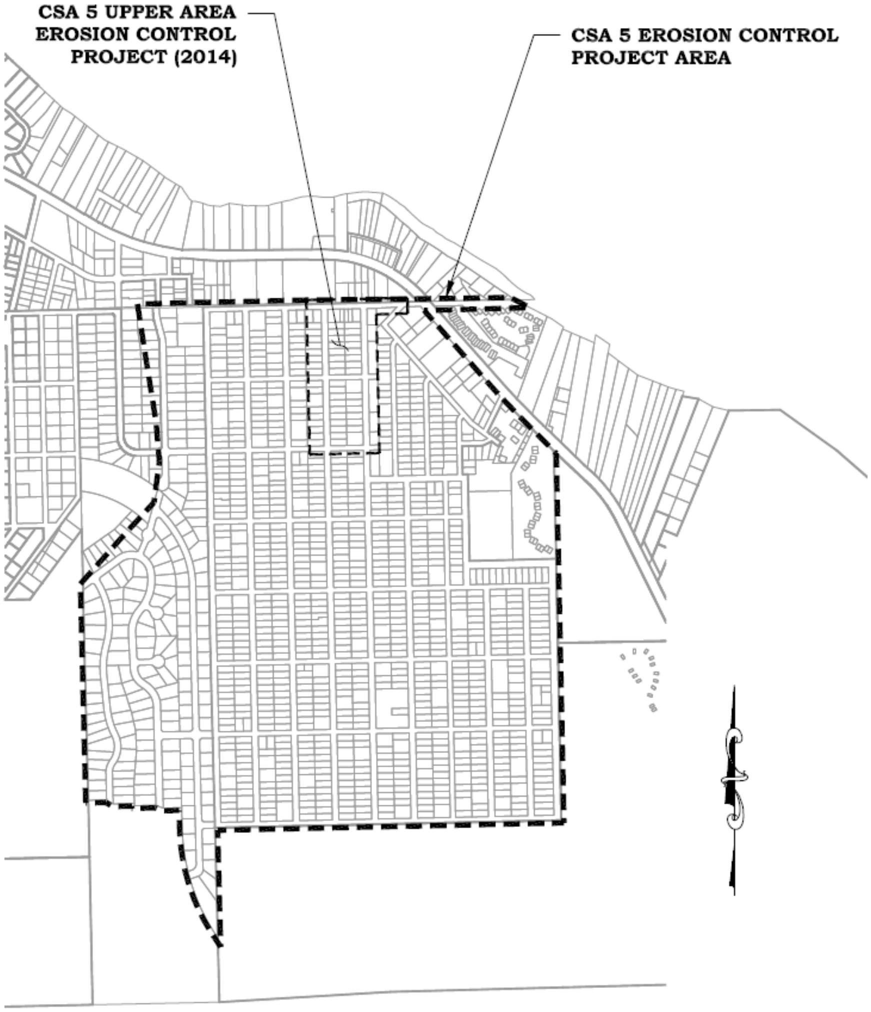
CSA 5
EROSION CONTROL PROJECT

Feasibility Report
JN 95157

December 2015



Prepared by:

County of El Dorado
Transportation Division
Tahoe Engineering Unit
924 B Emerald Bay Road
South Lake Tahoe, CA 96150

COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION
http://www.edcgov.us/DOT/

PLACERVILLE OFFICES:
MAIN OFFICE:
2850 Fairlane Court, Placerville, CA 95667
(530) 621-5900 / (530) 626-0387 Fax

MAINTENANCE:
2441 Headington Road, Placerville, CA 95667
(530) 642-4909 / (530) 642-0508 Fax

LAKE TAHOE OFFICES:
ENGINEERING:
924 B Emerald Bay Road, South Lake Tahoe, CA 96150
(530) 573-7900 / (530) 541-7049 Fax

MAINTENANCE:
1121 Shakori Drive, South Lake Tahoe, CA 96150
(530) 573-3180 / (530) 577-8402 Fax

The Feasibility Report provided herein has been prepared by or under the direction of the following registered person. The registered civil engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

CIVIL ENGINEER, RCE #C70168
Daniel W. Kikkert, P.E.
Senior Civil Engineer

REGISTERED PROFESSIONAL ENGINEER
Daniel W. Kikkert
No. C70168
Exp. 09/30/16
CIVIL
STATE OF CALIFORNIA

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1.0 Introduction

The Feasibility Report (Report) has been developed pursuant to the Storm Water Quality Improvement Committee (SWQIC) guidelines for erosion control projects in the Lake Tahoe Basin and has been prepared by the County of El Dorado Community Development Agency, Transportation Division (Transportation). This Report includes an analysis of the existing conditions and an analysis of potential alternatives for the CSA 5 Erosion Control Project (Project).

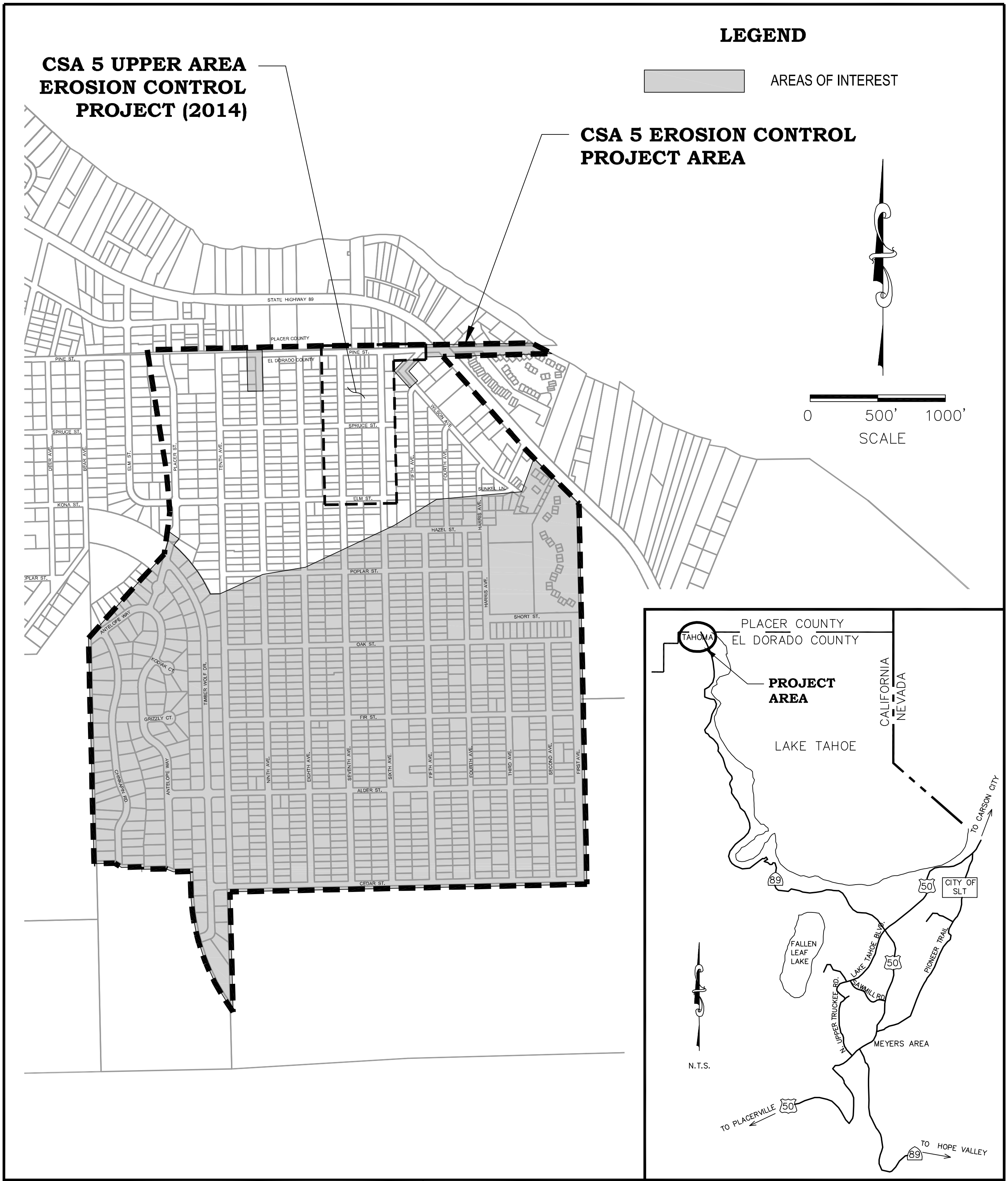
The Project area is located in Tahoma on the west shore of Lake Tahoe, and is bounded by Lake Tahoe and First Avenue to the east, the El Dorado/Placer County line to the north, Chinkapin Road and Placer Street to the west and Cedar Street to the South (Figure 1). The Project area is identified in the Tahoe Regional Planning Agency's (TRPA) Environmental Improvement Project (EIP) list as project number 01.01.01.0067 (formally No. 10062) and is located within TRPA designated Priority 2 Watershed 56 (General Creek).

The Project was initiated due to the analysis completed as identified in the 2009 Transportation's Pollutant Load Reduction Strategy (PLRS) Report. The report focused on assessing discharges to surface waters for the Total Maximum Daily Load (TMDL) and the County's National Pollutant Discharge Elimination System (NPDES) permit. As part of that analysis, the County identified three watersheds outfalls which were connected to Lake Tahoe: 1) the outfall from the Gray Basin (located in Placer County) which drains to McKinney Creek; 2) the 36" storm drain pipe which conveys storm water runoff from a portion of the subdivisions in the Project area directly into Lake Tahoe with minimal infiltration or treatment; and 3) a surface channel which drains the remaining portions of the subdivisions in the Project area.

In 2011 Transportation requested and received funds from the USFS to develop the Planning, Environmental, and Preliminary Engineering documents. In 2013 Transportation requested and received Site Improvement funding from the USFS to construct improvements which will address the identified water quality issues within the Project area. In 2014, the CSA 5 - Upper Area Erosion Control Project was constructed with funds received from the California Tahoe Conservancy (CTC). The project was comprised of modifications to a small subset of structures and conveyance features within the existing storm drain system, in order to provide water quality treatment through infiltration and sediment capture.

The current Project will address areas of interest that were not addressed by the 2014 project (Figure 1). It is anticipated that all of the proposed improvements for the current Project will be modifications to existing infrastructure within the County rights-of-way. The County is currently preparing an Initial Study to assess the Project's potential effects on the environment and significance of those effects.

This Report provides the background on existing information concerning the Project and outlines how Transportation identifies potential water quality, erosion control, and storm water hydrologic and pollution problems. Transportation utilized the CTC's Preferred Design Approach (PDA) guidelines,[1] the SWQIC process[2] and the County of El Dorado Drainage Manual[3] to develop this Report.



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CSA 5
EROSION CONTROL PROJECT

LOCATION MAP

FIGURE

1

DATE: 12/2015	PROJECT NO.: 95157	BY: ALD

2.0 Project Overview

The primary problems to be addressed with this Project are defined under CTC guideline categories as Source Control (SC), Hydrologic Design (HD), or Treatment (T). These categories include, but are not limited to, the following sub-categorically defined areas:

1. Untreated direct discharge of storm water runoff and snow melt via culverts or watercourses into Lake Tahoe.
2. Eroding roadside ditches along the County rights-of-way (ROW).
3. Sediment accumulations along roads with subsequent discharge into watercourses.
4. Poor surface runoff water quality.
5. Sediment migrating from private parcels to County ROW.

To discuss the Project and obtain agency and public input, a project development team (PDT) meeting with agency and utility company staff was held on November 3, 2015 and a public meeting was held on November 12, 2015. A summary of public comments received can be found in Appendix F.

2.1 Tahoe Basin Goals and Objectives

The five key milestones within the development of storm water and erosion control goals and objectives within recent Tahoe regulatory history include:

1. Pursuant to the requirements of Section 208 of the Clean Water Act, the TRPA prepared a Water Quality Management Plan (208 Plan) in 1978 for the Lake Tahoe Basin and revised the plan again in 1988.[4] The 208 Plan identifies erosion, runoff, and disturbance resulting from development, such as subdivision roads, as primary causes of the decline of Lake Tahoe's water quality. The 208 Plan also mandates that capital improvement projects such as this Project be implemented to bring all County roads into compliance with Best Management Practices (BMPs) by the year 2008.

2. In the early 1980's, Lahontan adopted a Basin Plan that also mandated that BMPs be implemented within the Tahoe Basin to protect the water quality of Lake Tahoe and its tributaries (See Chapter 5 of the Basin Plan).

3. In 1987, the CTC completed a report entitled "A Report on Soil Erosion Control Needs and Projects in the Basin," that further identified specific project areas for BMP retrofit.

4. In 1997, the TRPA developed a Basin-wide EIP that defined various projects in need of BMP retrofits. This list of projects with assigned project numbers was also linked to the 1987 CTC Report.

5. In 2011 the Lake Tahoe Total Maximum Daily Load (TMDL) was adopted by the California Regional Water Quality Control Board – Lahontan Region. One of the requirements of the TMDL is for local California jurisdictions within the Lake Tahoe Basin to take appropriate measures to decrease pollutant loading to Lake Tahoe from urbanized areas.

2.2 Project Goals and Objectives

The overall goal of this Project is to improve the water quality of runoff to Lake Tahoe and its tributaries by reducing erosion and sediment transport originating from the CSA 5 Project Area.

The Project goals and extent could be expanded during the Project Development Process - Scoping Phase to accommodate the Project Development Team (PDT) endorsed Work Plan. The Project objectives represent physical conditions that can be measured to assess the success of the Project in achieving the Project goals. The Project will conform to the Preferred Design Approach as detailed in the SWQIC process.

The Project goals and objectives are as follows:

Goals		Objectives
1.	Reduce the amount of very fine inorganic sediment by 12%, fine inorganic sediment by 25%, and coarse inorganic sediment by 33% from the urbanized watershed bounded by the Project boundary or to the maximum extent practicable prior to discharging into Lake Tahoe. Very fine sediment is defined as particles with a diameter of 20 microns or less (<20 μm), fine sediment is defined as particles which pass a #200 sieve (<74 μm), and coarse sediment is defined as particles retained on or greater than the #200 sieve (>74 μm).	Stabilize eroding slopes with County approved slope stabilization (Source Control) BMPs; Stabilize eroding channels/ditches with County approved channel or road treatment source control BMPs; Utilize various County approved sediment trapping BMPs (Sediment Traps, Infiltration, Sediment Basins, etc.) to capture sediment from impervious surfaces and eroding areas; Capture de-icing abrasives tracked in from local roads and highways to prevent discharge to watercourses; and, Define and increase the sweeping frequency within the ROW as funding and resources are available. Current County sweeping frequency is a minimum of once per year.
2.	Reduce the 25-year, 1-hour storm surface water volume from the urbanized watershed bounded by the Project boundary by 33% or to the maximum extent practicable prior to discharging into Lake Tahoe.	Utilize County ROW and publicly owned parcels to capture, store, and infiltrate a portion of the 25-year, 1-hour volume, which are at main discharge points within the watersheds; and, Utilize various County approved infiltration and storage BMPs prior to discharging into Lake Tahoe.

3.	Reduce the 25-year, 1-hour storm surface water peak flow from the urbanized watershed bounded by the Project boundary by 33% or to the maximum extent practicable prior to discharging into Lake Tahoe.	Utilize County ROW and publicly owned parcels to detain, spread, and infiltrate the storm water within the watershed prior to discharging into Lake Tahoe without violating drainage laws; and Utilize various storm water drainage systems, which increase the time of concentration and reduce the peak discharge to the main discharge points into Lake Tahoe.
4.	Complete a comprehensive BMP Retrofit Watershed Master Plan which will include private BMP development as part of the Project Delivery Process (PDP). Achieve 25% participation with the private homeowners within the limits of the Project.	Utilize the TRPA Home Landscaping Guide for evaluating and developing BMP solutions for each driveway within the limits of the Project area; and Coordinate the private BMP's design within ROW with the Tahoe Resource Conservation District (TRCD)/Natural Resources Conservation District (NRCS).

2.3 Measures of Progress

TRPA is now using performance measures (PM) to monitor the effectiveness of the key thresholds associated with the Environmental Improvement Program (EIP). This Project (EIP No. 01.01.0067) has four (4) separate performance measures with corresponding definitions:

<u>4 - Parcels with Storm Water Retrofits</u>

The number of developed parcels in the Tahoe Basin that are retrofitted with best management practices (BMPs) that emphasize removal of fine sediment particles and nutrients. This PM also tracks the number of facilities retrofitted with stormwater BMPs on property belonging to large, public landowners. To qualify, all parcels and facilities must have appropriate operations and maintenance plans. Installing and maintaining BMPs is mandated by regional ordinances, reduces pollutant loads and benefits the clarity of Lake Tahoe.

<u>5 - Miles of Road Treated</u>

The amount of city, county, state, and federal roads that are retrofitted or obliterated to reduce stormwater pollution through capital improvements. Operations and maintenance activities are captured by other PMs. This PM is reported in three categories of treatment priority based on water quality risk. Treating high-priority roads reduces stormwater pollution and cost-effectively improves the clarity of Lake Tahoe.

<u>6 - Miles of Street Sweeping</u>

Miles of city, county, and state roads that are swept to reduce stormwater pollution during each EIP reporting year as part of regular operations and maintenance procedures. Capital stormwater infrastructure improvement activities are captured by other PMs. Sweeping streets reduces a major source of pollutants in stormwater runoff that flows to Lake Tahoe and works toward reducing clarity loss.

9 – Acres of SEZ Restored or Enhanced

Amount of SEZ that is restored or enhanced in order to regain natural or historic function and values. The goals of restoring and enhancing habitat are multi-faceted. Benefits include increased habitat for sensitive species, reduced sediment and nutrient concentrations, enhanced recreational value and increased flood dispersal capacity.

The threshold units for this Project are:

PM	PM Indicator	PM Unit of Benefit
4	Parcel Type	# of Parcels
5	Road Priority	Miles Retrofitted
6	Sweeper Type	Miles Swept
9	Reduced Sediment Amount	Acres Restored or Enhanced

Note that threshold values do not take into account the relative connectivity of a watershed.

2.4 General Site Description

The Project area is located in Tahoma on the west shore of Lake Tahoe, in portions of Sections 17 and 18, Township 14 North, Range 17 East, Mount Diablo Meridian. The Project area is bounded by Lake Tahoe and First Avenue to the east, the El Dorado/Placer County line to the north, Chinkapin Road and Placer Street to the west and Cedar Street to the South (Figure 1).

The total Project area is approximately 300 acres and encompasses County lots and ROW, Caltrans ROW, CTC, USFS, and privately owned residential lots and includes the Tahoe Cedars Tract, Tahoe Cedars Addition, Tahoe Cedars Addition No. 2, Wilson Subdivision No. 1, Sonoma Pines, Water’s Edge Unit No. 1, and Westlake Village Unit Nos. 4, 5, and 9 subdivisions. Improvements within the Project area include paved County roads within 40 to 56 foot wide ROW, unpaved roads, rock slope protection, curb and gutter, AC dike, AC swales, solid wall and perforated pipe storm drain systems, infiltrating sediment basins, channels, and overhead and underground utilities. Portions of the paved County roads may not be centered within the ROW.

Within the Project area approximately 11% of the parcels are publicly owned by the CTC, USFS, or El Dorado County. The majority of the privately owned parcels have been developed with single-family residences.

