

Santa Ana Garden Grove Fixed Guideway Corridor

Appendix T

Water Resources Technical Report



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List of Acronyms

ACOE	U.S. Army Corps of Engineers
BMPs	Best Management Practices
BRT	Bus Rapid Transit
CEQA	California Environmental Quality Act
CCC	Criteria Continuous Concentration
CMC	Criteria Maximum Concentration
CSMP	Construction Site Monitoring Program
CTR	California Toxics Rule
CWA	Clean Water Act
DAMP	Drainage Area Management Plan
DCIA	Directly Connected Impervious Areas
EIR	Environmental Impact Report
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
IRWD	Irvine Ranch Water District
LID	Low Impact Development
LIP	Local Implementation Plan
mg/L	Milligrams per Liter
MS4	Municipal Separate Storm Sewer System
MSDS	Materials Safety Data Sheets
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NOP	Notice of Preparation
NPDES	National Pollutant Discharge Elimination System
NTS	Natural Treatment System
OC/EHD	County of Orange Environmental Health Department
OCTA	Orange County Transportation Authority
OCWD	Orange County Water District
PE ROW	Pacific Electric right-of-way
PCE	Tetrachloroethylene
RCP	Reinforced Concrete Pipe
RWQCB	Regional Water Quality Control Board
SARB	Santa Ana River Basin
SARTC	Santa Ana Regional Transportation Center
SATZC	Santa Ana Transit Zoning Code
SIP	State Implementation Plan
SWDR	Storm Water Data Report
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TSM	Transportation System Management
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
WDR	Waste Discharge Requirements
WQMP	Water Quality Management Plan

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EXECUTIVE SUMMARY

This Water Resources Technical Report has been prepared as a background technical report to support the environmental analysis for the Santa Ana and Garden Grove Fixed Guideway Project (Project). The Study Area is located within in the cities of Santa Ana and Garden Grove in central Orange County, California. More specifically, the Study Area encompasses a proposed, four-mile, transit corridor that extends from the intersection of Harbor Boulevard and Westminster Avenue in the City of Garden Grove, at its western terminus, to the Santa Ana Regional Transportation Center (SARTC) in the City of Santa Ana, at its eastern terminus.

The Project is currently undergoing environmental study and evaluation pursuant to the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Four alternatives have been identified for detailed environmental review for the proposed Project: a No Build Alternative; a Transportation System Management (TSM) Alternative; and two streetcar Build Alternatives: Streetcar Alternative 1 (Santa Ana Boulevard/Fourth Street Couplet); and Streetcar Alternative 2 (Santa Ana Boulevard/Fifth Street and Civic Center Drive Couplet). These four alternatives are labeled as follows:

- No Build Alternative
- TSM Alternative
- Streetcar Alternative 1 (Santa Ana Boulevard/Fourth Street Couplet)
- Streetcar Alternative 2 (Santa Ana Boulevard/Fifth Street and Civic Center Drive Couplet)

The City of Santa Ana is the CEQA lead agency and the Federal Transit Administration is the NEPA lead agency.

The Study Area of the proposed Project site is located in a highly urbanized area. Water quality and existing drainage patterns in the Study Area have been affected by past and present actions, including roadway construction and residential and commercial/light industrial development.

This report establishes existing and future land use hydrology, channel routes, and area characteristics as well as drainage requirements that would be required to maintain the existing and cumulative condition drainage patterns. Potential impacts to water resources associated with the various proposed Project alternatives are identified and discussed in the following topical areas:

- Hydrology
- Floodplains
- Water quality

In addition, project design features are discussed at a conceptual level. This report purposely leaves the hydraulic design, selection of conduit cross-section, and construction materials for further detailed analysis that occurs later in the proposed Project development process. The hydrological discussions and analyses presented in this report are intended to provide a general description of those facility improvements that would be needed to address and mitigate potential Project impacts.

No significant impacts were identified relative to hydrology or floodplains as a result of the proposed Project.

The change in impervious area added by the alternatives for the proposed Project would not affect the existing drainage facilities, given that the land use throughout this portion of the Study Area was assumed to be commercial for the hydrology analysis and sizing of the City's drainage facilities. The proposed Project alternatives do not significantly increase the existing hydrologic flows. Existing drainage patterns would not be altered and the affected city drainage facilities would still drain to the same watersheds.

There are no proposed channel modifications with this project. As currently proposed, the Project's structures will have no impact to the regional floodplains. Modifications to protect the proposed Project within the western portion of the alignment, where 100-year floodplain conditions exist, will be necessary but the impacts should be less than significant with mitigation. The goal of these modifications would be to protect the project from flooding.