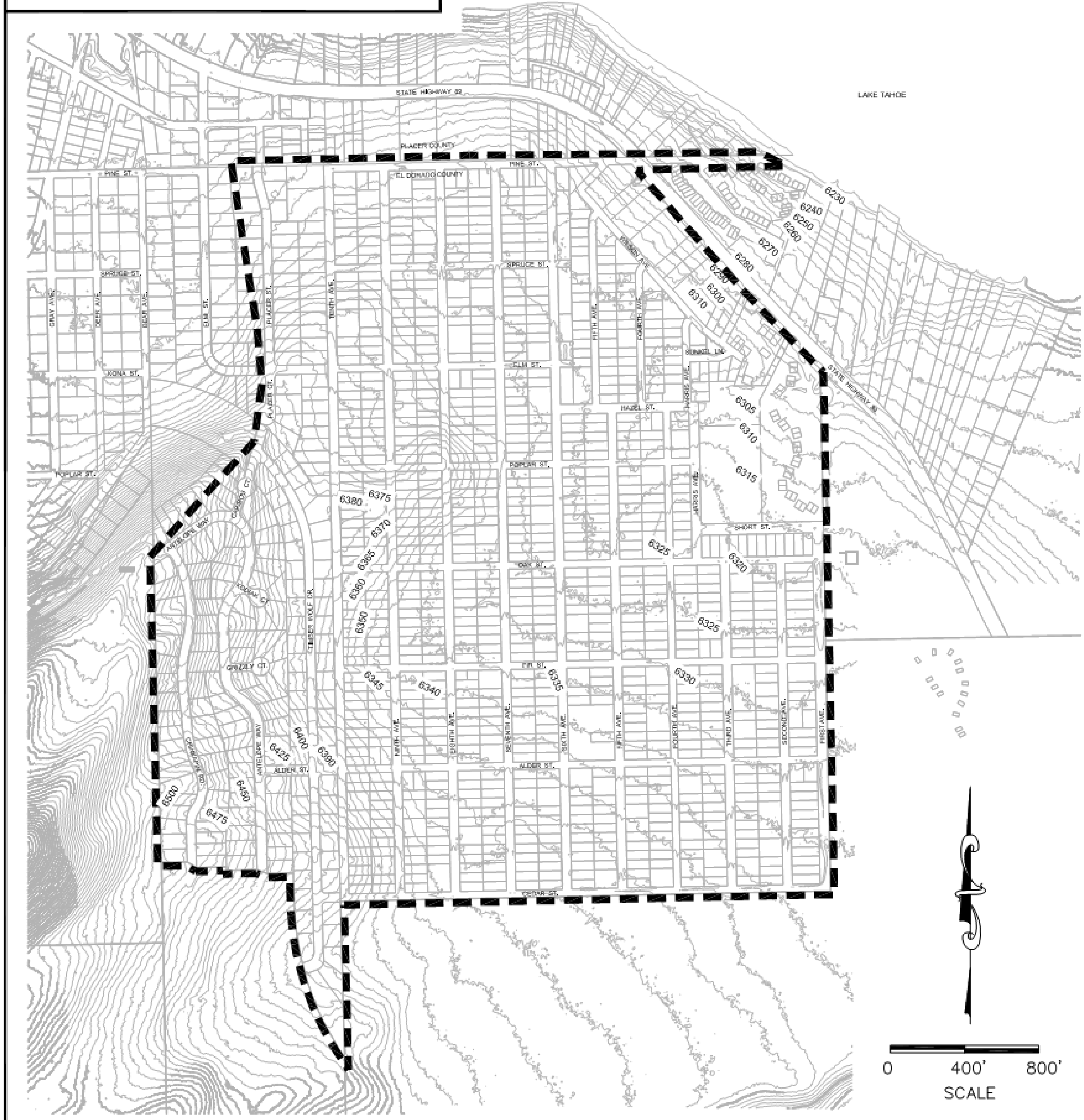
3.0 Existing Site Characteristics

3.1 Topography

As presented on Figure 2, the approximate elevation range of the Project area is from 6,230 to 6,506 feet above mean sea level (NGVD 1929). Project area topography consists of sloping terrain with typical slopes ranging from 0% to 10% with some areas exceeding 38% as shown on Figure 3.

LEGEND

	PARCEL BOUNDARY, COUNTY, OR CALTRANS RIGHT-OF-WAY
▬ ▬ ▬	PROJECT AREA
6225	CONTOUR WITH ELEVATION



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CONTOUR MAP

FIGURE
2

DATE:	PROJECT NO.:	BY:
10/2015	95157	ALD

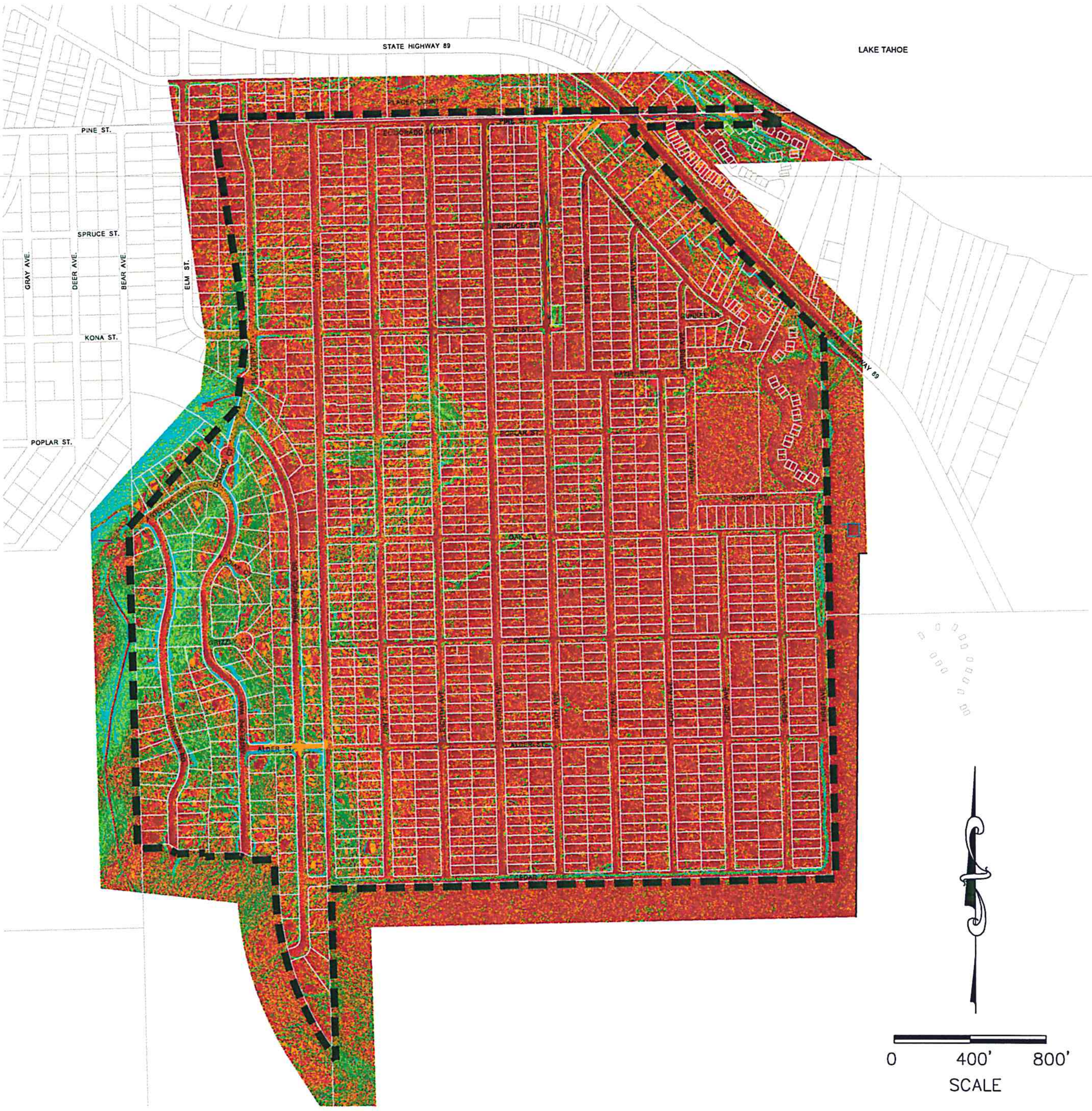
LEGEND

PARCEL BOUNDARY, COUNTY, OR CALTRANS RIGHT-OF-WAY

PROJECT AREA

SURFACE SLOPE DATA

NUMBER	MINIMUM SLOPE	MAXIMUM SLOPE	COLOR	NUMBER	MINIMUM SLOPE	MAXIMUM SLOPE	COLOR
1	0%	5%	🟥	4	15%	25%	🟩
2	5%	10%	🟥	5	25%	35%	🟩
3	10%	15%	🟧	6	35%	> 35%	🟦



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SLOPE MAP

FIGURE

3

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BY: ALD

3.2 Geology

A preliminary review of regional geology within the Project area reveals this geomorphic unit has a moderate slope comprised of two main geologic map units as shown on Figure 4.[5]

3.2.1 Tahoe Glacial Till (Ql)

This soil type makes up approximately 85% of the Project area. Lake deposits of thin-bedded sandy silts and clay.

3.2.2 Tahoe Glacial Till (Qta)

This soil type makes up approximately 15% of the Project area. Unconsolidated bouldery till with a distinct yellow-brown weathered matrix. The deposits are preserved as larger moraines with more rounded and broader crests. Locally may include outwash deposits.

3.3 Hydrology

The United States Geological Survey (USGS) has divided the Tahoe Basin into 110 hydrologic basins and intervening areas contributing to outflow from Lake Tahoe.[6] The Project area is located within USGS Basin 95 (Intervening Area), which has a drainage area of 0.6 square miles. The watershed drains directly into Lake Tahoe through established storm drain and surface channel systems. The USGS basins are depicted in Figure 5.

Runoff from the Project area is directed toward drainage facilities within the County ROW and is generally conveyed along existing road shoulders or rock-lined channels, into storm drain systems. These storm drain systems consist of inlet and junction structures that provide no treatment and solid wall or perforated corrugated metal pipes (CMP). Transportation has divided the Project area into 5 primary watersheds using topographic maps based on LiDAR developed in 2013[7] and field surveys. Two of the watersheds drain into channels at the subdivision boundary, east toward Highway 89. Runoff is then directed via pipe under the highway to channels that convey flow to Lake Tahoe. One of the watersheds drains into a storm drain system which outlets directly to Lake Tahoe and two watersheds are conveyed in a storm drain system into the Gray Basin, north of the County line.

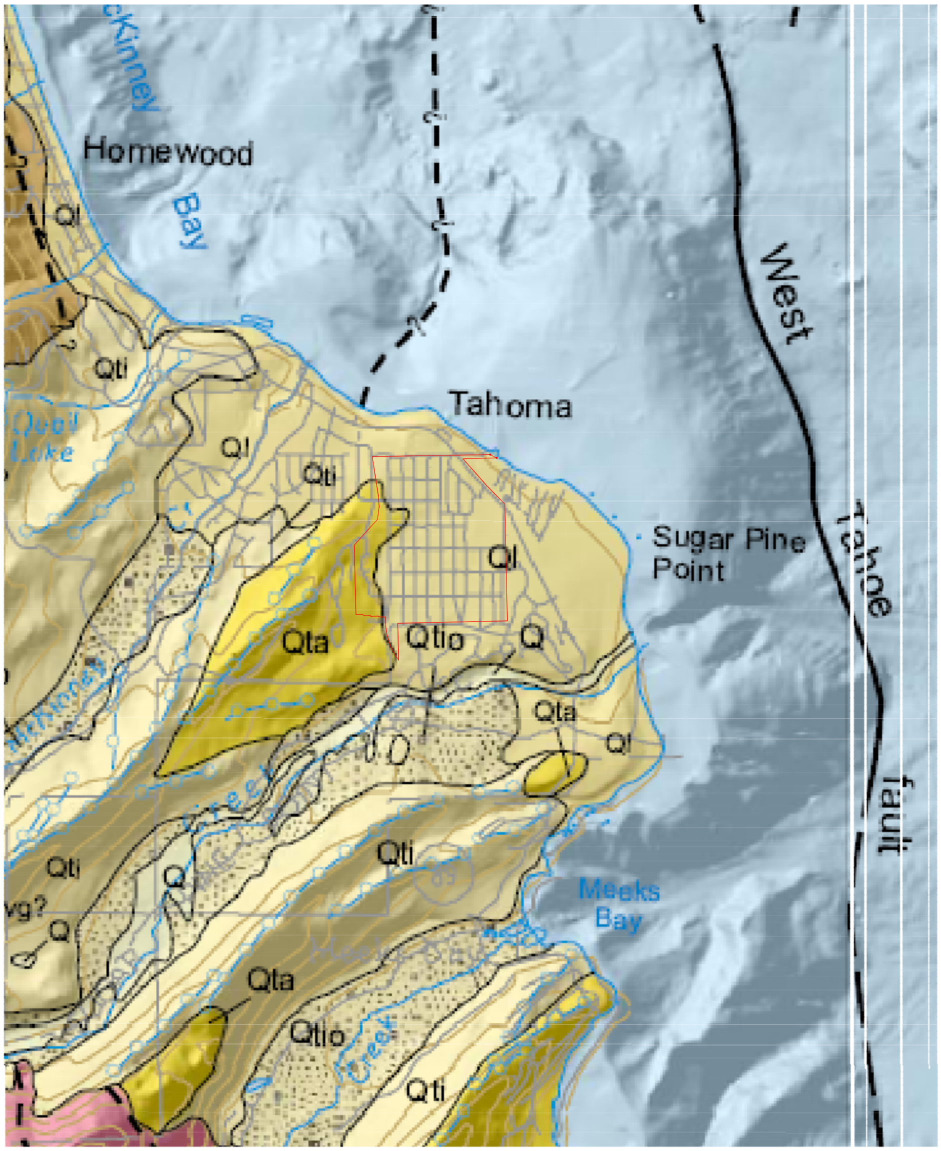
A comprehensive hydrological analysis of the Project area is found in Section 4.

3.4 Soils

The 2007 Natural Resources Conservation Service (NRCS) soil survey data for the El Dorado County Tahoe Basin Area was used to determine the primary soils units within the Project area.[8] The soils found within the Project area boundary are presented on Figure 6 and are described below.

- Tallac gravelly coarse sandy loam, 5 to 15 percent slopes, very stony (7521). This soil consists of colluvium over till derived from mixed sources. Average total available water in the top five feet of soil is 3.2 inches. Hydrologic soil group is A and runoff class is low. Water table is present within the soil profile.

- Tallac gravelly coarse sandy loam, 15 to 30 percent slopes, very stony (7522). This soil consists of colluvium over till derived from mixed sources. Average total available water in the top five feet of soil is 3.2 inches. Hydrologic soil group is A and runoff class is medium. Water table is present within the soil profile.



LEGEND

Ql Lake deposits (Holocene)

Q Alluvium (Holocene and Pleistocene)

Tioga glacial deposits (Pleistocene)

Qti Till

Qtio Outwash deposits

Tahoe glacial deposits (Pleistocene)

Qta Till

Granitic rocks

Krvg Rockbound Valley granodiorite (Cretaceous)

Project Area (Approximate)

Fault - solid where well located; dashed where approximately located; short dash where inferred; dotted where concealed; queried where continuation or existence is uncertain. Ball and bar on downthrown side. ***(The age and location of the faults in the lake bottom and cutting Quaternary deposits should be considered preliminary interpretations.)***

NOT TO SCALE

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GEOLOGY MAP

FIGURE 4

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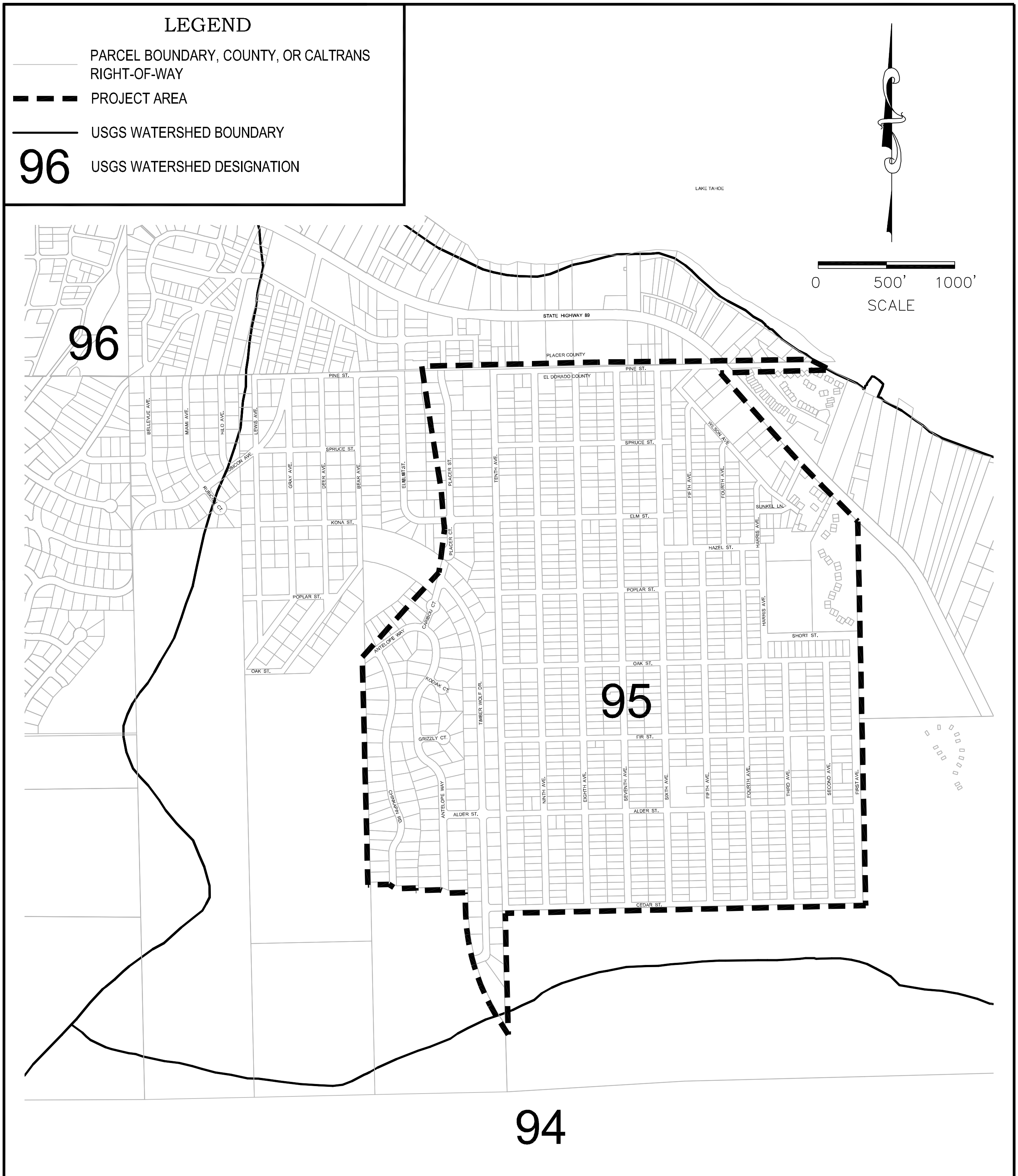

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USGS WATERSHED MAP

FIGURE
5

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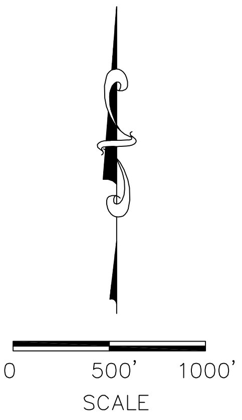
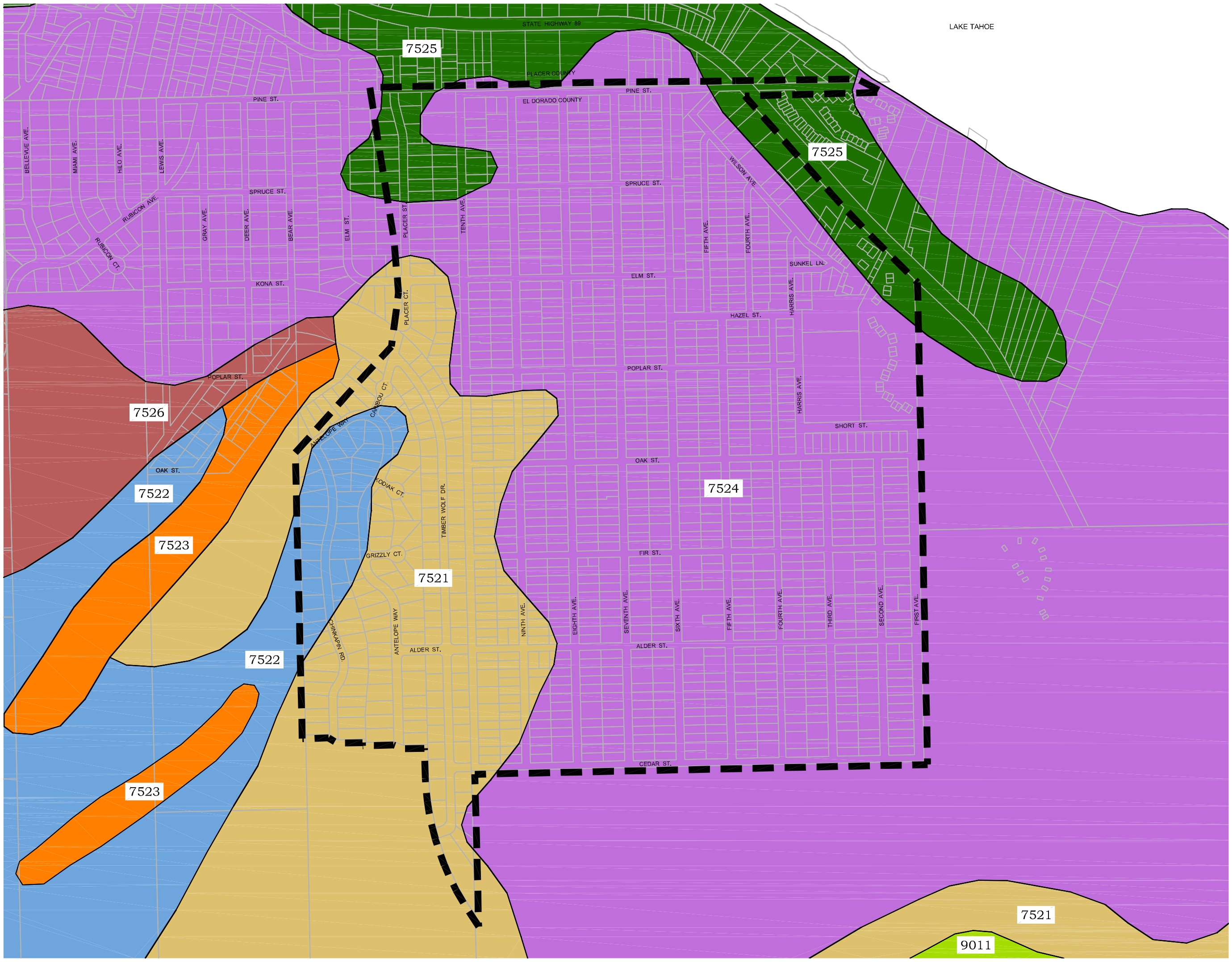
LEGEND

MAP UNIT COLOR/SYMBOL		MAP UNIT NAME
🟨	7521	TALLAC GRAVELLY COARSE SANDY LOAM, 5% TO 15% SLOPES, VERY STONY
🟦	7522	TALLAC GRAVELLY COARSE SANDY LOAM, 15% TO 30% SLOPES, VERY STONY
🟧	7523	TALLAC GRAVELLY COARSE SANDY LOAM, 30% TO 70% SLOPES, VERY STONY
🟪	7524	TALLAC GRAVELLY COARSE SANDY LOAM, MODERATELY WELL DRAINED, 0% TO 5% SLOPES
🟩	7525	TALLAC GRAVELLY COARSE SANDY LOAM, MODERATELY WELL DRAINED, 5% TO 9% SLOPES
🟥	7526	TALLAC GRAVELLY COARSE SANDY LOAM, MODERATELY WELL DRAINED, 2% TO 9% SLOPES, RUBBLY
🟩	9011	OXYAQUIC CRYORTHENTS-AQUIC XERORTHENTS-TAHOE COMPLEX, 0% TO 15% SLOPES
─		PARCEL BOUNDARY, COUNTY, OR CALTRANS RIGHT-OF-WAY
▬ ▬ ▬		PROJECT AREA





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SOILS MAP

FIGURE
6

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BY: ALD

- Tallac gravelly coarse sandy loam, moderately well drained, 0 to 5 percent slopes (7524). Average total available water in the top five feet of soil is 3.2 inches. Hydrologic soil group is A and runoff class is very low. Water table is present within the soil profile. Representative Ksat value of 4.0 inches per hour is given but to be conservative 2.0 inches was used for modeling.

- Tallac gravelly coarse sandy loam, moderately well drained, 5 to 9 percent slopes (7525). Average total available water in the top five feet of soil is 3.2 inches. Hydrologic soil group is A and runoff class is low. Water table is present within the soil profile. Representative Ksat value of 4.0 inches per hour is given but to be conservative 2.0 inches was used for modeling.

3.5 Land Capability

The TRPA developed the land capability system currently used in the Tahoe Basin. All the lands within the basin are divided into seven classes based on soil types, potential for erosion, and other related characteristics.[9] Lands with a ranking of 1 have the highest potential for erosion and 7 the lowest. Level 1 is also subdivided into three categories: 1a – least tolerance for use; 1b – poor natural drainage in a stream environmental zone (SEZ); and 1c – fragile flora and fauna. There are four land capability classes within the Project area (Table 1 and Figure 7). Land capability groups were based on TRPA Plan Area Statement maps. A request for Verification of Land Capability by TRPA staff will be forwarded shortly for those areas where work is proposed.

Table 1 – Area Distribution by Land Capability Class

Land Capability Class	Percent
1a	8%
1b	19%
3	2%
5	71%

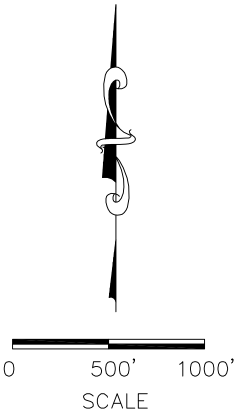
3.6 Land Use

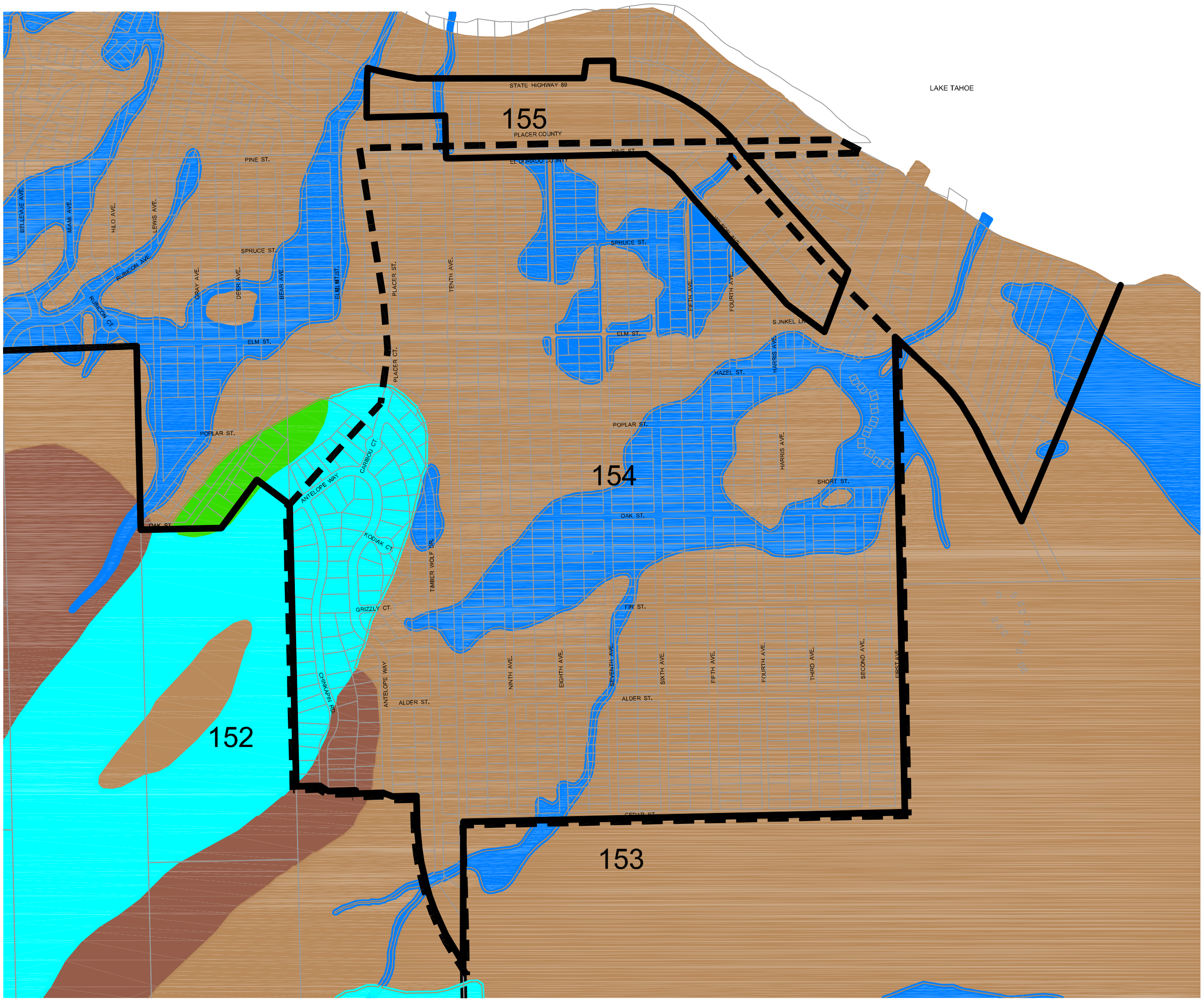
The majority of the Project area boundary lies within the TRPA Plan Area Statement (PAS) 154 – Tahoma Residential, with a small portion falling within PAS 155 – Tahoma Commercial (Figure 7). For PAS 154, the land use classification is residential, the management strategy is mitigation, and the special designation is preferred affordable housing area. For PAS 155 the land use classification is tourist, the strategy is redirection, and the special designation is preliminary community plan area.

Within PAS 154, the existing uses are a mixture of residential uses ranging from higher density condominiums to low density single family dwellings. The shoreline is in private ownership and the area is 70% built out. Within PAS 155 the existing uses are a mixture of small commercial services and older motels with the area 75% built out.[10]

LEGEND

155	TRPA PAS NUMBER
▬	PAS BOUNDARY
—	PARCEL BOUNDARY, COUNTY, OR CALTRANS RIGHT-OF-WAY
- - -	PROJECT AREA
🟦	LAND CAPABILITY CLASS 1a
🟦	LAND CAPABILITY CLASS 1b
🟩	LAND CAPABILITY CLASS 1c
🟫	LAND CAPABILITY CLASS 3
🟫	LAND CAPACILITY CLASS 5





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LAND CAPABILITY AND LAND USE MAP

FIGURE 7

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BY: ALD

3.7 Biological Resources

3.7.1 Wetlands

Jurisdictional waters of the U.S. are classified into multiple types based on topography, edaphics (soils), vegetation, and hydrologic regime. Primarily, the U.S. Army Corps of Engineers establishes two distinctions: Wetland and non-wetland waters of the U.S. Non-wetland waters are commonly referred to as other waters.

Transportation retained NCE to determine the presence of jurisdictional wetlands.[11] NCE noted the presence of features that appear to conform to the definition of waters of the U.S. per Section 404 of the federal Clean Water Act. If necessary, Transportation will submit the results of the study to the U.S. Army Corps of Engineers for a permit. The determinations will be taken into account when finalizing the preferred alternative design.

3.7.2 Vegetation

Transportation retained NCE to determine the presence of special status plant species, vegetation classifications, and invasive/noxious weed species within a one-half mile radius of the Project area.[12] [13] NCE found Tahoe yellow cress is documented to be within the Project boundary in an area where no improvements are proposed. Fen and Stebbins' phacelia are documented outside of the Project boundary but within the one-half mile radius. No special status species were encountered during the field surveys, however, NCE identified one noxious weed species (oxeye daisy) within the Project boundary and determined there is a moderate overall risk of noxious weed establishment as a result of the Project.

These findings and determinations will be taken into account when finalizing the preferred alternative design.

3.7.3 Wildlife

Transportation retained NCE to determine the presence of special status wildlife species and habitat within a one-half mile radius of the Project area.[14] Background research found detections of four special status species within the one-half mile radius boundary; however, NCE adds that habitat found within the Project area is marginal and would not support the reproductive requirements of special status species. NCE's findings and any limited operating periods will be considerations in the preferred alternative design and construction schedule.

3.8 Cultural Resources

Transportation retained NCE to determine the presence of previously recorded archaeological or historical sites located in or near the Project area.[15] NCE's findings were compiled in a letter to Tom Fuller of the USFS Lake Tahoe Basin Management Unit for concurrence. These findings will be taken into account when finalizing the preferred alternative design.

3.9 Property Network

The Project property network was developed from field survey, ROW, and recorded subdivision maps and depicts County and Caltrans road ROW and property lines. The purpose of this property network is to depict a best-fit representation of the subdivisions based on the respective found monuments such that Transportation can identify the properties and ROW affected by the erosion control projects for engineering and design purposes.

Figure 8 presents the Project area which is comprised primarily of private lots containing single family dwellings. There is a small portion of commercial lots that front Highway 89 and the area by the lake shore is condominiums. No attempt was made to resolve any mathematical discrepancy with the individual property lines or ROW within the project area. Additional surveying and analysis would be required to provide specific and final resolution for any given property line. All planned improvements are within the existing County ROW or publically owned parcels. If determined necessary, Transportation will begin the process of ROW acquisition for easements, special use permits, and license agreements for any affected parcels during the development of the preferred design alternative.

3.10 Existing Utilities

Numerous underground and overhead utilities are within the Project area. The Existing Utilities Map (Figure 9) was developed using available record information and shows the approximate location and utility type. Utility owners are listed in Table 2.

Table 2 – Utility Owner List

Utility Type	Owner	Owner Address	Contact Name
Telephone	AT&T	12824 Earhart Ave. Auburn, CA 95602	Astrid Willard
Electricity	Liberty Energy	933 Eloise Avenue, S. Lake Tahoe, CA 96150	Jeff Mathews
Sewer	TCPUD	P.O. Box 5249 Tahoe City, CA 96145	Tony Laiotis
Water	Tahoe Cedars Water Company	6998 W. Lake Blvd. Tahoma, Ca 96142	Robert Marr
Cable Television	Suddenlink Communications	10607 West River St., Bldg 3, Unit D, Truckee, CA 96161	Bart Givens
Natural Gas	Southwest Gas	1740 D Street, Unit No.4 South Lake Tahoe, CA 96150	Jimmy Smith

3.11 Driveway and Private BMP Inventory

A driveway and BMP inventory was not completed for this Project.

3.12 Maintenance

During the winter months, the County of El Dorado Maintenance Division removes snow by plowing within and adjacent to the Project limits on an as-needed basis. Snow is plowed along every street of the Project area with snow storage occurring at the ends of streets or cul-de-sacs where stacked snow does not interfere with driveway access. Transportation road maintenance activities in the winter are primarily limited to snow removal. However, in extreme conditions, road abrasives are applied as required on the steeper sections of roadways. Sweeping of the roads and directing runoff into existing basins are currently the primary methods of collecting sediment generated by road abrasives, naturally occurring sediment, or sediment tracked into the Project area.

LEGEND

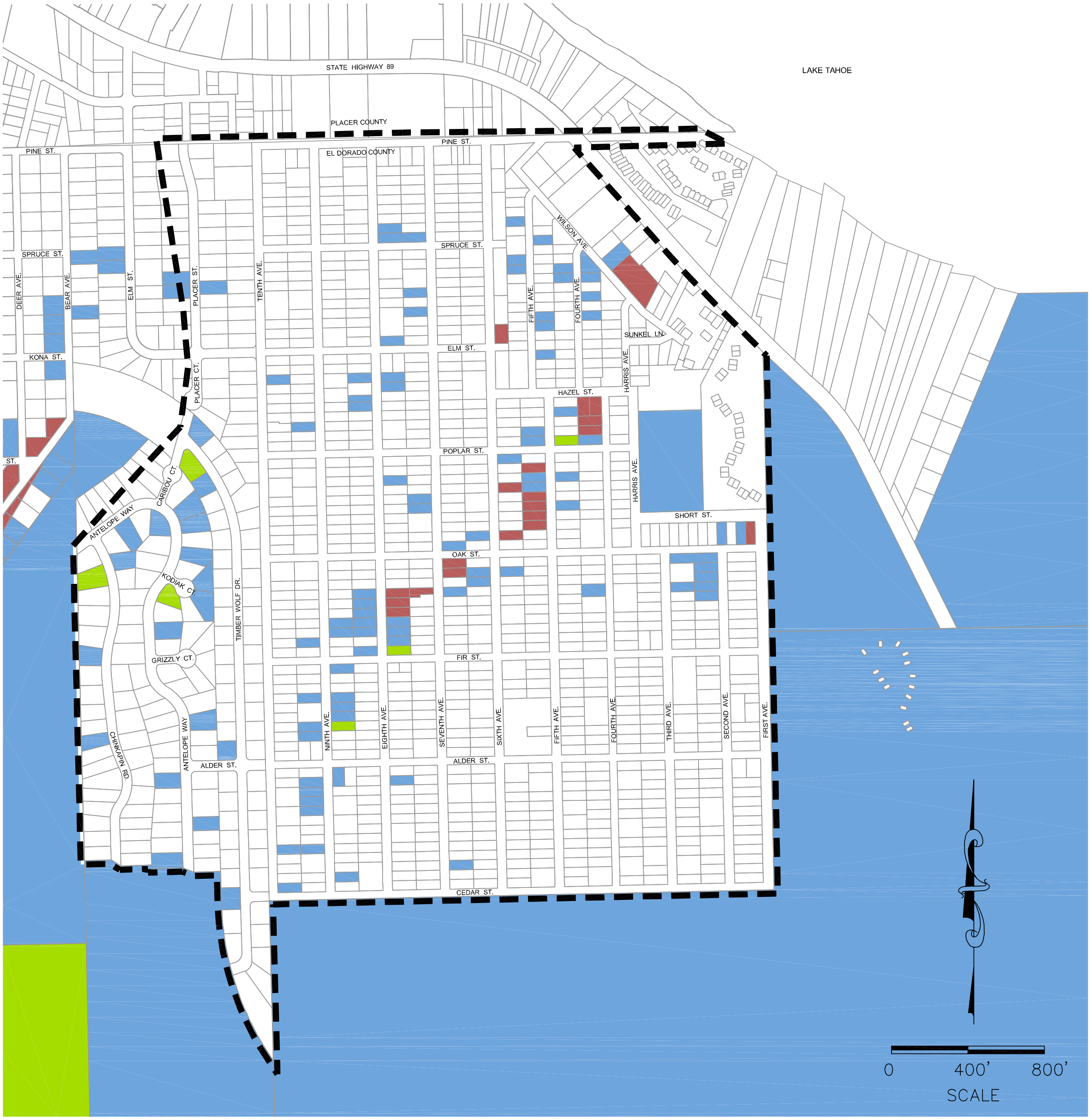
🟥 COUNTY OF EL DORADO

🟩 US FOREST SERVICE

🟦 STATE OF CALIFORNIA

— PARCEL BOUNDARY, COUNTY, OR CALTRANS RIGHT-OF-WAY

▬ ▬ ▬ PROJECT AREA



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

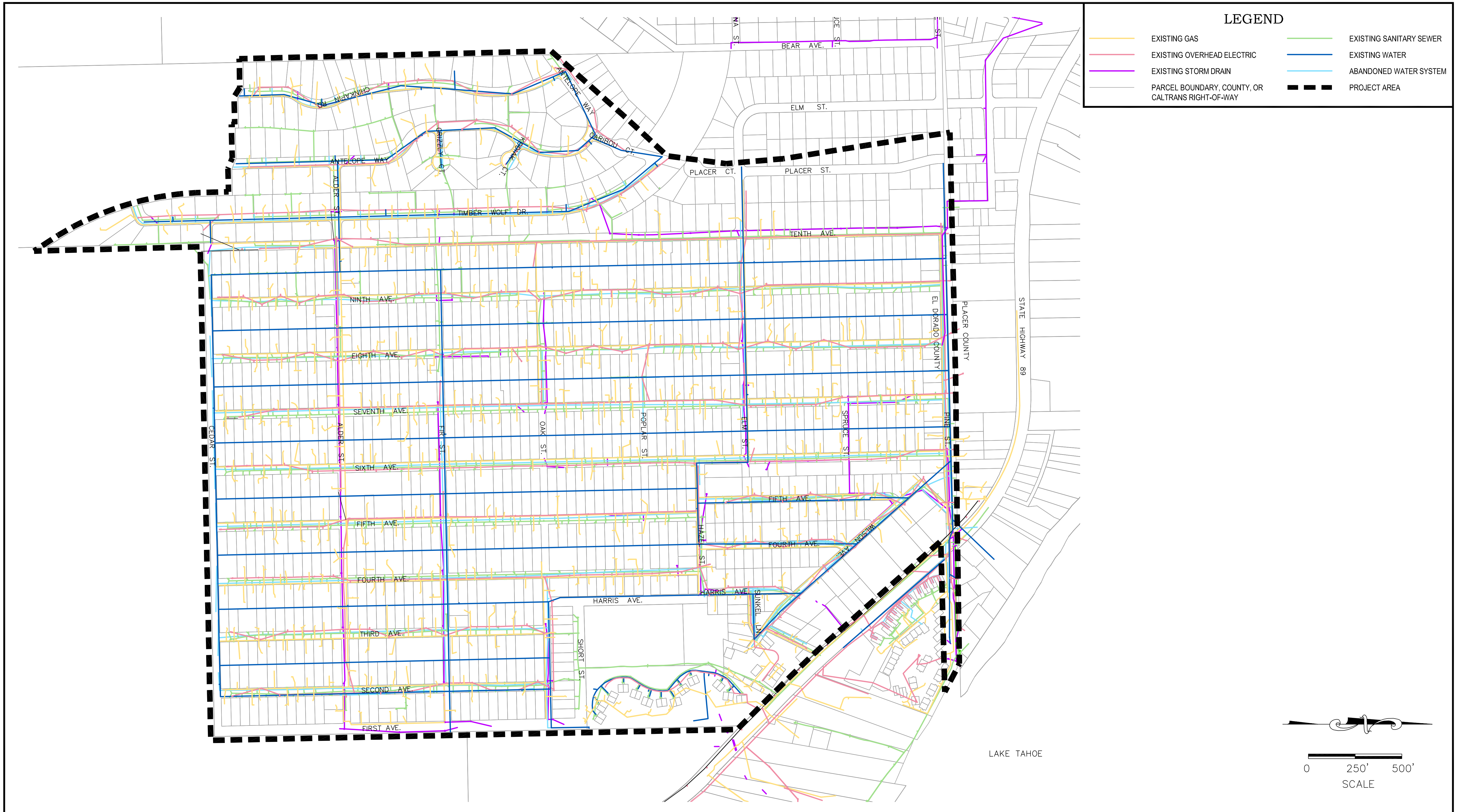
PUBLIC PROPERTY MAP

FIGURE
8

DATE: 10/2015

PROJECT NO.: 95157

BY: ALD



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

UTILITY MAP

FIGURE

9

DATE:	10/2015	PROJECT NO.:	95157	BY:	ALD

4.0 Hydrology Summary

The hydrologic characteristics of the Project area were analyzed in accordance with techniques outlined in the 1995 El Dorado County Drainage Manual (Drainage Manual).[16]

4.1 Watershed Characteristics

Runoff generally flows from the southwest to the northeast. Using topographic mapping based on recent field and aerial survey data collected, Transportation has defined 5 primary watersheds within the Project area (Figures 10 and 11).