The proposed Project alternatives, both during the construction and operational phases, would potentially generate pollutants in storm water runoff and impact water quality. Impacts would be reduced through project features designed to prevent and treat runoff from the Project. The implementation of identified best management practices (BMPs), as recommended in this report, during Project construction and operation will further reduce the potential for pollutants to become introduced into storm water runoff. With the proposed BMPs, the project alternatives would cause less than significant impacts to water quality.

CHAPTER 1 INTRODUCTION

This technical report assesses potential impacts to hydrology, floodplains, and water quality associated with the proposed Santa Ana and Garden Grove Fixed Guideway Project. This chapter provides a brief description of the proposed Project location and alternatives. Subsequent chapters identify the hydrology, floodplains, and water quality characteristics that currently exist in the project Study Area, discuss the basic technical approach to identify and assess potential impacts, and recommend measures to mitigate impacts if needed.

1.1 PROJECT DESCRIPTION

Four alternatives have been identified for the Project. These alternatives consist of a No Build Alternative, a Transportation System Management (TSM) Alternative and two streetcar Build Alternatives. The four alternatives are labeled as follows:

- No Build Alternative
- TSM Alternative
- Streetcar Alternative 1 (Santa Ana Boulevard and Fourth Street Couplet)
- Streetcar Alternative 2 (Santa Ana Boulevard/Fifth Street and Civic Center Drive Couplet)

A detailed project description is provided in Appendix A.

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CHAPTER 2 PURPOSE OF THIS REPORT

The introduction of a new transit system in the City of Santa Ana has the potential to affect water quality and alter existing drainage patterns. These elements of hydrology, in addition to flood potential and groundwater effects, were evaluated with respect to the proposed Project to assess potential impacts attributable to the proposed Project alignments. An impact analysis has been prepared and documented within this Water Resources Technical Report to describe the proposed Project's potential impacts to the existing and cumulative hydrological setting and to identify Project design features and best management practices which would mitigate potential impacts of the proposed Project to hydrology, floodplains, and water quality.

California Environmental Quality Act (CEQA) guidelines require the consideration of a No Build Alternative that represents the existing conditions, as well as what would reasonably be expected to occur in the foreseeable future if the project were not approved. For purpose of this report, this alternative is referred to as the No Build Alternative. The main purpose of the No Build Alternative is to provide a baseline to allow decision makers to compare the impacts of the proposed Project versus no project.

State and federal environmental guidelines also require an analysis of cumulative conditions, which assesses impacts generated by the anticipated development and potential cumulative environmental impacts of the proposed Project combined with applicable related projects in the vicinity. It should be noted that the existing condition means the physical conditions of the affected areas as they exist at the time the project Notice of Preparation (NOP), consistent with CEQA Guidelines, was released and the cumulative condition refers to build out conditions as defined in the City of Santa Ana's General Plan. An important aspect of the purpose and need for the Project is to coordinate and integrate the development of transit in the Study Area with these future land uses. For the analysis of the cumulative condition, it is assumed that the future land uses and supporting street network and drainage facilities in the Study Area will be built out (build out is set at 2035) by the time that the proposed Project is completed.

2.1 THRESHOLD CRITERIA

The following thresholds of significance are based on Appendix G of the CEQA Guidelines. For purposes of this Water Resources Technical Report, impacts to hydrology, floodplains, and water quality are considered significant if the proposed Project would:

2.1.1.1 Hydrology

- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site;
- Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems;
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.

2.1.1.2 Floodplain

- Place facilities within a 100-year flood hazard area as mapped on a Federal Flood Hazard Zone or Flood Insurance Rate Map (FIRM) or other flood hazard delineation map;
- Place within a 100-year flood hazard area structures which would impede or redirect flood flows;
- Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam; or inundation by seiche, tsunami, or mudflow.

2.1.1.3 Water Quality

- Violate any water quality standards or waste discharge requirements;
- Provide substantial additional sources of polluted runoff;
- Otherwise substantially degrade water quality;
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.

2.2 LEVEL OF DETAIL

This report establishes existing and future land use hydrology, channel routes, and area characteristics as well as drainage requirements that would be required to maintain the existing and cumulative condition drainage patterns. Potential impacts to water resources associated with the various proposed Project alternatives are identified and discussed in the following sections of this report: hydrology, floodplains, and water quality. In addition, project design features are discussed at a conceptual level. This report purposely leaves the hydraulic design, selection of conduit cross-section, and construction materials for further detailed analysis that occurs later in the proposed Project development process. The hydrological discussions and analyses presented in this report are intended to provide a general description of those facility improvements that would be needed to address and mitigate potential Project impacts.

2.3 CONSTRAINTS AND LIMITATIONS

The analysis for the cumulative conditions in the Water Resources Technical Report was developed based on the most current description of the future land use plans and related hydrological features within the proposed alignment area available at the time of this preparation.

CHAPTER 3 HYDROLOGY

The hydrology analysis presented in this section evaluates the proposed Project as to whether or not it would substantially alter the existing drainage pattern in the Study Area or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems. The main backbone storm drain facilities generally are Orange County Flood Control facilities that are designed for a 100-Year peak storm event. The City of Santa Ana storm drain facilities are designed for a 25-Year peak storm event. Hydrology analysis is used to assess peak flows at critical locations within a proposed Project site. Peak flow is directly proportional to the watershed area, rainfall intensity and a loss coefficient. The loss coefficient at a specific location is influenced by the morphology of the region, the degree of the slopes, the type of soil material, and the type of land use. The coefficient is the fraction of the average annual precipitation that does not infiltrate into the soil and is not transferred back to the atmosphere through evapotranspiration.

The hydrology analysis conducted for the proposed Project takes into account potential changes in land use associated with the two alignments under evaluation, such as the amount of impervious surface that would be added by these two alternatives, as well as future changes in land use and hydrology planned for the City of Santa Ana.

The No- Build and TSM Alternatives were not analyzed from a hydrologic perspective as there would be no change to the current storm drain systems. The current water quality conditions are not impacted by the No Build or TSM Alternatives as the overall project alignment location is within an existing urban downtown area that is managed through both the city of Santa Ana (<http://www.ci.santa-ana.ca.us/pwa/stormdrain/faq.asp>) and city of Garden Grove's (<http://www.ci.garden-grove.ca.us/?q=pw/stormwater>) National Pollutant Discharge Elimination System (NPDES) Programs and the County's NPDES Urban Runoff Program (<http://www.ocwatersheds.com/StormwaterProgram.aspx>). The storm water flows from volumetric, flow and water quality perspectives do not currently pose any significant impacts as is common to these types of existing land uses. This means that the existing conditions, even when modified by this project, are currently managed in such a way that there are no significant impacts to the watershed.

3.1 EXISTING CONDITIONS WATERSHED ASSESSMENT

This project is located in the Cities of Santa Ana and Garden Grove which are located hydrologically within the Santa Ana River Basin. The project location is within a highly urbanized region which is managed through a standard flood control storm drain system. The specifics of this stormdrain system, and the subwatersheds this project will discharge to, are discussed in the following sections.

3.1.1 EXISTING CONDITIONS WATERSHED DESCRIPTION

An inventory of all existing drainage systems was conducted for each segment of the proposed Project's streetcar alternatives. Drainage facilities were identified using various as-builts from the City dating back to 1950. In addition, extensive field investigations verified curb inlet openings, parkway culverts, catch basins, cross-gutters, flow lines, and drainage area limits. (Cordoba Corporation, 201G, *Drainage Technical Report*.)

The City of Santa Ana maintains approximately 1,600 storm drain inlets and 34,000 linear feet of open channels that transport urban runoff and discharge to the Lower Santa Ana River, Newport Bay, and Bolsa Chica water bodies (*Final Drainage Technical Report*, September 2011). The City of Santa Ana General Plan describes a fully urbanized city; yet, there are certain areas which have not been modified due to historic structures. Consequently, the City's hydrologic characteristics reflect past efforts to facilitate drainage and eliminate recurring flooding and ponding.

The City of Garden Grove's storm drain system was developed in a similar manner. In 1991 a storm drain master plan was also developed by the City of Garden Grove and the City has moved forward over the years to meet the goals of this plan.

The project is located within three watersheds: Newport Bay, Santa Ana River and Anaheim Bay- Huntington Harbour within the cities of Santa Ana and Garden Grove, as depicted in Figure 3-1, Existing Watershed Areas.

Existing land use within the Study Area of the proposed Project includes existing urban/downtown mixed land uses, with portions of commercial, industrial and residential uses throughout the proposed alignment of the Project.

3.1.2 BACKGROUND INFORMATION/PREVIOUS STUDIES

This section identifies previously prepared documents that were used to provide background information on the master planning efforts for flood control as well as providing a context for existing conditions in the Study Area, including the development and capacity of the major drainage facilities that currently serve the proposed Project's Study Area.