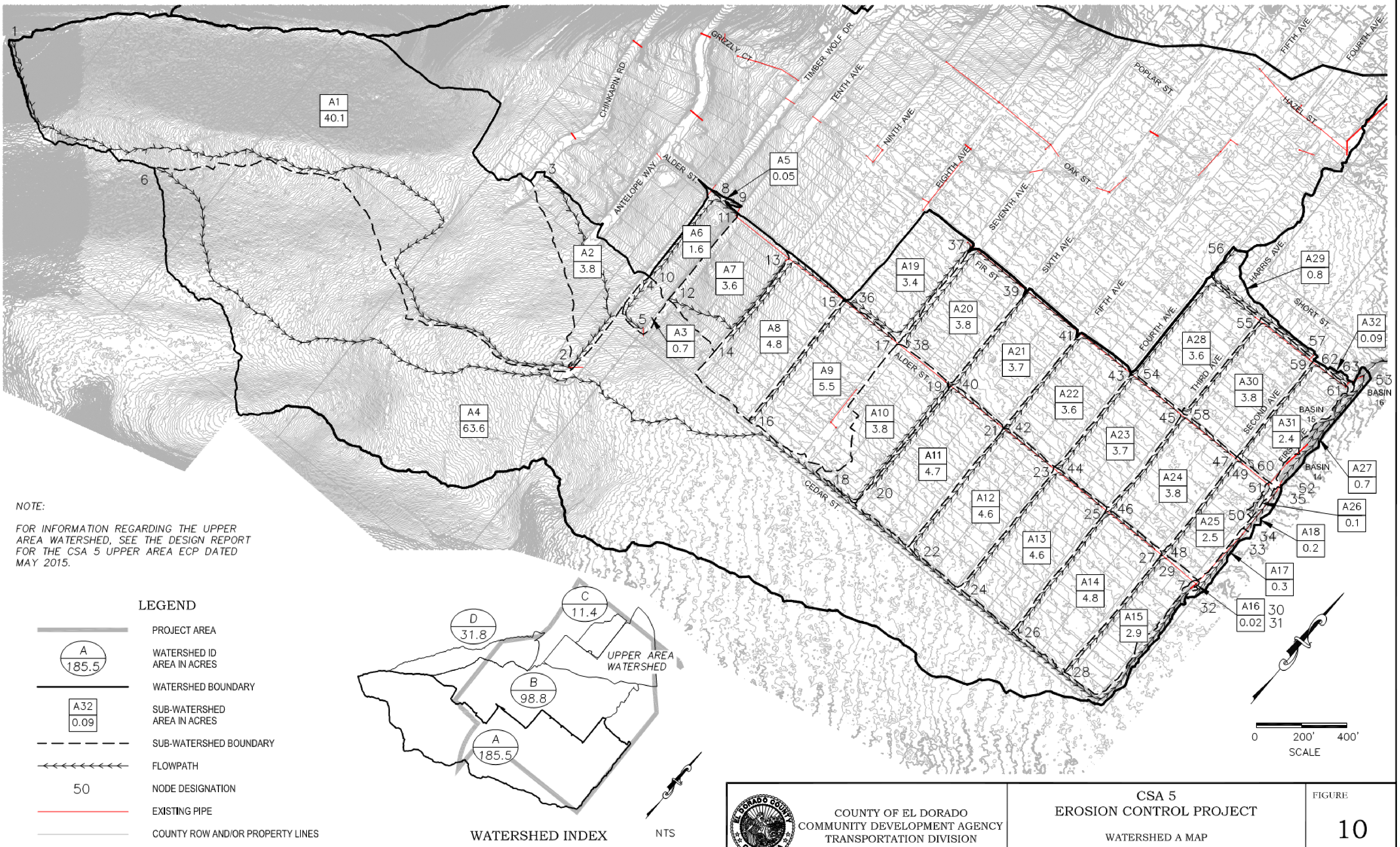
The Upper Area Watershed is approximately 50 acres divided into 25 sub-watersheds. This watershed is described in the Design Report for the CSA 5 Upper Area Erosion Control Project.[17] The remaining watersheds are specific to this project and designated as Watersheds A, B, C, and D. When necessary, the Upper Area Watershed will be discussed in this Report; however, for an in depth analysis, please refer to the Upper Area Design Report.

Watershed A is approximately 185 acres divided into 32 sub-watersheds. The southern portion of Watershed A drains to a channel constructed along the south and east boundary of the subdivision. Most of this runoff originates from undeveloped, mountainous terrain. The remaining portion of Watershed A is conveyed through the subdivision via pipe, sheetflow, roadside ditches, AC swales, or AC dike to CMP inlets. A pipe system connects the CMP inlets and conveys runoff to the east. Some pipes were perforated to allow for infiltration under the roads and dirt shoulders. Confluencing with the flow from the south, the combined runoff continues along the eastern edge of the subdivision through a series of channels and basins before leaving the Project boundary. The northeasternmost sub-watersheds not conveyed through the series of channels and basins do receive some treatment within the channel leaving the Project area.

Watershed B includes approximately 99 acres divided into 35 sub-watersheds. The majority of runoff from this watershed originates within the subdivision and is conveyed via pipe, sheetflow, roadside ditches, AC swales, or AC dike to CMP inlets and channels. Some pipes connecting CMP inlets were perforated to allow for infiltration under the roads and dirt shoulders. Most of the runoff from Watershed B is directed into an infiltration basin before being conveyed in a channel beyond the Project boundary. Runoff from the easternmost and northernmost sub-watersheds do not flow into the infiltration basin but do receive treatment within the channel leaving the Project area.

Watershed C is approximately 11 acres divided into 2 sub-watersheds. Runoff originates within the subdivision. It is conveyed via sheetflow, AC dike, and roadside ditch to a CMP inlet connected to a pipe system that conveys runoff to the Gray Basin north of the County line, beyond the Project boundary.

Watershed D is approximately 32 acres divided into 5 sub-watersheds. The majority of runoff from this watershed originates from undeveloped, mountainous terrain. Runoff is then conveyed through the subdivision via pipe, sheetflow, and roadside ditches or channels. In some locations, CMP inlets intercept and direct runoff into storm drain systems. A pipe system along Tenth Avenue conveys most of the runoff north, to the Gray Basin. Runoff from sub-watershed D5 is conveyed via sheetflow and channel toward a storm drain system at the intersection of Pine Street and Bear Avenue. This storm drain system also conveys runoff to the Gray Basin.



WATERSHED INDEX

NOTE:

FOR INFORMATION REGARDING THE UPPER AREA WATERSHED, SEE THE DESIGN REPORT FOR THE CSA 5 UPPER AREA ECP DATED MAY 2015.

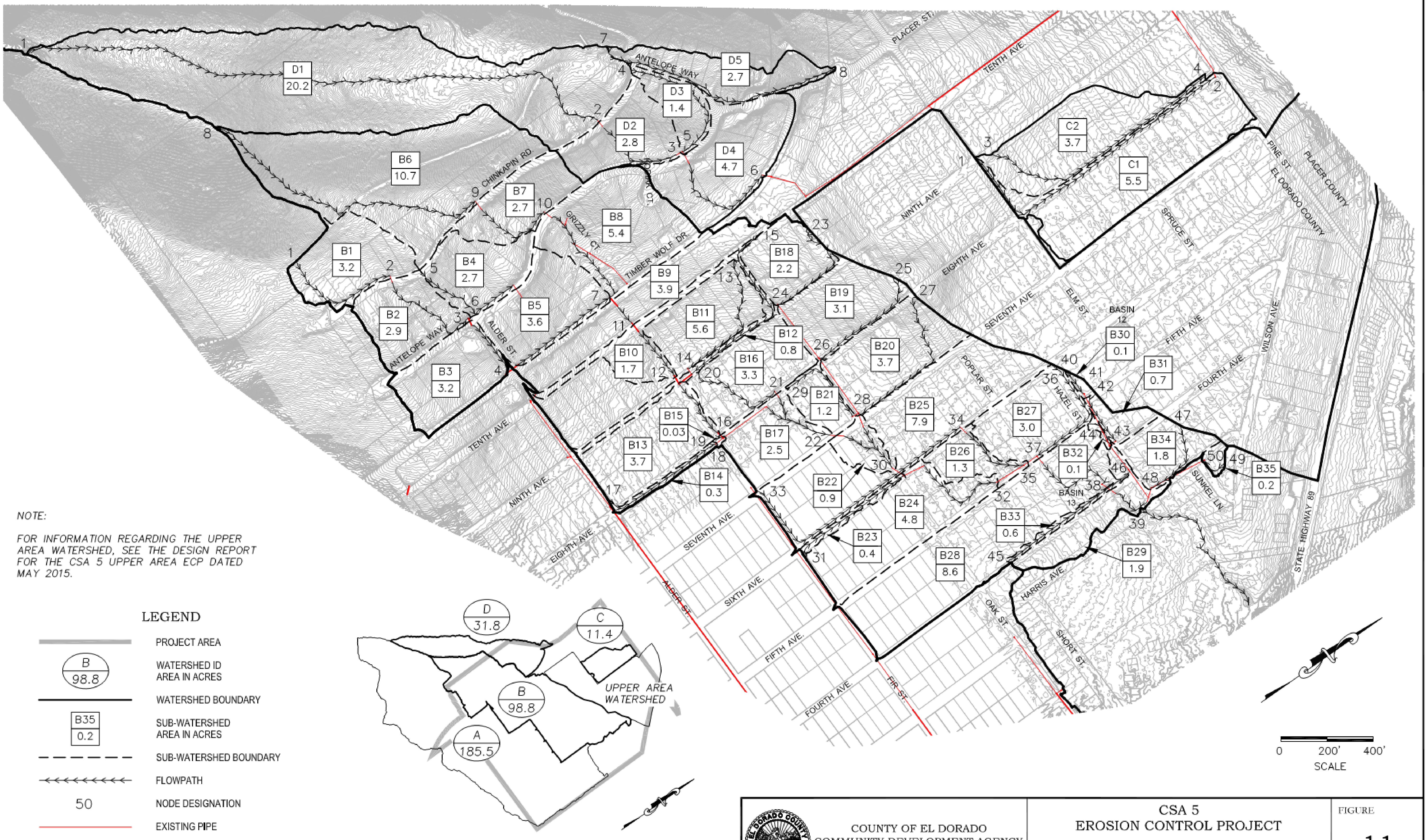
COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

WATERSHED A MAP

FIGURE 10

DATE:	12/2015	PROJECT NO.:	95157	BY:	ALD



NOTE:

FOR INFORMATION REGARDING THE UPPER AREA WATERSHED, SEE THE DESIGN REPORT FOR THE CSA 5 UPPER AREA ECP DATED MAY 2015.

LEGEND

▬	PROJECT AREA
B 98.8	WATERSHED ID AREA IN ACRES
━	WATERSHED BOUNDARY
B35 0.2	SUB-WATERSHED AREA IN ACRES
– – – –	SUB-WATERSHED BOUNDARY
<<<<<<<<<	FLOWPATH
50	NODE DESIGNATION
─	EXISTING PIPE
─	COUNTY ROW AND/OR PROPERTY LINES

WATERSHED INDEX

NTS

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

WATERSHEDS B, C, AND D MAP

DATE: 12/2015
PROJECT NO.: 95157
BY: ALD

FIGURE
11

4.2 Storm Frequency

A variety of storm frequency requirements have been recommended for erosion control projects within the Lake Tahoe Basin in various publications. Transportation utilizes the Drainage Manual as a guide for hydrologic and hydraulic design within the Tahoe Basin. The Drainage Manual requires that drainage facilities be designed to safely convey storm water runoff from an event with an average recurrence interval of 100-years for areas greater than 100 acres, and an average recurrence interval of 10-years for areas less than 100 acres.[18]

The TRPA Code of Ordinances stipulates an infiltration requirement for the 20-year, 1-hour storm runoff volume.[19] The TRPA Code of Ordinances also states that drainage conveyance facilities shall be designed for at least a 10-year, 24-hour storm and that drainage conveyance through a SEZ shall be designed for a minimum 50-year storm. The Lahontan Water Quality Control Plan states that the "design storm" for storm water control facilities in the Lake Tahoe Basin is the 20-year, 1-hour storm event.[20]

Four of the watersheds (Upper Area, Watersheds B, C and D) are less than 100 acres. At approximately 185 acres, Watershed A exceeds the 100 acre threshold, however, runoff from 103 acres of that watershed flows directly into the channel at the south and east boundaries of the subdivision. Therefore, any proposed design locations within the Project's areas of interest (Figure 1) will have less than 100 acres of runoff and the Project design hydrologic storm frequency is defined as the 25-year, 1-hour rain event. Although not reflected in the NRCS soil survey, SEZ has been identified within each of the watersheds in the Land Capability and Land Use Map (Figure 7). Any conveyance improvements within the SEZ will be designed to meet or exceed the 50-year storm requirement. For evaluation of hydraulic drainage structure conveyance, the Project design storm frequency is defined as the 10-year event with the storm duration equal to the time of concentration.[21] In addition, Transportation will analyze the peak runoff for the 100-year, 24-hour return period storm event.

4.3 Precipitation Values

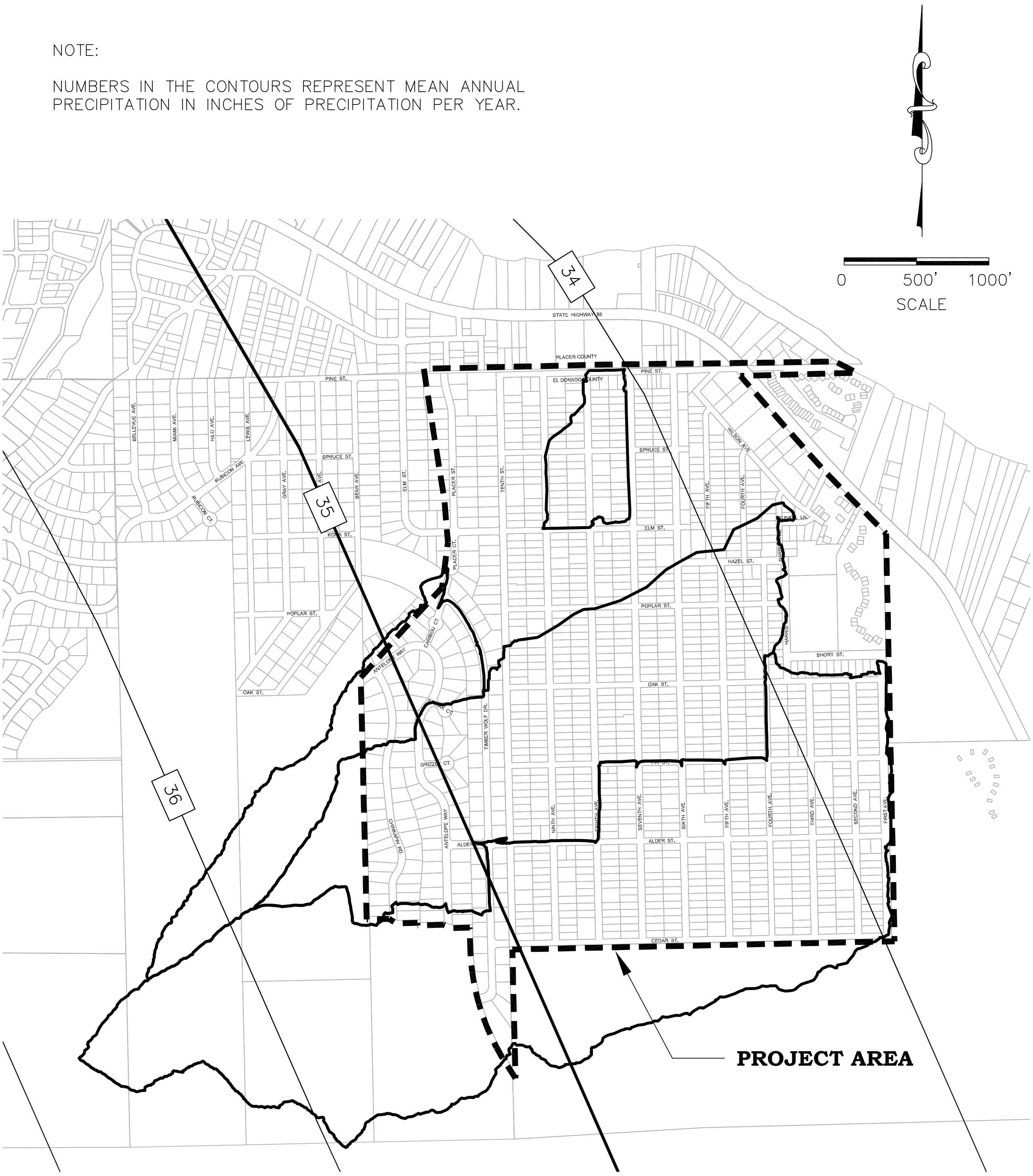
The mean annual rainfall for Watersheds A, B, C, and D is 35 inches (Figure 12) and the 1-hour rainfall depth is equal to 0.94 inches and 1.10 inches (Figure 13) for 10-year and 25-year return periods, respectively.[22] The 100-year, 1-hour rainfall depth is equal to 1.33 inches.[23] The TRPA Code of Ordinances stipulates that an average rain intensity of 1-inch per hour can be used for the 20-year, 1-hour storm for water quality evaluation.[24] The Lahontan Water Quality Control Plan states that for the Mammoth Lakes area, the 1-hour design storm is equal to 1 inch of rainfall.[25] Based on the location of the Project, the Project design rainfall intensity for the 1-hour storm is accepted as 1.10 inches to represent a storm event with a return period of 25-years. For evaluation of hydraulic drainage structures, the Project design precipitation value is based on the hydrologic response characteristics of the basin with the storm duration equal to the time of concentration.[26]

4.4 Hydrologic Methods

The objective of the hydrologic analysis is to estimate the peak flow and the total runoff volume for the Project design storm and precipitation values. Two hydrologic techniques were used; the Rational Method and the Unit Hydrograph Method. An Excel spreadsheet was used to calculate peak flows and velocities using the Rational Method and the computer program *Hydrologic Engineering Center - Hydrologic Modeling System, HEC-HMS*, version 3.5.0, was used to calculate peak flows and volumes using the Unit Hydrograph Method. The results from these analyses were accepted to represent design storm peak flow and volumes without the presence of base flow.

NOTE:

NUMBERS IN THE CONTOURS REPRESENT MEAN ANNUAL PRECIPITATION IN INCHES OF PRECIPITATION PER YEAR.



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

MEAN ANNUAL RAINFALL

DATE: 12/2015

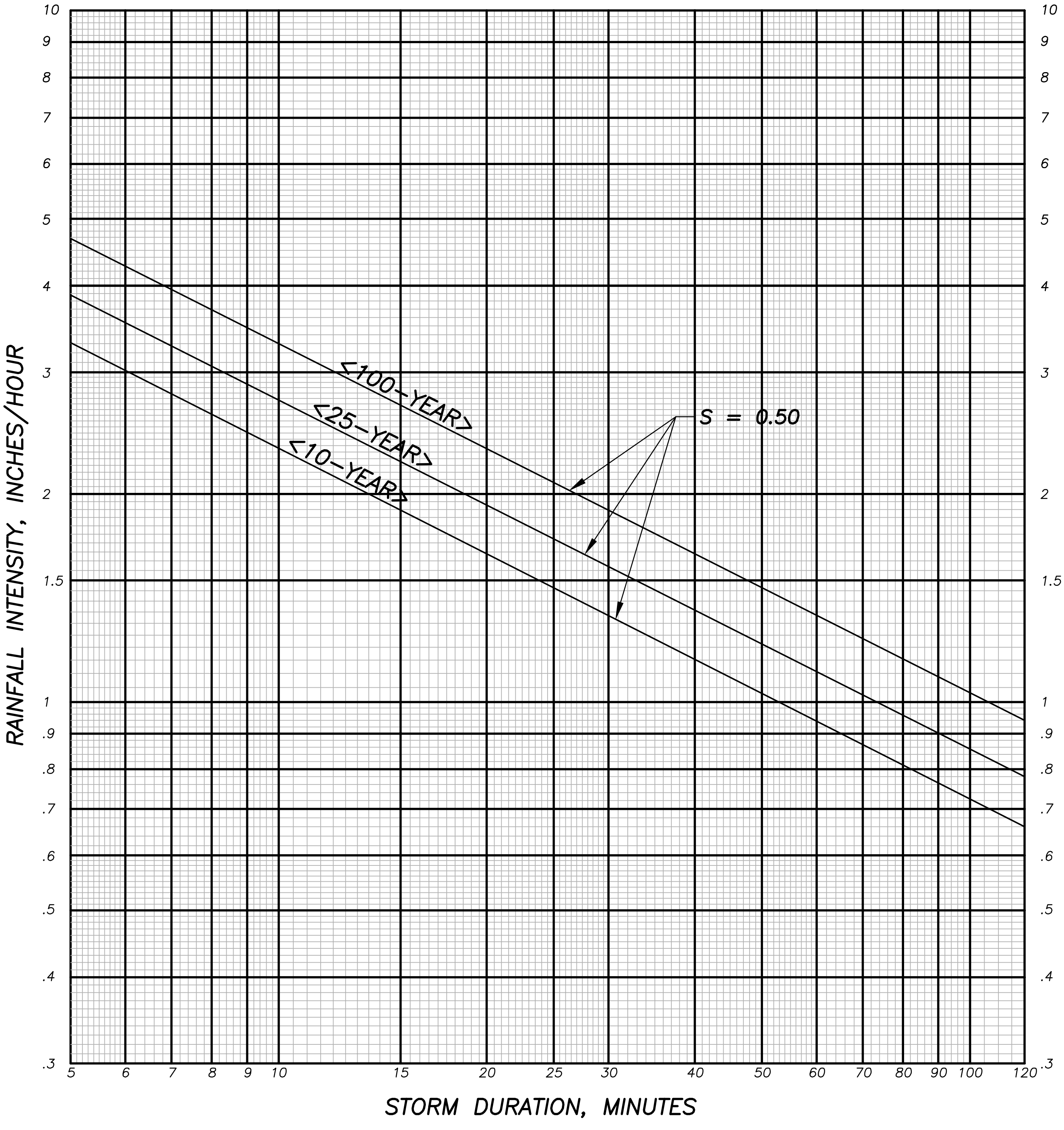
PROJECT NO.: 95157

BY: ALD

FIGURE

12

RAINFALL INTENSITY DURATION FREQUENCY CURVE



SOURCE: COUNTY OF EL DORADO DRAINAGE MANUAL, 1995
UPDATED FROM EL DORADO COUNTY DESIGN RAINFALL, GOODRIDGE 2008
MEAN ANNUAL RAINFALL – ISOHYET 35 IN.