The City of Santa Ana Drainage Master Plan was used as a guideline for proposing new drainage systems along the streetcar alignment alternatives. Also, the City of Santa Ana's design manual and standard plans were integrated into this analysis to address the City's requirements.

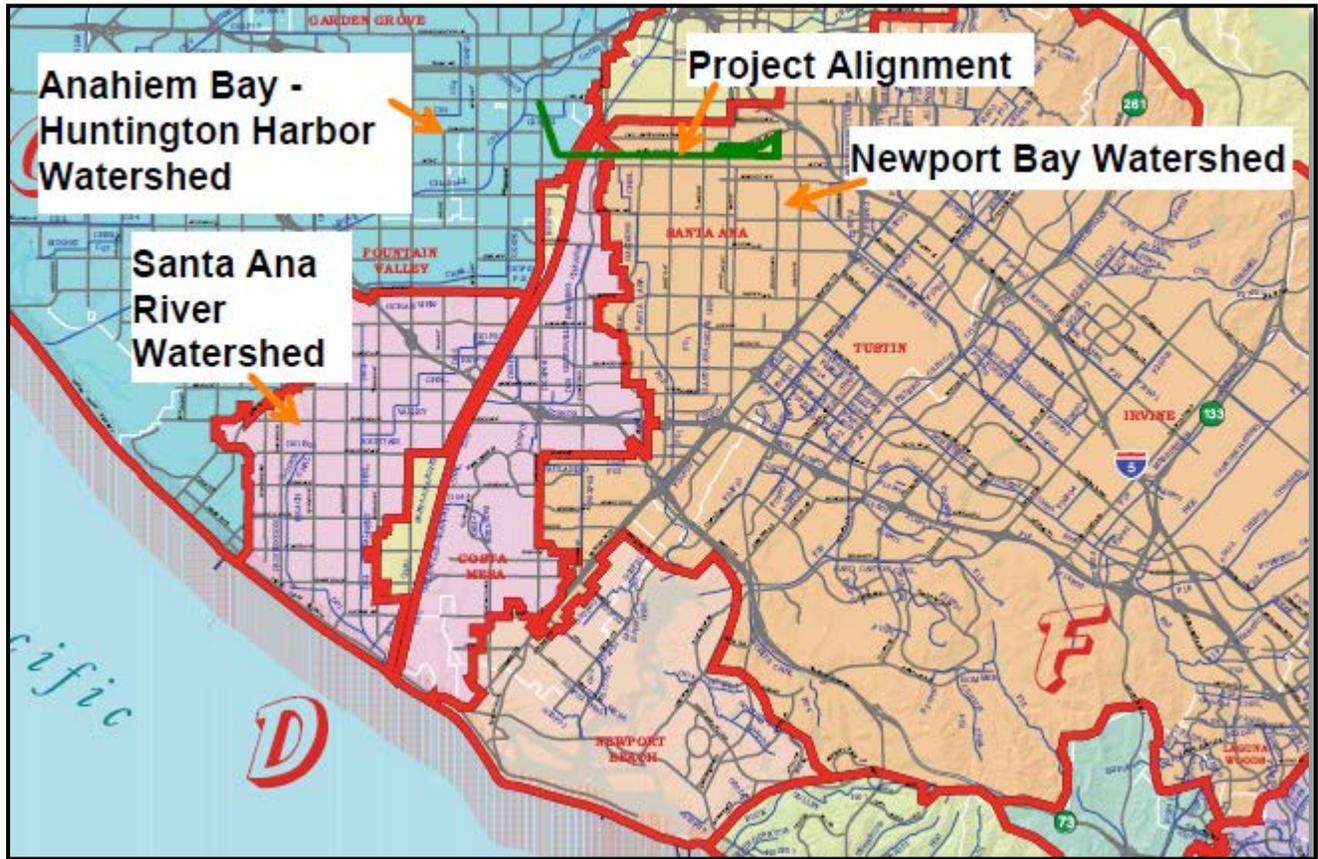
The Project is partially located within the boundaries of the recently adopted City of Santa Ana Transit Zoning Code (SATZC), and proposed Project area drainage systems were analyzed in Chapter 4.6 of the associated Environmental Impact Report (EIR) for this project. In general, if any portion of an existing or future storm drain system would be impacted by the streetcar alignment improvements, then the storm drain system was included as part of this analysis, and the proposed drainage systems would adhere to the requirements identified in the EIR. The

SATZC (Chapter 41, Article XIX, City of Santa Ana Municipal Code) presents general land uses requirements applicable to this project including:

- A mixture of development and open spaces that situates commerce, work places, residences, and civic buildings within walking distance of transit and one another.
- Streets that meet the needs of many transit modes including public transit, pedestrians, cyclists and automobiles.
- Development that is maximally transit supportive.
- The repair and stabilization of the area's existing urban fabric, characterized by an interconnected gridded street pattern and a mixture of architectural styles and uses, in order to support the successful expansion of public transit and compatible development.