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

RAINFALL INTENSITY-DURATION-FREQUENCY CURVES

FIGURE
13

DATE: 10/2015
PROJECT NO.: 95157
BY: ALD

Watersheds A, B, and D were divided into sub-watersheds in order to estimate the peak flow and volume at specific locations such as existing drainage structures and existing stormwater treatment locations. In addition to estimating the peak flow and volume at existing drainage structures, Watershed C was divided into sub-watersheds to ensure runoff from proposed improvements could be safely conveyed in the existing storm drain system.

4.4.1 Rational Method

The Rational Method was used to calculate the peak discharge from the Project area based on the 25-year Project design rainfall intensity. This method relies on four input variables and was calculated using equation 1:[27]

$$Q = C \cdot C_f \cdot I \cdot A \tag{1}$$

Where Q is peak discharge in cfs, C is the runoff coefficient, C_f is the runoff coefficient frequency adjustment factor, I is the rainfall intensity in inches per hour, and A is the area of the watershed in acres. For the Project area an unadjusted runoff coefficient C of 0.1 was selected based on the type of drainage area being unimproved. For this Project design rainfall return period of 100-years, a runoff coefficient frequency adjustment factor C_f of 1.25 was applied to the runoff coefficient.[28] The rain intensity I of the design storm was dependent on the duration and the area A of the sub-watershed varied by location.

The flow paths for the Project watersheds were segregated into overland sheet flow on the unimproved areas and shallow concentrated flow along the County roads for paved and unpaved surfaces. The times of concentration were calculated for each watershed to determine the time required for runoff to travel from the hydraulically most distant part of the watershed to the outlet from the Project area. For this Project area, the overland-flow roughness coefficient was estimated to be 0.40 based on woods with light underbrush.

The travel time for sheet flow was calculated using the kinematic-wave equation and is presented as equation 2:[29]

$$T_t = 0.007 \frac{(n \cdot L)^{0.8}}{P^{0.5} \cdot S^{0.4}} \tag{2}$$

Where T_t is sheet flow time of travel in hours, n is overland-flow roughness coefficient, L is length of overland flow in feet (300 foot maximum), P is rainfall depth in inches, and S is land slope in feet per feet. The velocity of shallow flow over unpaved surfaces was estimated based on equation 3:[30]

$$V_U = 16.1345 \cdot S_O{}^{0.5} \tag{3}$$

Where V_U is flow velocity in feet per second and S_0 is land slope in feet per feet. The velocity of shallow flow over paved surfaces was estimated based on equation 4:[31]

$$V_P = 20.3283 \cdot S_O{}^{0.5} \tag{4}$$

Where V_P is flow velocity in feet per second and S_0 is land slope in feet per feet. The times of concentration for shallow flow over unpaved and paved surfaces were calculated by dividing the flow path length by the velocity. The watershed time of concentration for each of these flow path segments was summed to determine the total time.

4.4.2 Unit Hydrograph Method (HEC-HMS)

The Unit Hydrograph Method is commonly used for determining the peak flow (Q) and the hydrograph from relatively large watersheds (up to 10 sq. mi.). Transportation used the unit hydrograph for an entire watershed tributary to its outflow. This method was used to determine the peak runoff rates for the Project watersheds.

The program requires input parameters and variables such as a Basin Model, Meteorological Model, and a Control Storm. The Basin Model parameters include input of the drainage area, lag time, percent impervious, initial abstraction I_a, and any base flow information. The lag time is the product of 0.6 multiplied by the time of concentration derived from the Rational Method.[32] The impervious coverage was estimated using existing aerial topographic mapping for each watershed along with the land use maps developed for the recently updated NPDES Permit.[33] The initial abstraction was calculated using equation (5):

$$I_a = 0.2\left(\frac{1000}{RI} - 10\right) \tag{5}$$

With the runoff index (*RI*) being equivalent to a weighted curve number (CN). For the Meteorological Model, the Soil Conservation Services (SCS) method was chosen with a Type 1A storm, per the Drainage Manual (Ford 1995).

Output results for HEC-HMS are contained in Appendix B.

4.5 Hydrologic Results

Based on the results of the Rational Method, the peak discharge for the watersheds is presented in Table 3. The peak discharge for the sub-watersheds within each watershed is presented in Table 4.

Table 3 – Watershed Characteristics & Peak Flow Summary (Rational)

WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
		C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
A	185.5	0.19	93	0.88	26.7	31.2	47.1	11
B	98.8	0.27	86	0.92	20.7	24.2	36.6	21
C	11.4	0.25	50	1.22	3.0	3.5	5.3	19
D	29.1	0.18	45	1.27	5.6	6.6	9.9	10
D5[3]	2.7	0.27	16	2.14	1.3	1.6	2.4	22

Notes:
1. For 100-year events, value increased by 25%.
2. Only 25-year event is listed here.
3. Sub-watershed D5 is shown separately since it does not confluence with runoff from Watershed D until flows reach the Gray Basin which is beyond the scope of this Report.

Table 4 – Sub-Watershed Characteristics & Peak Flow Summary (Rational)

WS	Sub WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
			C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
A	A1	40.1	0.12	36	1.43	5.9	6.9	10.4	3
	A2	3.8	0.24	37	1.40	1.1	1.3	1.9	17
	A3	0.7	0.35	8	2.98	0.6	0.7	1.1	32
	A4	63.6	0.12	64	1.07	7.1	8.3	12.6	3
	A5	0.05	0.74	7	3.36	0.1	0.1	0.2	80
	A6	1.6	0.27	9	2.82	1.0	1.2	1.8	21
	A7	3.6	0.25	35	1.45	1.1	1.3	2.0	19
	A8	4.8	0.27	49	1.22	1.4	1.6	2.4	22
	A9	5.5	0.29	15	2.23	3.0	3.5	5.4	24
	A10	3.8	0.29	73	1.00	1.0	1.1	1.7	24
	A11	4.7	0.27	66	1.05	1.1	1.3	2.0	21
	A12	4.6	0.29	72	1.00	1.1	1.3	2.0	24
	A13	4.6	0.30	76	0.98	1.2	1.4	2.0	25
	A14	4.8	0.27	63	1.08	1.2	1.4	2.1	21
	A15	2.9	0.26	74	0.99	0.6	0.7	1.1	21
	A16	0.02	0.10	9	2.92	0.0	0.0	0.0	0
	A17	0.3	0.29	21	1.88	0.1	0.2	0.3	24
	A18	0.2	0.30	28	1.63	0.1	0.1	0.2	26
	A19	3.4	0.29	12	2.50	2.0	2.4	3.6	23
	A20	3.8	0.28	12	2.48	2.2	2.6	4.0	23
	A21	3.7	0.28	13	2.44	2.1	2.5	3.8	22
	A22	3.6	0.29	12	2.46	2.2	2.6	3.9	24
	A23	3.7	0.27	13	2.43	2.1	2.4	3.6	21
	A24	3.8	0.26	15	2.20	1.9	2.2	3.3	20
	A25	2.5	0.31	12	2.54	1.6	1.9	2.9	26

WS	Sub WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
			C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
A	A26	0.1	0.33	11	2.65	0.1	0.1	0.2	29
	A27	0.7	0.10	12	2.51	0.2	0.2	0.3	0
	A28	3.6	0.29	14	2.31	2.0	2.4	3.6	24
	A29	0.8	0.44	13	2.35	0.7	0.8	1.2	42
	A30	3.8	0.26	14	2.33	2.0	2.3	3.5	20
	A31	2.4	0.25	13	2.40	1.3	1.5	2.2	19
	A32	0.1	0.34	31	1.54	0.0	0.0	0.1	29
B	B1	3.2	0.23	19	1.96	1.2	1.5	2.2	16
	B2	2.9	0.28	2	7.01	4.9	5.7	8.6	22
	B3	3.2	0.33	1	9.36	8.2	9.7	14.6	28
	B4	2.7	0.22	9	2.88	1.4	1.7	2.6	15
	B5	3.6	0.32	2	6.70	6.5	7.6	11.5	27
	B6	10.7	0.17	28	1.63	2.5	3.0	4.5	9
	B7	2.7	0.28	1	7.62	4.8	5.7	8.5	22
	B8	5.4	0.29	1	7.21	9.7	11.5	17.3	24
	B9	3.9	0.31	0.3	16.36	17.0	20.1	30.1	27
	B10	1.7	0.41	1	8.94	5.2	6.2	9.3	39
	B11	5.6	0.23	38	1.38	1.5	1.8	2.6	16
	B12	0.8	0.69	10	2.74	1.2	1.4	2.1	73
	B13	3.7	0.22	3	5.12	3.5	4.2	6.3	15
	B14	0.3	0.58	10	2.74	0.5	0.5	0.8	60
	B15	0.03	0.67	7	3.33	0.1	0.1	0.1	71
	B16	3.3	0.21	70	1.02	0.6	0.7	1.1	14
	B17	2.5	0.26	2	5.75	3.2	3.7	5.6	20
	B18	2.2	0.31	37	1.41	0.8	0.9	1.4	26
	B19	3.1	0.29	23	1.8	1.4	1.7	2.5	24

WS	Sub WS	Area (ac)	Parameters			Q Peak (cfs)			% Impervious
			C[1]	Tc (min)	I[2] (in/hr)	10-Yr, 6-Hr	25-Yr, 1-Hr	100-Yr, 24-Hr	
B	B20	3.7	0.30	38	1.38	1.3	1.6	2.4	26
	B21	1.2	0.28	26	1.67	0.5	0.5	0.8	22
	B22	0.9	0.21	1	6.63	1.1	1.3	1.9	13
	B23	0.4	0.54	11	2.56	0.4	0.5	0.7	55
	B24	4.8	0.22	4	4.33	3.9	4.6	6.9	15
	B25	7.9	0.28	18	2.05	3.9	4.6	7.0	23
	B26	1.3	0.25	3	5.23	1.4	1.7	2.5	18
	B27	3.0	0.22	15	2.25	1.3	1.5	2.2	15
	B28	8.6	0.25	4	4.46	8.2	9.6	14.5	19
	B29	1.9	0.35	2	6.62	3.8	4.5	6.7	32
	B30	0.1	0.35	7	3.20	0.1	0.2	0.2	31
	B31	0.7	0.47	22	1.85	0.5	0.6	1.0	46
	B32	0.1	0.48	8	3.14	0.1	0.2	0.2	48
	B33	0.6	0.32	25	1.71	0.3	0.3	0.5	28
	B34	1.8	0.28	42	1.32	0.5	0.6	1.0	22
	B35	0.2	0.35	19	1.97	0.1	0.2	0.2	31
C	C1	6.9	0.26	16	2.12	3.2	3.8	5.7	20
	C2	4.5	0.24	49	1.22	1.1	1.3	2.0	17
D	D1	20.2	0.13	38	1.39	3.2	3.7	5.6	4
	D2	2.8	0.27	7	3.22	2.1	2.5	3.7	22
	D3	1.4	0.32	8	2.99	1.1	1.3	2.0	27
	D4	4.7	0.27	9	2.88	3.2	3.7	5.6	22
	D5	See Table 3							

Notes:

1. For 100-year events, value increased by 25%.
2. Only 25-year event listed here.

Based on the results of the HEC-HMS model, the peak discharge and volumes for the 25-year, 1-hour storm for the watersheds are presented in Table 5.

Table 5 – Watershed Peak Flow Summary [25-yr, 1-hr] (Unit Hydrograph)

WS	Area (acres)	Area (sq mi)	Q Peak (cfs)	Volume (ac-ft)	Volume (ft^3)
A	185.5	0.2898125	16.95	1.9194	83,609
B	98.8	0.1543438	17.70	1.8823	81,993
C	11.4	0.0178281	2.72	0.1989	8,664
D	31.8	0.0496966	4.72	0.3255	14,179

Exhibit 1 of Appendix B depicts the locations of five infiltrating sediment basins within the Project area. Three basins are located within Watershed A, one within Watershed B, and one within the Upper Area Watershed. Table 6 presents the results of the HEC-HMS model peak discharge and volumes for the 25-year, 1-hour storm at the basins in Watersheds A and B.

Table 6 – Infiltration Basin Peak Flow Summary [25-yr, 1-hr] (Unit Hydrograph)

Basin	Tributary Sub-WS	Area (acres)	Area (sq mi)	Q Peak (cfs)	Volume (ac-ft)	Volume (ft^3)
BASIN 13	B1-B28	93.3	0.1458281	16.54	1.7306	75,385
BASIN 14	A1-A18	149.7	0.2338750	11.69	1.1881	51,754
BASIN 15	A19-A26	24.4	0.0381719	10.41	0.5076	22,111
BASIN 16	A28-A32	10.7	0.0166406	3.97	0.2230	9,714

The peak discharge based on the Rational Method is greater than the results from the HEC-HMS model. The differences can be attributed to the different parameters required for the calculations. For watersheds less than 100 acres, Transportation utilizes the Rational Method results for analyzing existing and proposed storm drain systems. The Unit Hydrograph modeling provides the runoff volumes required for confirming compliance with permitting requirements and analyzing existing and proposed infiltration/detention systems.

4.6 Hydrologic Validation

Hydrologic validation will be performed once the selection of the alternative has been finalized.

5.0 Hydraulics Summary

The intent of the hydraulic analysis is to confirm whether the existing storm drain systems are adequate for conveyance of the calculated runoff, whether inlet conditions accommodate that runoff, and to evaluate erosion conditions within the Project area. There are solid wall and perforated pipes, channels, CMP and rectangular concrete drainage inlets, storm drain manholes, and infiltrating sediment basins throughout the Project area (Exhibits 1 and 2, Appendix B). These facilities were installed as subdivision infrastructure or as part of erosion control projects constructed in 1987 and 2014. This analysis will be limited to only those systems in the areas of work shown on Alternative 1, as discussed in Sections 8 and 9.

5.1 Pipe Characteristics

The pipe systems within the Project's areas of interest (Figure 1) are comprised of 12", 18", 24", and 36" diameter CMP and 21"x15" and 28"x20" arch CMP. The pipes were installed during subdivision development or as part of the 1987 Storm Drain Erosion Control and Street Improvement Program for County Service Area No. 5 Project. The Manning's roughness coefficient (n) of the CMP was estimated to be 0.024.[34]

5.2 Shoulder Characteristics

Drainage along the existing road shoulders is conveyed by AC dike, AC swale, dirt swale, or sheet flow. Evidence of erosion along the shoulders is apparent on Antelope Way, Placer Street, and the west end of Alder Street. Elsewhere, erosion along the shoulders is minimal and sources of sedimentation are typically unpaved driveways and roadside parking.

5.3 Hydraulic Methods

For circular pipes, the full capacity of the pipe was calculated using the Manning's equation which is presented as equation 5:[35]

$$Q = 0.463 \cdot \frac{D^{8/3} \cdot S_f{}^{1/2}}{n} \tag{5}$$

Where Q is discharge in cubic feet per second, D is pipe diameter in feet, S_f is slope of the energy grade line in feet/feet, and n is Manning's roughness coefficient. For arch CMP, the equation was used for the equivalent circular pipe size. The hydraulic capacity of the existing pipes was compared to the results of the hydrologic analysis for the design storm.

5.4 Hydraulic Results

Based on the Rational Method results, most of the pipes within the Project area were found to be sized correctly for the 25-year, 1-hour event. Table 7 contains a summary of the existing pipes, inflows, and capacities in the areas of anticipated work. A complete list can be found in the hydraulics section of Appendix B.

Table 7 – Existing Pipe Characteristics [25-yr, 1-hr] (Rational)

WS & Pipe ID	Pipe Size & Material	Inlet / Outlet Facility	Q Capacity (cfs)	Q 25-yr, 1-hr (cfs)	% Capacity
A 438	18" CMP	CMP I / SDMH	4.1	0.1	3
A 439	18" CMP	CMP I / SDMH	6.0	1.2	20
A 441	18" CMP	CMP I / SDMH	7.8	1.3	17
A 2801	18" CMP	CMP I / PIPE 444	4.2	5.1	123
A 2802	18" CMP	CMP I / PIPE 445	6.9	5.4	78

WS & Pipe ID	Pipe Size & Material	Inlet / Outlet Facility	Q Capacity (cfs)	Q 25-yr, 1-hr (cfs)	% Capacity
B 1656	24" CMP	CMP I / CHANNEL	11.9	22.7	190
C 471	18" CMP	CMP I / CMP I	6.2	3.8	62
D 2934	18" CMP	CHANNEL / CHANNEL	16.2	3.7	23
D 2936	18" CMP	CHANNEL / UNKNOWN	14.8	4.9	33
D 381	18" CMP	CHANNEL / CMP I	8.9	6.6	74
UA 482	18" P CMP	PIPE 481 / CMP I	7.0	3.2	46
UA 1660	30" CMP	CMP I / SDMH	73.2	7.9	11
UA 1683	42"x29" CMP	SDMH / SDMH	63.1	11.4	18

In the areas of anticipated work, there are two locations where runoff exceeds the capacities of the pipes. Reasons for this being reflected in these calculations could be attributed to different design criteria such as Rational Method peak discharge being greater than HEC-HMS or the design may have been based on a 10-year, 6-hour event which would be a valid approach with the tributary watershed areas being less than 100 acres. Another consideration is the existing systems were designed for infiltration and detention, which Transportation is not accounting for in this analysis. During development of the Design Report, Transportation will conduct a more thorough analysis for those specific areas of work included in the preferred alternative.

6.0 Storm Water Quality and Loading Summary

6.1 Water Quality Monitoring Plan

Transportation has developed a Water Quality Monitoring Plan for the Project area which includes visual and photographic documentation of storm water runoff before and after construction of this erosion control project. In addition, the Water Quality Monitoring Plan outlines methods which will be utilized to record the peak flow, and volume and water quality characteristics of runoff near the outfalls of each watershed (Figure 14). The pre-construction and post-construction results will be analyzed on an annual basis with technical memos summarizing monitored storm events.

The primary goal of the monitoring plan is to quantify the existing sediment load and determine the hydrologic reduction in runoff peak flows and volume of runoff to Lake Tahoe based on the water quality loading benefits of this erosion control project. The monitoring results will be used to calibrate and validate technical watershed models and pollutant reduction and treatment analyses. The current specific water quality effluent objectives for runoff from the Project area after construction are based on TRPA and Lahontan water quality limits as presented in Table 8.[36] One of the goals of this Project is to meet these water quality limits by providing source control, hydrologic design, and treatment BMPs within the Project area for the 25-year 1-hour runoff event.

LEGEND

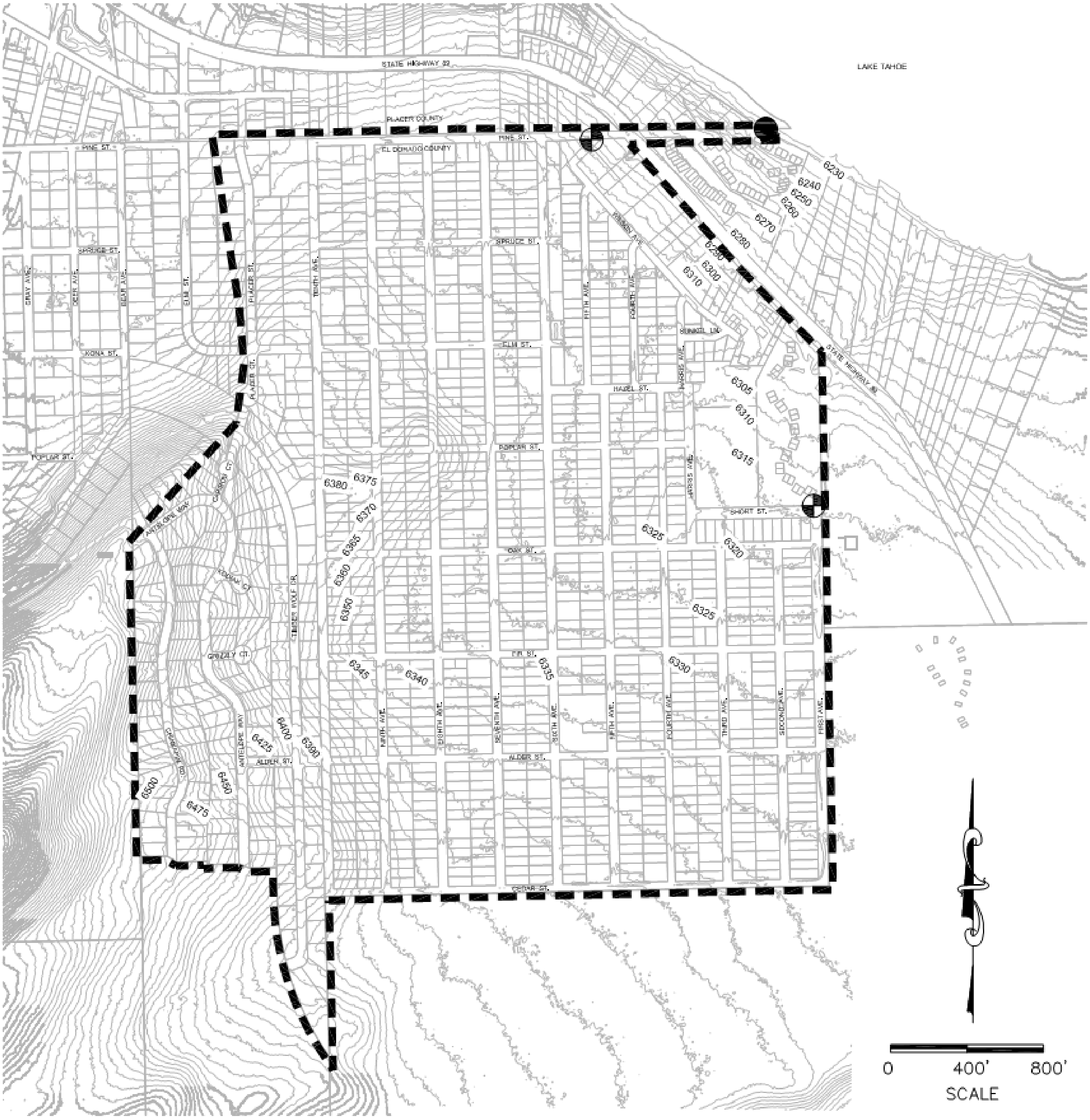
PARCEL BOUNDARY, COUNTY, OR CALTRANS RIGHT-OF-WAY

PROJECT AREA

6225 CONTOUR WITH ELEVATION

PRESSURE TRANSDUCER (TRANSPORTATION)

● AUTOSAMPLER (IMP)



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

STORM WATER MONITORING LOCATIONS

FIGURE
14

DATE: 10/2015
PROJECT NO.: 95157
BY: ALD

Table 8 – TRPA and Lahontan Water Quality Limits

Constituent	Surface Waters		Infiltration Systems	
	Lahontan	TRPA	Lahontan	TRPA
Total Nitrogen as N	0.5 mg/l		5 mg/l	
Dissolved Nitrogen as N		0.5 mg/l		5 mg/l
Total Phosphate as P	0.1 mg/l		1 mg/l	
Dissolved Phosphate as P		0.1 mg/l		1 mg/l
Total Iron	0.5 mg/l		4 mg/l	
Dissolved Iron		0.5 mg/l		4 mg/l
Turbidity	20 NTU		200 NTU	
Suspended Sediment		250 mg/l		
Grease & Oil	2 mg/l	2 mg/l	40 mg/l	40 mg/l

6.2 Storm Water Loading Summaries

6.2.1 Modeling Results

Load analysis from this Project was estimated using a model (PLRM) developed by NHC.[37] The PLRM utilizes a model to estimate average annual pollutant loads from the individual Project watersheds based on the following factors: watershed size, slope, land uses, road condition, shoulder condition, estimated connectivity of the roadway section, roadway maintenance practices, and number of private BMP's installed. A PLRM analysis was completed on each of the 5 main watersheds (A, B, C, D, UA) (Table 9).

Table 9 – Annual Pollutant Load (PLRM) – Existing Condition

WS	Area (acres)	Volume (Acre-Ft / Year)	TSS[1] (lbs/yr)	FSP[1] (lbs/yr)	TP[1] (lbs/yr)	TN[1] (lbs/yr)
A	185.645	25.7	17065	10736	43	168
B	98.865	24.7	12319	6799	35	156
UA	49.773	15.7	12045	7458	28	110
C	11.424	1.9	845	484	3	11
D	31.834	3.6	3091	1800	7	27
TOTAL	**377.541**	**71.6**	**45365**	**27277**	**116**	**472**

1. Based on Characteristic Runoff Concentrations as a funtion of land use.

A detailed analysis of the estimated average annual pollutant load will be completed as part of the Design Report.

6.2.2 Sampling Results

The Implementers Monitoring Program (IMP) was developed jointly by the California and Nevada implementing jurisdictions in order to collectively fulfill the National Pollutant Discharge Elimination System (NPDES) Permit requirements.[38] The IMP is a partnership between the Tahoe Resource Conservation District, El Dorado County, Placer County, the City of South Lake Tahoe, Douglas County, Washoe County, the Nevada Tahoe Conservation District, NDOT, and Caltrans. The Tahoe Resource Conservation District is the lead in working on behalf of the local jurisdictions to implement coordinated monitoring. The IMP has established multiple monitoring sites around Lake Tahoe to monitor either outfalls or BMP effectiveness. One of the sites selected is the 36” outfall pipe at the end of the condominium access road (referred to in the IMP as the Tahoma pipe).

Beginning in January 2014, as part of the IMP, storm water samples have been collected from the Tahoma pipe. During the 2014 water year measured turbidities were in the range of 1,500 to 2,500 NTU for Fall/Winter events and 400 to 700 NTU for Spring events. It was hypothesized that the increase in Fall/Winter was due to the presence of road sands.[39] The results recorded at this site will be used for to complete a pre-project/post-project project improvement effectiveness analysis.

7.0 Existing Conditions Problem Summary

Most of the terrain is gently sloping to the northeast toward Highway 89 with steeper slopes on the western edge of the Project boundary. Roads in the steeper locations were graded with steep cut and fill slopes.

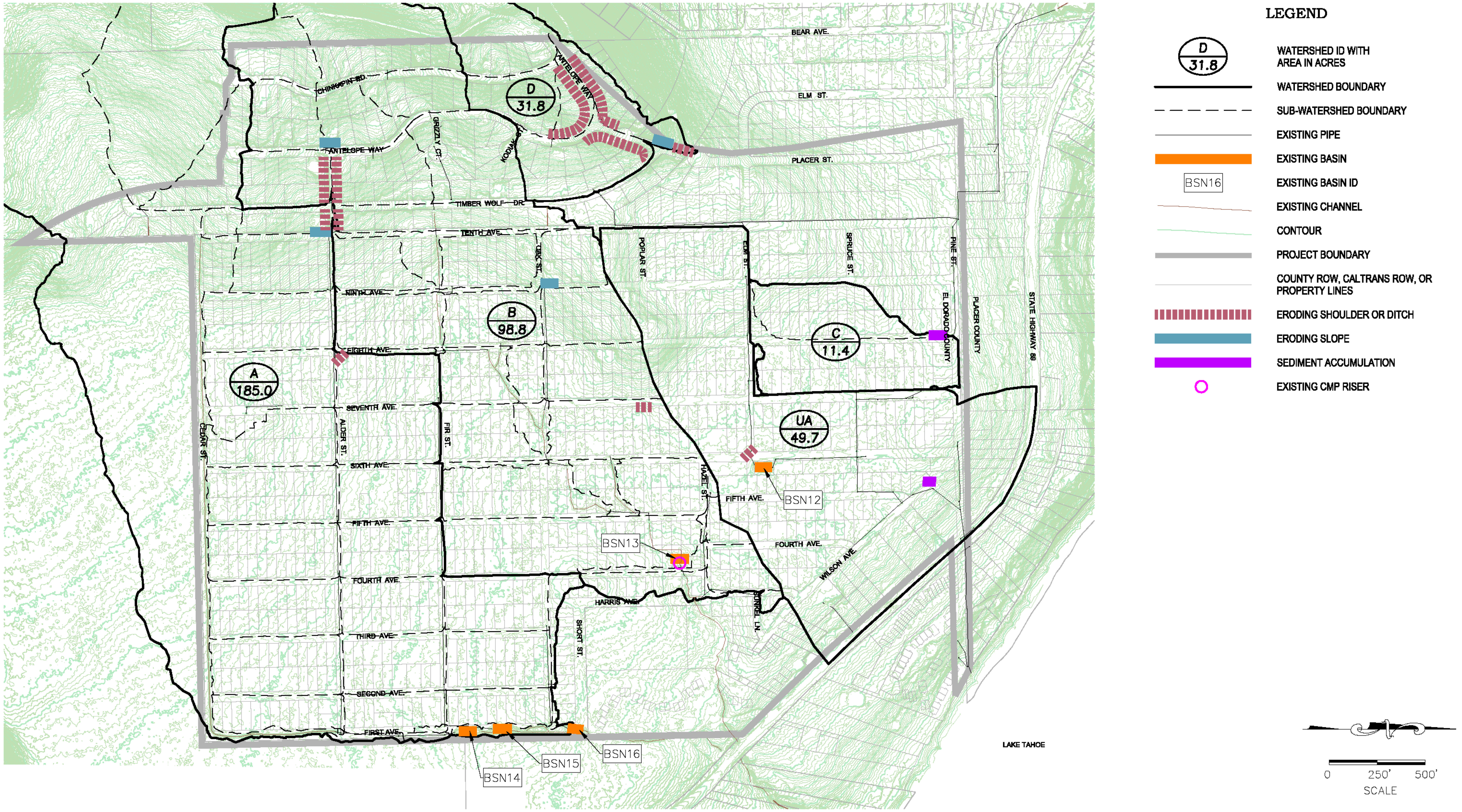
The existing erosion control and water quality measures within the Project boundary primarily consist of AC dike, AC swales, roadside ditches, revegetation, solid wall and perforated pipes, rock bowls at CMP inlets, rock-lined channels, and infiltrating sediment basins. With the construction of the 1987 and 2014 projects, infiltration of urbanized runoff has been increased and most of the Project area has been stabilized. This Project is intended to stabilize any remaining locations exhibiting erosion and add more infiltrating elements prior to runoff reaching Lake Tahoe.

7.1 Problem Areas, Opportunities, and Constraints

The problem areas depicted on Figure 15 are typical of older residential subdivisions within the Tahoe Basin. Eroding cut slopes and roadside ditches, unpaved driveways and vehicle parking on the dirt road shoulders are main contributors to sediment deposition. Photographic documentation of general problems found in the subdivision is included in Appendix C.

7.1.1 Eroding Road Shoulders

PROBLEM: The road shoulders along the north and northwest portions of Antelope Way and the southern portion of Placer Street are moderately to severely eroded. The road slope along Antelope Way between Chinkapin Road and Placer Street varies from approximately 9% to 14%. The road slope of Placer Street between Antelope Way and Timber Wolf is approximately 13.5%. A dirt access road above the subdivision conveys concentrated flow toward Antelope Way. The volume of runoff and the steepness of the roadways have created erosive conditions. A portion of the runoff flowing down Antelope



COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

PROBLEM AREA MAP

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FIGURE

15

Way is conveyed south to a pipe crossing Antelope Way then east toward a storm drain pipe at Timber Wolf Drive. The remainder of the runoff flows east over the slope at the Antelope Way/Placer Street intersection or is conveyed north along Placer Street. There are no existing facilities with sediment trapping capabilities in these areas.

A portion of Alder Street has severely eroding road shoulders. The runoff volume is small; however, the steepness of the roadway increases velocities to the degree that erosion is occurring. The road slope between Antelope Way and Timber Wolf Drive is approximately 8%. The road slope between Timber Wolf Drive and Tenth Avenue is approximately 12.5%. Runoff from a portion of Antelope Way is conveyed via pipe and roadside ditch to Alder Street. This runoff is then conveyed via AC ditch and pipe under Timber Wolf Drive to the channels north of this intersection. There are no existing facilities with sediment trapping capabilities near this location. Runoff from a portion of Timber Wolf Drive is conveyed via roadside ditch to Alder Street. The existing facilities downslope of this location have no sediment trapping capabilities and the material transported reduces the overall effectiveness of the infiltrating storm drain system.

At the intersections of Poplar Street and Seventh Avenue and Elm Street and Sixth Avenue, the road shoulders and roadside ditches are eroding. There are no existing facilities with sediment trapping capabilities at these locations. However, at Poplar Street and Seventh Avenue, runoff flows toward an unpaved section of Poplar Street and at Elm Street and Sixth Avenue, runoff is conveyed to an adjacent basin.

At the corner of Alder Street and Eighth Avenue, it appears the radius of the asphalt curve return at the northeast corner is too small, causing vehicle to drive partially on the shoulder when turning north onto Eighth Avenue. This has caused the shoulder material to loosen and erode over time.

OPPORTUNITY: For the steep portions of Antelope Way and Placer Street, there is opportunity for source control, improved hydraulic conveyance, and treatment for this problem. All three can be accomplished with the construction of AC dike or armored channels and installing infiltrating CMP inlets with sediment trapping capabilities.

For the steep portions of Alder Street, there is opportunity for source control, improved hydraulic conveyance, and treatment for this problem. All three can be accomplished with the construction of AC dike or armored channels along Alder Street and replacing the existing CMP inlets with infiltrating inlets that have sediment trapping capabilities.

For the intersections of Poplar Street and Seventh Avenue and Elm Street and Sixth Avenue, source control and improved hydraulic conveyance can be achieved through the construction of AC dike, AC swale, or a channel stabilizing treatment such as a grass-lined swale. For Poplar Street, treatment can be accomplished by redirecting flows through the unpaved portion of Poplar Street for infiltration.

For the corner of Alder Street and Eighth Avenue, source control in the form of additional pavement would stabilize this location.

CONSTRAINT: Determining the location of the paved roadway relative to the County's rights-of-way and whether dike, swales, or channels can be installed while maintaining a standard road width needs to be confirmed. Subsurface conflicts, such as existing utilities, may impact installation of the sediment trapping facilities. At the Antelope Way/Placer Street location, an easement from the CTC may be required.

7.1.2 Eroding Slopes

PROBLEM: At the intersections of Placer Street and Timber Wolf Drive, Antelope Way and Alder Street, Alder Street and Tenth Avenue, and Oak Street and Tenth Avenue, there are areas of eroding cut slopes. At two of these locations, the eroding slopes are just above CMP inlets.

OPPORTUNITY: The solution to this problem is through source control. By installing rock slope protection or planting suitable vegetation, soil erosion can be greatly minimized and, in some cases, eliminated.

CONSTRAINT: The location of the eroding slopes relative to the County's rights-of-way needs to be determined. If the slope is beyond the right-of-way, an easement would be required. Another constraint is that not all locations are suitable for vegetation and rock can be considered by some to be aesthetically unappealing. Soil conditions, slope steepness, and intense sun exposure are non-conducive to establishing vegetation. Cost can also be a constraint when choosing a material for slope stabilization.

7.1.3 Sedimentation of Roadside Ditches

PROBLEM: Throughout the subdivision, roadside ditches convey runoff from the paved roads. Most of these ditches are stable, either by proper compaction or vegetation. However, a few locations exhibit sedimentation and ponding possibly caused by disturbance from vehicles parking on the dirt shoulders. At Wilson Avenue near Pine Street, the 1987 improvement plans show a previously existing 36" CMP inlet with pipes, but this inlet is not visible on the surface and the plans do not mention if it was removed or abandoned. Parking on the dirt shoulder at this location has created ponding and tracking of mud and dirt onto the roadway.

OPPORTUNITY: The solution to this problem is through source control and improved hydraulic conveyance. By reestablishing a flowpath and compacting the shoulder or revegetating, the areas can be stabilized. With the ponding at Wilson Avenue, reestablishing a drainage inlet in addition to inhibiting parking may be warranted.

CONSTRAINT: If the source of sedimentation is beyond the County's rights-of-way, an easement would be required. Measures for preventing vehicle parking in dirt shoulders in established subdivisions are often unpopular with residents.

7.1.4 Aging Infrastructure

PROBLEM: Infiltrating systems lose effectiveness over time due to sedimentation and other factors. The storm drain system from 1987 included perforated CMP for the infiltration of urban runoff and to reduce the volume of runoff discharging into Lake Tahoe. The service life of CMP is approximately 50 years. After almost 30 years of service there are no indications that the pipes are not adequately conveying the runoff; however, it can be assumed that the infiltrating capacities have been reduced.

Basin and channel infiltration can become impaired over time through soil compaction, sediment accumulation, and excessive vegetative matting. The riser in the basin on Fourth Avenue is rusted and no longer plumb.

OPPORTUNITY: There is opportunity for improved hydraulic conveyance and increasing treatment for this problem. This can be accomplished by replacing CMP inlets with infiltrating inlets that have sediment trapping capabilities and replacing the infiltrating CMP system with a smooth wall HDPE pipe system. Installation of infiltration galleries on Elm Street and the condominium access road on the east side of Highway 89 would augment the existing system with increased treatment prior to stormwater discharging into Lake Tahoe.

To reestablish maximum infiltration in the basins and channels, clearing of sediment and debris and scarifying to loosen the soil would be performed. Any rock lining the channels would be restored, disturbed areas revegetated and, if applicable, blanket placed for stabilization of the seeded areas. The riser in the basin on Fourth Avenue should be replaced to ensure a secure connection with the outlet pipe.

CONSTRAINT: Replacement of the inlets and infiltrating pipe system would increase land disturbance and may be cost prohibitive. Subsurface conflicts, such as existing utilities, may impact installation of the CMP inlets. Existing utilities and the locations of the existing storm drain pipes may impact the size and placement of the infiltration galleries. At the Elm Street location, an easement from the CTC may be required. Within the condominium access road, there is a drainage easement in place. However, the location of the storm drain pipe relative to the easement needs to be determined and, based on that determination, an additional easement from the Homeowners Association may be required as well as temporary construction/access easements.

7.2 Summarization of Opportunities and Constraints

Table 10 summarizes the opportunities and constraints for each of the problem areas discussed in Section 7.

Table 10 – Summary of Opportunities and Constraints

Problem	Opportunity	Constraint	PDA Category
Eroding road shoulder, lack of infiltration and sediment retention.	Stabilize shoulder with dike, swale, channel, or AC pavement; replace inlets with infiltrating inlets with sumps.	Location of road in relation to right-of-way, subsurface conflicts.	SC, HD, T
Eroding slopes	Stabilize sediment sources with rock or vegetation.	Location of slopes in relation to right-of-way, easements, material aesthetically unappealing, capitol cost.	SC
Sedimentation of roadside ditches	Stabilize sediment sources, improve drainage, inhibit parking.	Location of work in relation to right-of-way, easements.	SC, HD
Aging infrastructure	Replace existing system; increase sediment capture, hydraulic capacity, and infiltration.	Subsurface conflicts, increased land disturbance, easements, capital costs.	HD, T

8.0 Formulating Alternatives

In order to satisfy the goals of the Project, three alternatives were formulated to mitigate specific erosion and storm water runoff water quality problems within the Project area. A fourth "do nothing" alternative does not satisfy the Project goals or objectives and is therefore not a viable alternative for consideration.

The alternatives were developed using the BMP categories of source control, hydrologic design, and treatment of runoff. Many BMPs satisfy more than one category. Appendix D contains detailed BMP toolbox sheets for each specific facility and treatment proposed.

Important design considerations in formulating alternatives were ROW constraints, capital costs of the proposed improvements, relative cost vs effectiveness of the proposed improvements, and the relatively high cost of easement acquisition on private property. Suitable BMPs chosen for consideration for the Project alternatives include:

Revegetation

Revegetation is a proven source control mitigation measure. In order for revegetation to be successful as a soil stabilization BMP, the characteristics of the application need to be tailored to the specific conditions of each site. These characteristics should include selection of a soil stabilization material and developing an appropriate plan for the growth of vegetation. Revegetation alone is not expected to be successful for all areas of bare soil. This is primarily due to the dryness of some sites, granitic characteristics of the soil, and the depth to groundwater.

Channels and Swales

Hard armored channels and vegetated swales have been constructed on numerous erosion control projects. Rock-lined channels are a proven source control, hydrologic design, and treatment alternative for conveying and treating runoff. The suspended sediments settle into the voids between the rock and runoff is infiltrated into the in situ soils beneath the channel.

When located in the correct environment, seed and blanket channels and grass-lined swales are a proven source control, hydrologic design, and treatment alternative for conveying runoff, stabilizing roadside ditches, and treating runoff. Once established, suspended sediments are stabilized within the root system and runoff is infiltrated into the in situ soils beneath the channel. Seed and blanket-lined channels and grass-lined swales have been constructed on numerous erosion control projects with varying degrees of success, primarily due to location.

AC Dike and AC Swales

AC dike and AC swales are successful source control mitigation alternatives which have been used on similar erosion control projects. The costs, benefits, and limitations have been established and demonstrated on past projects. This alternative is successful in stabilizing bare shoulders, eroding shoulders, and roadside ditches and reduces the mobilization of sediment from roadside shoulders. AC dike and AC swales can potentially increase connectivity of impervious surface area; increasing runoff volumes and peak flow.

Asphalt Concrete (AC) Pavement

AC pavement is a proven technique for stabilizing bare soil and has successfully been implemented on past erosion control projects. AC pavement can be either permeable or impermeable. Permeable pavement meets the criteria for source control, hydrologic design, and treatment BMP in that it is very effective in stabilizing dirt surfaces, can be used to redirect flow, and is effective in decreasing runoff peak flow and volume; however, it is best suited for grades of 2 percent or flatter. Impermeable pavement meets the criteria for source control and hydrologic design BMP in that it is very effective in stabilizing dirt surfaces and can be used to redirect flow; however, runoff peak flow and volume is increased.

Drainage Inlets and CMP Inlets

A drainage inlet is primarily a hydrologic design BMP as is typically used to convey runoff from a paved surface into a pipe. A CMP inlet functions in the same manner except that runoff is often from off-road conveyance as well as paved surfaces. When constructed with infiltration and sediment capture capabilities, these facilities meets the criteria for treatment BMP with the reduction of suspended sediment through retention, the reduction of runoff volume through infiltration, and treatment of runoff through infiltration. Reduction of suspended sediment and the reduction in peak flow is dependent on the infiltration rate of the in situ soils, the runoff volume, and the volume of infiltration storage. The distance from the bottom of the infiltrating facility to groundwater and the rate of infiltration of the in situ soils is a factor in determining whether or not a proposed drainage inlet can be used for infiltration.

Pipe

Pipe meets the criteria for hydrologic design BMP through conveyance. Pipe can also meet the criteria for source control in areas where runoff has exceeded the capacity of the roadside conveyance and erosion or incising has occurred.

Perforated Pipe

Perforated pipe meets the criteria for hydrologic design and treatment BMP through conveyance and the reduction of suspended sediment, the reduction of runoff volume through infiltration, and treatment of runoff through infiltration. Perforated pipe can also meet the criteria for source control in areas where runoff has exceeded the capacity of the roadside conveyance and erosion or incising has occurred. Perforated pipes installed under an infiltrating facility can intercept and convey flow to down slope facilities for further treatment. Reduction of suspended sediment and peak flow and the treatment of runoff is dependent on the infiltration rate of the in situ soils and the runoff volume. The distance from the bottom of the perforated pipe to groundwater and the rate of infiltration of the in situ soils is a factor in determining suitable locations for this BMP.

Infiltration System

Infiltration systems, or galleries, meet the criteria for a treatment BMP through the reduction of suspended sediment, the reduction of runoff volume through infiltration, and treatment of runoff through infiltration. Reduction of suspended sediment, peak flow, and the treatment of runoff is dependent on the infiltration rate of the in situ soils and the runoff volume. The distance from the bottom of the perforated pipe to groundwater and the rate of infiltration of the in situ soils are factors in determining suitable locations for this BMP.

Rock Slope Protection

Rock slope protection is a successful source control mitigation alternative which has been used extensively in prior erosion control projects in the Tahoe Basin. The costs, benefits, and limitations have been established and demonstrated on past projects. This alternative has a long design life, is resilient to snow removal activities, and is successful in stabilizing eroding slopes.

8.1 Alternatives

The three alternatives formulated to address the erosion, hydrologic, and treatment deficiencies with the Project area are described below.

Alternative 1

Figure 16 depicts the facilities and treatments proposed for Alternative 1. Conditions requiring source control include eroding roadside ditches, eroding slopes, and areas of sediment deposition.

An armored channel is proposed for the eroding roadside ditches along Antelope Way and Placer Street. Runoff will be conveyed south, along Antelope Way, to the nearest pipe crossing. At the Antelope Way/Placer Street intersection, an armored channel with AC dike will stabilize the eroding roadside ditch and direct flows over a slope to a rock dissipator on a CTC parcel. Along Placer Street, runoff will be conveyed in an armored channel to Timber Wolf Drive on the east side of the street and a CMP inlet on the west side. If site conditions warrant, AC dike or AC swale would be proposed as an alternative to the armored channels.

AC dike is proposed for the eroding roadside ditches along both sides of Alder Street. Runoff will be conveyed along the dike to the pipe crossing at the intersection of Alder Street and Timber Wolf Drive or to CMP inlets at the intersection of Alder Street and Tenth Avenue. If site conditions warrant, an armored channel would be proposed as an alternative to the AC dike. For the eroding shoulder and roadside ditch at the corner of Elm Street and Sixth Avenue, minor regrading to restore the flowpath is proposed with a vegetated channel to direct runoff from the roadside ditches to the CMP inlet.

AC dike or AC swale is proposed for stabilizing the eroding roadside ditch along Seventh Avenue at Poplar Street. CMP inlets on Poplar Street will intercept surface runoff currently impacting Seventh Avenue and will redirect this runoff, via pipe, to the undeveloped portion of Poplar Street for infiltration within the County ROW.

Rock slope protection is proposed for stabilizing the eroding slopes at Placer Street and Timber Wolf Drive, Antelope Way and Alder Street, Alder Street and Tenth Avenue, and Oak Street and Tenth Avenue; however, revegetation will be considered if site conditions will allow vegetation growth.

For the disturbed shoulder at the intersection of Alder Street and Eighth Avenue, reconfiguring the radius and repaving the AC curve return would stabilize the road shoulder and provide a paved surface for vehicle traffic.

Sediment deposition within the roadside ditches is evident at the north end of Eighth Avenue and on Wilson Avenue near Pine Street. Minor regrading and seeding is proposed at the north end of Eighth Avenue. A pipe will be installed to convey runoff from the restored roadside ditch into the storm drain system in Pine Street. At Wilson Avenue, a drainage inlet with treatment capabilities and a parking barrier, such as a 6” vertical curb, are proposed.

Sediment capture and treatment of storm water on Chinkapin Road, Antelope Way, Placer Street, and Timber Wolf Drive will be achieved by installing CMP inlets with infiltrating and sediment trapping capabilities at select locations. Sediment capture and treatment of storm water along the existing storm drain systems east of Timber Wolf Drive will be achieved by replacing existing CMP inlets at select locations with infiltrating inlets that have sediment trapping capabilities.

To increase and/or restore infiltration for five infiltrating sediment basins, revegetation is proposed. This work includes clearing sediment and debris from within the basins and scarifying the soil. Following seed placement, a blanket will be staked over the seeded areas. The CMP riser in the basin on Fourth Avenue will be replaced to ensure a secure connection with the outlet pipe. For the basin on Sixth Avenue, an access road that allows for vegetative growth will be established on the south side of the basin and a gate installed in the existing fence for walk-in basin access. For basins that appear to capture a fair amount of sediment, rock will be installed in the basin bottom in place of the seed and blanket in order to provide a surface that is compatible to more frequent maintenance activities.

To maximize treatment of stormwater before discharging into the lake, infiltration systems or galleries are proposed on Elm Street and the condominium access road, east of Highway 89. On Elm Street, the system will be in the road shoulder or within an adjacent CTC parcel. It will receive runoff from 9.3 acres of the Upper Area Watershed. The system located in the condominium access road will be within an existing drainage easement and will receive runoff from all of the Upper Area Watershed (49.7 acres) and a portion of Highway 89. If it is determined that the easement on the condominium access road will not accommodate an infiltration system, Pine Street, within the County ROW between Wilson Avenue and Highway 89, will be considered for an alternate location.

Alternative 2

Figure 17 depicts the facilities and treatments proposed for Alternative 2. Conditions requiring source control include eroding roadside ditches, eroding slopes, and areas of sediment deposition. AC dike is proposed for the eroding roadside ditches along both sides of Alder Street. Runoff will be conveyed along the dike to the pipe crossing at the intersection of Alder Street and Timber Wolf Drive or to CMP inlets at the intersection of Alder Street and Tenth Avenue. If site conditions warrant, an armored channel would be proposed as an alternative to the AC dike. For the eroding roadside ditch at the corner of Elm Street and Sixth Avenue, minor regrading to restore the flowpath is proposed. A vegetated channel will be constructed to direct runoff from the roadside ditches to the CMP inlet.

Rock slope protection is proposed for stabilizing eroding slopes at Alder Street and Tenth Avenue and Oak Street and Tenth Avenue; however, revegetation will be considered if site conditions will allow for vegetation growth.

For the disturbed shoulder at the intersection of Alder Street and Eighth Avenue, reconfiguring the radius and repaving the AC curve return would stabilize the road shoulder and provide a paved surface for vehicle traffic.

Sediment deposition within the roadside ditches is evident at the north end of Eighth Avenue and on Wilson Avenue near Pine Street. Minor regrading and seeding is proposed at the north end of Eighth Avenue. A pipe will be installed to convey runoff from the restored roadside ditch into the storm drain system in Pine Street. At Wilson Avenue, a drainage inlet with treatment capabilities and a parking barrier, such as a 6” vertical curb, are proposed.

Sediment capture and treatment of storm water will be increased by replacing the existing CMP inlets with infiltrating inlets that have sediment trapping capabilities and by upgrading the perforated CMP systems with smooth wall perforated HPDE along Alder, Fir, and Elm Streets.

To increase and/or restore infiltration for five infiltrating sediment basins, revegetation is proposed. This work includes clearing sediment and debris from within the basins and scarifying the soil. Following seed placement, a blanket will be staked over the seeded areas. The CMP riser in the basin on Fourth Avenue will be replaced to ensure a secure connection with the outlet pipe. For the basin on Sixth Avenue, an access road that allows for vegetative growth will be established on the south side of the basin and a gate installed in the existing fence for walk-in basin access. For basins that appear to capture a fair amount of sediment, rock will be installed in the basin bottom in place of the seed and blanket in order to provide a surface that is compatible to more frequent maintenance activities. To maximize infiltration within the channel system through Watershed B, clearing of sediment and debris and scarifying to loosen the soil would be performed. Any rock lining the channels would be restored, sod salvaged and transplanted, disturbed areas revegetated and, if applicable, blanket placed for stabilization of seeded areas.

To maximize treatment of stormwater before discharging into the lake, an infiltration system or gallery is proposed on the condominium access road, east of Highway 89. The system in the condominium access road will be within an existing drainage easement and will receive runoff from all of the Upper Area Watershed (49.7 acres) and a portion of Highway 89. If it is determined that the easement on the condominium access road will not accommodate an infiltration system, Pine Street, within the County ROW between Wilson Avenue and Highway 89, will be considered for an alternate location.

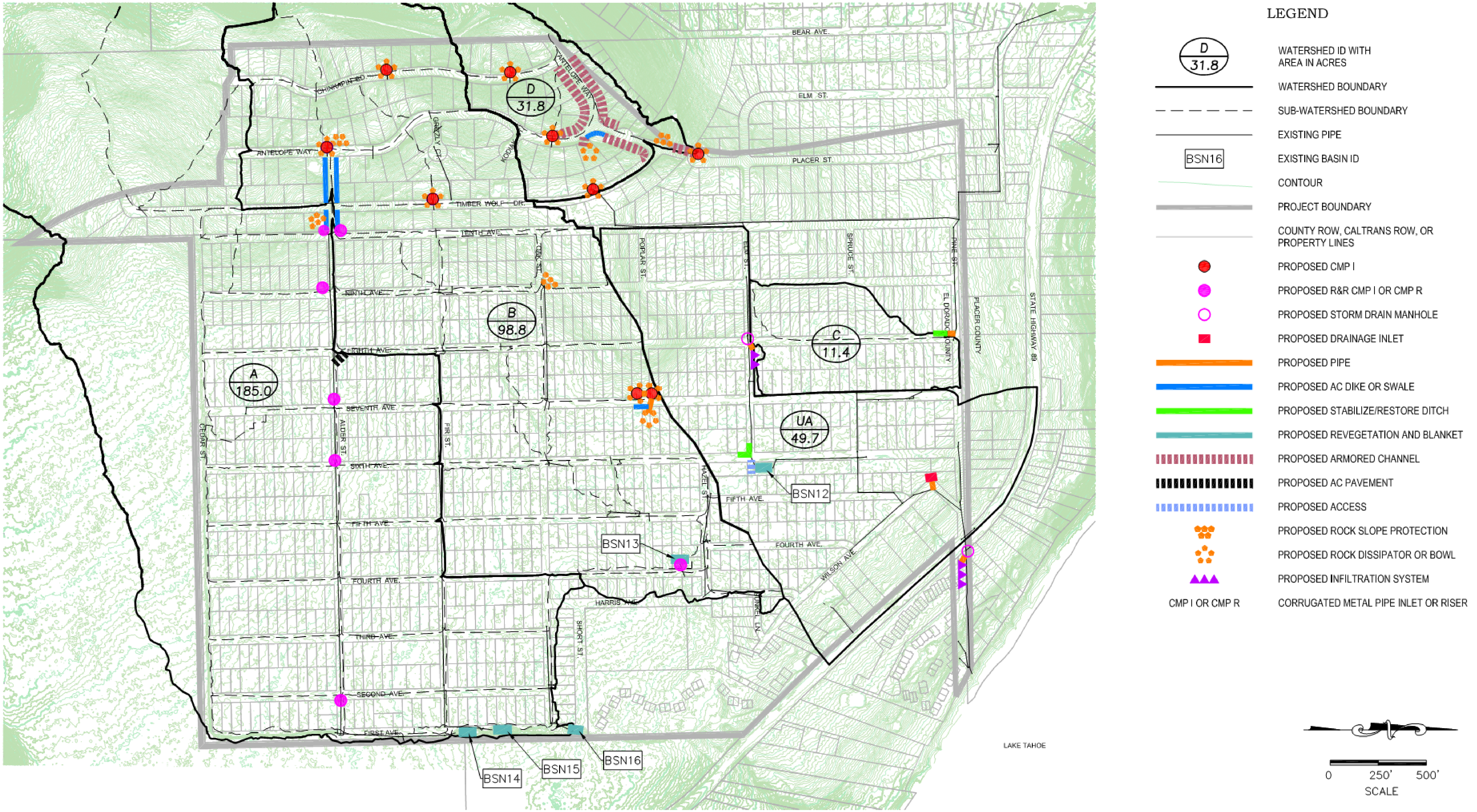
Alternative 3

Figure 18 depicts the facilities and treatments proposed for Alternative 3. Conditions requiring source control include eroding roadside ditches, eroding slopes, and areas of sediment deposition. AC dike is proposed for the eroding roadside ditches along both sides of Alder Street. Runoff will be conveyed along the dike to the pipe crossing at the intersection of Alder Street and Timber Wolf Drive or to CMP inlets at the intersection of Alder Street and Tenth Avenue. If site conditions warrant, an armored channel would be proposed as an alternative to the AC dike. For the eroding roadside ditch at the corner of Elm Street and Sixth Avenue, minor regrading to restore the flowpath is proposed. A vegetated channel will be constructed to direct runoff from the roadside ditches to the CMP inlet.

Rock slope protection is proposed for stabilizing eroding slopes at Alder Street and Tenth Avenue and Oak Street and Tenth Avenue; however, revegetation will be considered if site conditions will allow for vegetation growth.

Sediment deposition within the roadside ditches is evident at the north end of Eighth Avenue, and on Wilson Avenue near Pine Street. Minor regrading and seeding is proposed at the north end of Eighth Avenue. A pipe will be installed to convey runoff from the restored roadside ditch into the storm drain system in Pine Street. At Wilson Avenue, a drainage inlet with treatment capabilities and a parking barrier, such as a 6" vertical curb, are proposed.

To maximize treatment of stormwater before discharging into the lake, infiltration systems or galleries are proposed on Elm Street and the condominium access road, east of Highway 89. On Elm Street, the system will be in the road shoulder or within an adjacent CTC parcel. It will receive runoff from 9.3 acres of the Upper Area Watershed. The system located in the condominium access road will be within an existing drainage easement and will receive runoff from all of the Upper Area Watershed (49.7 acres) and a portion of Highway 89. If it is determined that the easement on the condominium access road will not accommodate an infiltration system, Pine Street, within the County ROW between Wilson Avenue and Highway 89, will be considered for an alternate location.



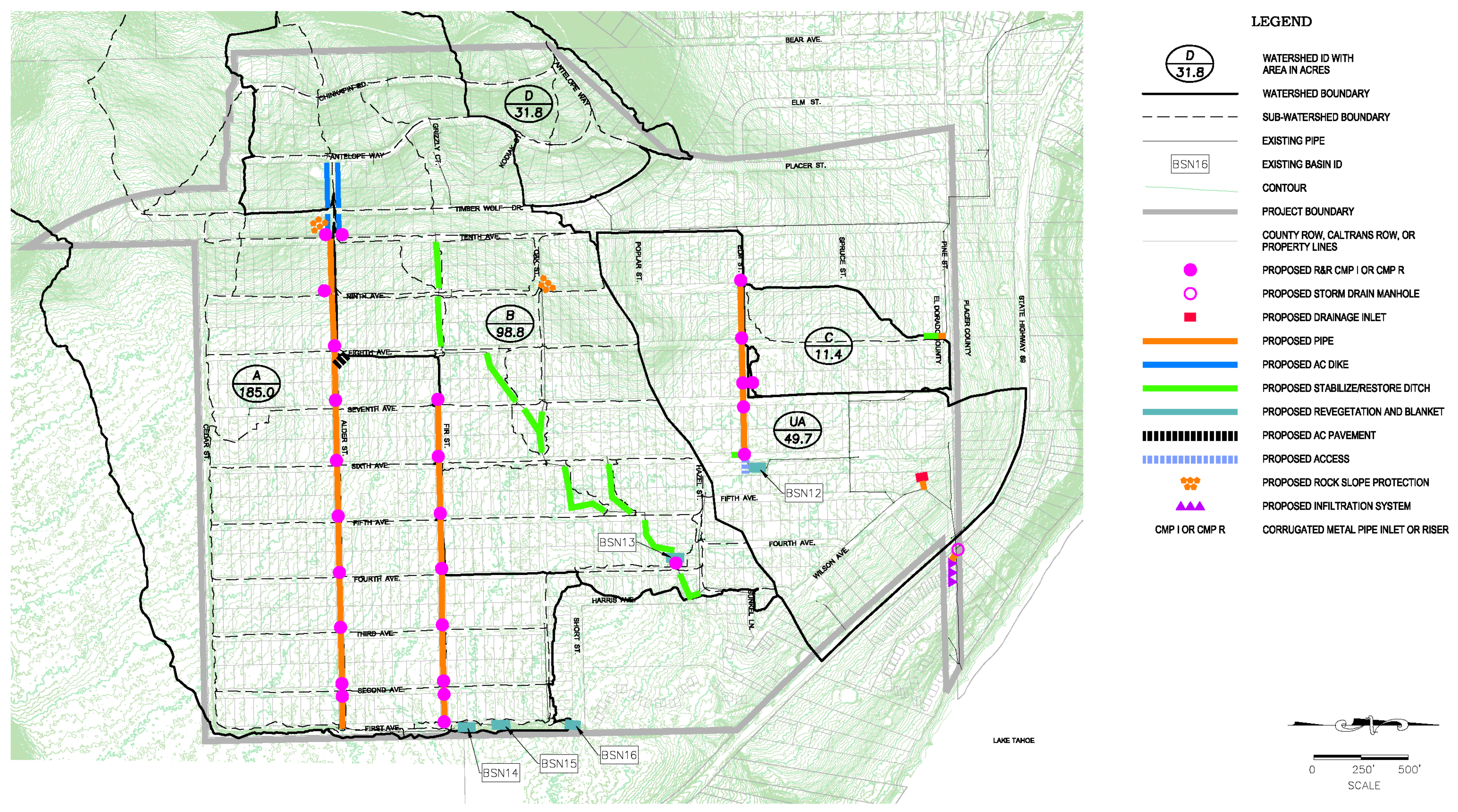
COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

ALTERNATIVE 1

DATE: 12/2015
PROJECT NO.: 95157
BY: ALD

FIGURE 16



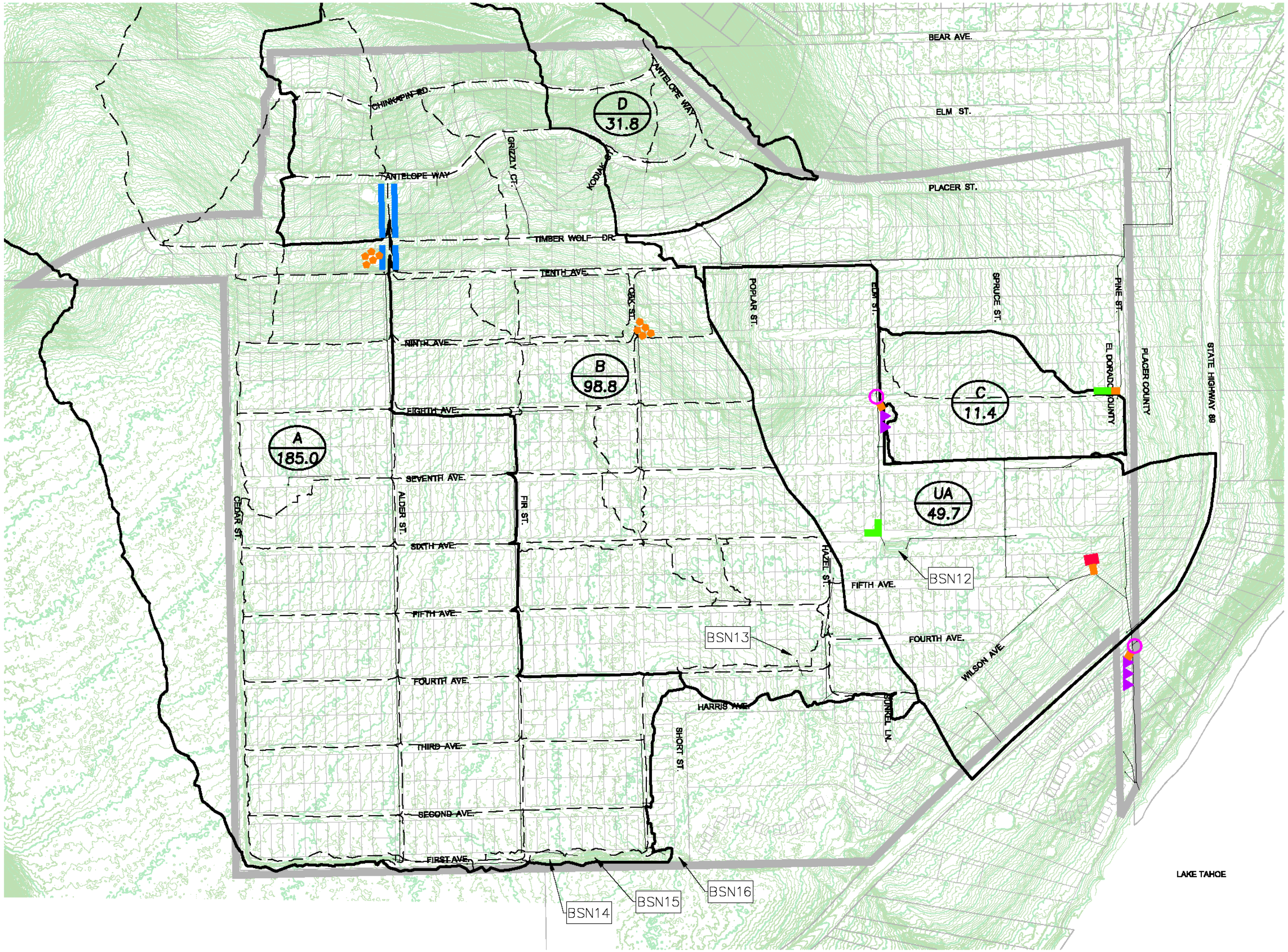
COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

ALTERNATIVE 2

DATE:	12/2015	PROJECT NO.:	95157	BY:	ALD

FIGURE
17



LEGEND

D 31.8	WATERSHED ID WITH AREA IN ACRES
━━	WATERSHED BOUNDARY
– – –	SUB-WATERSHED BOUNDARY
───	EXISTING PIPE
BSN16	EXISTING BASIN ID
───	CONTOUR
━━	PROJECT BOUNDARY
───	COUNTY ROW, CALTRANS ROW, OR PROPERTY LINES
○	PROPOSED STORM DRAIN MANHOLE
🟥	PROPOSED DRAINAGE INLET
🟧	PROPOSED PIPE
🟦	PROPOSED AC DIKE
🟩	PROPOSED STABILIZE/RESTORE DITCH
●	PROPOSED ROCK SLOPE PROTECTION
▲▲▲	PROPOSED INFILTRATION SYSTEM

0 250' 500'
SCALE

COUNTY OF EL DORADO
COMMUNITY DEVELOPMENT AGENCY
TRANSPORTATION DIVISION

CSA 5
EROSION CONTROL PROJECT

ALTERNATIVE 3

DATE: 12/2015
PROJECT NO.: 95157
BY: ALD

FIGURE 18

8.2 Alternatives Unit Cost for Meeting Goals

The costs to satisfy the goals of the Project were calculated on a unit cost basis for each alternative in order to evaluate and compare each alternative's relative benefit and are presented in Appendix E. For this analysis the capital costs were based on Transportation's Engineer's Estimate database using project bid summaries from 2010 through 2015 for all bids. Maintenance costs were not considered within this Report; however, the maintenance costs will be a factor during the evaluations. The unit costs of each alternative were calculated for the cost to provide source control, the cost to reduce and treat runoff volume and peak flow, and the cost to reduce sediment.

The unit cost to reduce runoff volume, peak flow, and sediment was calculated by assuming that treatment will be provided by each alternative at an annual frequency of 35 storm events per year for the design life of the alternative. The basis for this treatment frequency is the mean annual precipitation at the Project site divided by the 1-inch per hour design storm event. The effectiveness of each BMP was determined by estimating the storage volume, determining the infiltration volume for a 1 hour duration based on 1.25 feet per hour infiltration rate, and estimating the runoff total suspended sediment concentration based on an assumed 150 mg/L.

The estimate of the cost to reduce runoff volume and peak flow assumes that runoff is directed to each BMP throughout the design storm event. The calculation of the cost to reduce sediment assumes that each treatment alternative is maintained throughout the design life and operated in a first flush configuration which results in complete reduction of suspended sediment from the runoff. These conditions will not be satisfied for most storm events experienced during the design life of each BMP; however, since the purpose of this analysis is to evaluate the relative effectiveness of each BMP, these assumptions are accepted for this alternatives comparison.

8.2.1 Calculation of BMP Unit Costs

Source control unit cost was calculated using equation 7:

$$C_C = \frac{U_{bmp}}{D} \qquad (7)$$

Where C_C is the unit cost of source control in $/square feet, U_{bmp} is the unit construction cost of the BMP in $/square feet, and D is the design life in years.

The volume reduction unit cost was calculated by equation 8:

$$C_V = \frac{U_{bmp} \big/ (D \cdot F)}{V_I + V_S} \qquad (8)$$

Where C_V is the unit cost of the reduction in runoff volume in $/cubic feet, F is the annual frequency of storm events, V_I is the volume of infiltration in one hour per unit in cubic feet, and V_S is the volume of storage per unit in cubic feet.

The peak flow reduction unit cost was calculated by equation 9:

$$C_P = \frac{U_{bmp} \big/ (D \cdot F)}{V_I / 3600} \qquad (9)$$

Where C_P is the unit cost of the reduction in peak flow in \$/cfs.

The total suspended sediment concentration reduction unit cost was calculated by equation 10:

$$C_S = 16{,}017 \cdot \frac{U_{bmp} / (D \cdot F)}{(V_I + V_S) \cdot C_i} \qquad (10)$$

Where C_S is the unit cost of the reduction of sediment in runoff in \$/pounds and C_i is the concentration of total suspended sediment in mg/L.

8.2.2 BMP Unit Costs

The relative unit costs for source control and the reduction in runoff volume, peak flow, and sediment is presented in Table 11. These relative unit costs are presented as one tool for evaluating the relative cost efficiency of the alternatives considered in this analysis and does not represent a complete evaluation of each alternative's overall effectiveness. In addition, depending on site conditions, some BMPs are more appropriate than others for source control, hydrologic design, and treatment of runoff, irrespective of the unit costs. This variable is not represented in the unit cost analysis.

Table 11 – BMP Unit Costs

BMP	Unit	Unit Costs			
		Reduce Volume (per ft^3)	Reduce Peak (per cfs)	Reduce Sediment (per lb)	Source Control (per ft^2)
CMP Inlet	EA	\$0.14	\$1,747.04	\$15.24	N/A
Infiltration (Perf Pipe)	LF	\$0.04	\$265.14	\$4.45	N/A
Infiltration (Gallery)	CF	\$0.00	\$54.86	\$0.00	N/A
Drainage Inlet	EA	\$0.22	\$4,114.29	\$23.77	NA
Rock-Lined Channel	LF	\$0.02	\$75.89	\$2.25	\$0.92
Rock Dissipator/Bowl	SF	\$0.02	\$60.34	\$1.79	\$0.73
Seed and Blanket Chnl	LF	\$0.01	\$46.63	\$1.38	\$0.57
Grass-Lined Swale	LF	\$0.01	\$38.40	\$1.14	\$0.47
Revegetation	SF	NA	NA	NA	\$0.10
Rock Slope Protection	SF	NA	NA	NA	\$0.57
AC Dike	LF	N/A	N/A	N/A	\$2.87
AC Pavement	SF	N/A	N/A	N/A	\$1.07
Sweeping	---	NA	NA	\$0.05	NA

CMP Inlets, perforated pipes, infiltration galleries, drainage inlets, rock-lined channels, seed and blanket channels, and grass-lined swales all perform satisfactorily in volume and peak flow reduction and treatment of runoff. The most cost efficient means of satisfying the reduction in volume, peak flow, and suspended sediment goals of the Project are with the infiltration gallery, seed and blanket channel, and grass-lined swale. However, the infiltration gallery is limited in that it requires a fairly large footprint and is not suitable for all site conditions. The seed and blanket channel and grass-lined swale are limited in that they are not suitable for all site conditions and are not suitable for detention.

Revegetation is a practical and inexpensive means of source control but is not suitable for all site conditions. Rock-lined channels, seed and blanket channels, and grass-lined swales provide source control at a higher cost but also provide multiple benefits which offset the unit cost increase.

For the collection of sediment, infiltration gallery and sweeping costs per pound recovered are significantly less expensive than all other BMPs. The effectiveness of removing fines (<125 microns) with sweeping is in question.[40]

9.0 Evaluating Alternatives

If designed and maintained properly, Alternatives 1 and 2 should meet the objectives of this Project. As the most reduced in scope, Alternative 3 will likely not. However, ongoing efforts to sweep the impervious surfaces within the County ROW will continue to reduce the amount of sediment which is available for suspension in runoff thereby reducing the sediment load of runoff. The Preferred Alternative will be outlined in the Preferred Alternative Memorandum and will be selected based on the evaluation of the three alternatives and the degree to which each meets the objectives of the Project as presented in this report.

9.1 Alternatives Summary

Alternative 1 proposes a comprehensive plan with augmentation of existing facilities in select locations and providing mitigation measures for those areas within the Project’s areas of interest currently without adequate source control, hydrologic design, and treatment.

Alternative 2 reflects a comprehensive plan with the replacement of existing systems and providing mitigation measures for those areas within the Project’s areas of interest currently without adequate source control, hydrologic design, and treatment.

Alternative 3 reflects a reduction in scope from Alternatives 1 and 2 in that the focus is providing mitigation measures only for those areas within the Project’s areas of interest currently without adequate source control, hydrologic design, and treatment.

Reduction of Coarse, Fine, and Very Fine Sediments

The reduction of coarse, fine, and very fine sediments by 33%, 25%, and 12%, respectively, is one of the goals of the Project. Table 12 reflects the anticipated reduction in sediment from each facility per storm event. The reduced sediment was calculated by assuming that reduction will be provided by each facility at an annual frequency of 35 storm events per year for the design life of the facility. The basis for this treatment frequency is the mean annual precipitation at the Project site divided by the 1-inch per hour design storm event. The effectiveness of each BMP was determined by estimating the storage volume and estimating the runoff total suspended sediment concentration based on an assumed 150 mg/L.

Table 12 – Anticipated Load Reduction Per Storm Event

BMP	Unit	Reduced Sediment Load (lbs)
CMP Inlet	EA	0.2810
Infiltration (Perforated Pipe)	LF	0.0314
Infiltration (Gallery)	CF	9.3771
Drainage Inlet	EA	0.1800
Rock-Lined Channel	LF	0.0351
Rock Dissipator/Rock Bowl	SF	0.0117
Seed and Blanket Channel	LF	0.0352
Grass-Lined Swale	LF	0.0352
Revegetation	SF	0.0008
Rock Slope Protection	SF	0.0008
AC Dike	LF	N/A
AC Pavement	SF	N/A

Taking the values from Table 12 and the proposed facilities from Figures 16, 17, and 18, the total potential sediment load reduction per storm event from Alternative 1 would be 88 lbs., from Alternative 2, 200 lbs., and from Alternative 3, 25 lbs. Using the unit costs from Table 11, the cost per pound of sediment load reduction per storm event for each Alternative would be $4,682, $16,199, and $138, respectively.

Reduction in Runoff Volume and Peak Flow

Reduction in total runoff volume and peak discharge leaving the site from a 1-inch/hour storm by 33% is a goal of the Project. Table 13 reflects the anticipated reduction in volume and peak flow from each facility. The reduced runoff volume and peak flow was calculated by assuming that treatment will be provided by each facility at an annual frequency of 35 storm events per year for the design life of the facility. The basis for this treatment frequency is the mean annual precipitation at the Project site divided by the 1-inch per hour design storm event. The effectiveness of each BMP was determined by estimating the storage volume and determining the infiltration volume for a 1 hour duration based on 1.25 feet per hour infiltration rate.

Table 13 – Anticipated Volume and Peak Reduction Per Storm Event

BMP	Unit	Reduced Volume (ft^3)	Reduced Peak (cfs)
CMP Inlet	EA	30.03	0.0025
Infiltration (Perforated Pipe)	LF	3.31	0.0005
Infiltration (Gallery)	CF	1001.25	0.0007
Drainage Inlet	EA	19.25	0.0010
Rock-Lined Channel	LF	3.75	0.0010
Rock Dissipator/Rock Bowl	SF	1.25	0.0003
Seed and Blanket Channel	LF	3.75	0.0010
Grass-Lined Swale	LF	3.75	0.0010
Revegetation	SF	0.08	0.0000
Rock Slope Protection	SF	0.08	0.0000
AC Dike	LF	N/A	N/A
AC Pavement	SF	N/A	N/A

Capital Costs

Rough Order of Magnitude (ROM) cost estimates, prepared for each of the Project alternatives, can be found in Appendix E. The quantities for each alternative were tabulated based on the proposed improvements shown on Figures 16 through 18. The unit costs for each facility were based on bid summaries from Transportation's erosion control and air quality projects within the Lake Tahoe Basin constructed between 2010 and 2015. Data for AC dike was unavailable between 2010 and 2015; therefore, the unit cost for AC dike is based on project bid summaries between 2008 and 2009. Table 14 presents a summary of the ROM construction cost estimates for each of the alternatives.

Table 14 – Alternative ROM Construction Cost Estimate Summary

	Alt-1	Alt-2	Alt-3
Mobilization	$ 40,000	$ 50,000	$ 35,000
Traffic Control	$ 20,000	$ 20,000	$ 20,000
Sweeping	$ 10,000	$ 17,500	$ 7,500
Trench Excavation & Safety	$ 7,000	$ 7,000	$ 7,000
Install & Maintain Temp BMPs	$ 15,000	$ 25,000	$ 10,000
Remove CMP Inlet	$ 7,700	$ 28,600	$ -
Remove CMP	$ -	$ 260,000	$ -
CMP Inlet/Riser or Drainage Inlet	$ 76,500	$ 121,500	$ 4,500
18" HDPE Pipe	$ 24,200	$ 89,650	$ 11,000

	Alt-1	Alt-2	Alt-3
18" HDPE Perforated Pipe	$ -	$ 424,850	$ -
24" HDPE Pipe	$ -	$ 43,750	$ -
24" HDPE Perforated Pipe	$ -	$ 185,225	$ -
Infiltration System	$ 40,000	$ 20,000	$ 40,000
Storm Drain Manhole	$ 11,200	$ 5,600	$ 11,200
AC Dike	$ 35,700	$ 29,400	$ 29,400
AC Pavement (incl R&R D/Ws)	$ 3,200	$ 19,200	$ -
Basin Access with Gate	$ 6,000	$ 6,000	$ -
Armored Channel	$ 123,200	$ -	$ -
Rock Slope Protection	$ 25,500	$ 13,600	$ 13,600
Rock Bowl/Rock Dissipator	$ 6,500	$ -	$ -
Restore Road Ditch (GLS)	$ 4,200	$ 2,940	$ 4,200
Clear and Restore Channel	$ -	$ 116,500	$ -
Revegetation (Basins)	$ 15,000	$ 15,000	$ -
Revegetation (General)	$ 15,000	$ 30,000	$ 7,500
California Conservation Corps	$ 6,000	$ 6,000	$ 4,200
Project Sign	$ 2,000	$ 2,000	$ 2,000
Subtotal	$ 493,900	$1,539,315	$ 207,100
Contingency Percentage	20%	20%	20%
Contingency	$ 98,780	$ 307,865	$ 41,420
Total	**$ 592,680**	**$1,847,180**	**$ 248,520**

Planning and Design Costs

Planning and design costs include costs associated with the preparation of environmental documentation and plans and specifications up to the 100% stage. The level of detail and effort necessary for the planning and design for Alternative 1 would be slightly less than Alternative 2 and, being greatly reduced in scope, planning and design costs for Alternative 3 would be much less than the other 2 alternatives.

Operations and Maintenance Costs

There will be an increase in maintenance of the sediment trapping inlets however, maintenance of the existing facilities will remain necessary, whether replaced or not. The new facilities and treatments are similar with all three alternatives therefore; annual operation and maintenance costs necessary for Alternatives 1, 2, and 3 will be similar.

It is anticipated that each mitigating measure will be relatively inexpensive to operate and maintain.

Design Life

The design life is defined as the number of years the facility is expected to function adequately without new construction. The design life for Alternatives 1, 2, and 3 will be similar.

ROW Acquisition

It is anticipated that all work will be performed within the County ROW or publically owned parcels.

Impacts to Existing Utilities

Impacts to existing utilities include costs associated with removals or relocations. Potential impacts to existing utilities are similar with all three alternatives.

Disturbance

Disturbance is defined as new temporary and/or new permanent earth disturbance. Work proposed in paved locations and areas exhibiting erosion or other forms of existing disturbance is not considered to be creating new disturbance. Work proposed in areas previously disturbed but restored as well as undisturbed areas is considered new disturbance. Due to the revegetation of the basins and the proposed infiltration system near the CTC parcel on Elm Street, all three alternatives will likely cause new disturbance. With the addition of the channel work, Alternative 2 would generate the greatest amount of new disturbance.

Aesthetics

Aesthetics represent the appearance of the completed Project. Each of the three alternatives is comprised of similar erosion mitigation techniques which have equivalent aesthetic characteristics.

Constructability

Constructability reflects the ease of construction of each alternative. The proposals for Alternatives 1, 2, and 3 are such that constructability aspects are similar.

Groundwater Impacts

Groundwater impacts reflect the potential for positive or negative effects to existing groundwater flow patterns, or mixing polluted surface water with groundwater. For the treatment of runoff, all three alternatives rely on infiltration. Any potential impact to groundwater quality will be similar with all three alternatives.

Impervious Surfaces

An impervious surface is a surface that does not allow infiltration of surface water. There is minimal to no change in impervious surface area with all three alternatives.

Road Sand/Cinders

Road sand/cinders are introduced sediments from County operations. The Transportation Maintenance Division routinely applies road sands/cinders within the Project area. The volume of road sand/cinder captured will increase with Alternatives 1 and 2 with the installation of CMP inlets with sediment capture capabilities.

Manmade Nutrient Sources

Manmade nutrient sources are from private lands and utilities such as lawn fertilizers and wastewater pipes. The collection, conveyance, and treatment of manmade nutrients are not goals for this Project. For this reason the alternatives were not formulated specifically to address manmade nutrients.

Public Safety

There will be no change to public safety as a result of the implementation of any of the three alternatives.

Wildlife Habitat

Impacts to wildlife habitat within upland and SEZs with thriving native vegetation were studied. With the majority of the work in the County's ROW, it is anticipated there will be no changes to wildlife habitat as a result of the implementation of any of the three alternatives.

Vector Control

During mosquito breeding season, water that is standing for 72 hours or longer could facilitate mosquito production. Each of the three alternatives will be designed and constructed in a manner that standing water will be present for less than 72 hours.[42]

Permitability

The length of time required to obtain the construction permits for Alternatives 1 and 2 will likely be increased from that required for Alternative 3 due to the proposed work in the basins and channels being in SEZ.

Fundability

Fundability considers the number of agencies needed for funding each alternative and the requirements each alternative must meet to receive that funding. With $344,166 separating Alternative 1 from Alternative 3, the construction costs of those two alternatives are relatively similar and the work proposed in Alternatives 1 and 3 provides mitigation measures for areas currently without adequate source control, hydrologic design, and treatment. Alternative 2 proposes work far beyond the scope of Alternatives 1 and 3 and the number of funding sources for construction of this work would need to be expanded.

9.2 Alternatives Evaluation Summary and Recommendations

The County has looked at the existing conditions in the Project area to identify problems and analyzed potential solutions to address the problems noted. The alternatives selected by the County were those that the County determined will meet the Project goals and objectives.

Implementing Alternative 1 ensures that the Project goals and objectives will be met to the maximum extent practicable. This alternative will mitigate water quality issues not currently addressed with the existing drainage systems and will stabilize areas that are beginning to become a detriment to water quality.

Implementing Alternative 2 will also meet the goals and objectives for the Project to the maximum extent practicable. This alternative will stabilize areas that are beginning to become a detriment to water quality, increases the design life of the existing storm drain systems, and maximizes water quality benefits.

Implementation of Alternative 3 will meet the goals and objectives for the Project to the maximum extent practicable but without the water quality benefits of sediment retention. Without this benefit, the existing storm drain systems would remain as the main conveyance of sediment and the ability of the systems to infiltrate runoff would continue degrading.

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