For those drainage features outside of the SATZC boundary and within the City of Garden Grove, city-specific requirements are being utilized.

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LEGEND

-  Watershed Boundary
-  Transportation Corridor, Freeway, or Major Street
-  Watercourse Includes:
 - OCFD Main Channel
 - OCFD Earth Channel
 - OCFD Reinforced Concrete Trapezoidal Channel
 - OCFD Reinforced Concrete Rectangle Channel
-  City / County Jurisdiction
-  River, Lake or Reservoir



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3.1.3 EXISTING REGIONAL DRAINAGE FACILITIES

A regional facility is defined as a drainage system with a tributary area greater than 1,000 acres. The Santa Ana Delhi, Santa Ana River and East Garden Grove Wintersburg Channels are all classified as regional drainage facilities. The existing regional facilities are mapped on Figure 3.1, Existing Watershed Areas. The following discussion addresses the regional facilities that would receive flows from the proposed Project's Study Area. The regional facilities are described and assessed so as to determine how the various alternatives for the proposed Project may potentially impact these facilities.

3.1.4 EXISTING CONDITIONS HYDROLOGY IMPACTS TO THE REGIONAL DRAINAGE FACILITIES

This section considers the potential hydrology impacts of the proposed Project to the regional drainage facilities that serve the Study Area – specifically whether or not the proposed Project would create or contribute runoff water which would exceed the capacity of existing regional drainage systems.

A hydrology analysis assessment for peak flows at critical locations of the proposed Project was completed in order to size drainage facilities. (Cordoba, 2011.) Peak flow is directly proportional to the watershed area, rainfall intensity and a loss coefficient. The loss coefficient is determined by soil type and land use. In theory, a potential hydrologic impact could occur if any of the factors used to determine peak flow are substantially altered. The two factors this proposed Project minimally affects in these runoff calculations are the watershed areas (due to the lack of potential change in drainage patterns) and the loss coefficient (due to the minimal change in impervious area). The delta in change is so minimal that there is no significant affect to the runoff calculations.

From a flood plain perspective, the regional drainage facilities within the Study Area have been designed for 100-year flow rates. The Study Area is currently highly developed so the change in runoff will be minimal. The existing regional drainage facilities were sized based on the same assumed land uses as were used for the runoff calculations, primarily existing urban development. The land use assumed for the background existing condition analysis is important because it determines the percentage of impervious surface that was used in the hydrology calculations. Each land use has a corresponding percentage impervious surface, which determines the loss coefficient for the watershed. For the proposed Project, the overall change in percentage of impervious surface is minimal.

Using a conceptual comparison approach it has been determined that each of the proposed Project alternatives would not change the land use types applied to calculate the 100-year flow rates for each regional facility. For either of the streetcar alternatives, the proposed Project follows an alignment generally along Santa Ana Boulevard within highly developed areas.

The proposed Project alternatives are consistent with the Santa Ana Drainage Master Plan's land use assumptions and the footprints of these alternatives are easily contained within the thresholds for impervious surfaces assumed by the Santa Ana Drainage Master Plan, which directly relates to the hydrology analysis and peak flow rates calculated for each watershed.

Therefore the regional drainage facilities design peak flow rates would not be altered with the addition of the proposed Project.

3.1.5 EXISTING CITY DRAINAGE FACILITIES

For purposes of this hydrologic analysis, the alignment corridors may be divided into several segments based on existing conditions, and existing or proposed storm drain facilities identified in the City of Santa Ana Drainage Master Plan. A Drainage Technical Report (Cordoba, 201G) has been developed for this Project and is attached as Appendix Ó to this Water Resources Technical Report. Appendix B of the Drainage Technical Report provides an exhibit which shows existing drainage flow patterns and facilities within the Study Area limits of the proposed Project.

Each of the existing city drainage facilities were designed for 25-year peak flow rates. As the design flow rates were calculated assuming future commercial land use, the city drainage facilities have been sized appropriately for current city land zoning.

3.1.5.1 Downtown Segment

1. Santiago Street to French Street
2. French Street to Ross Street
3. Ross Street to Flower Street

3.1.5.2 Raitt to Flower Segment

1. Flower Street to Shelton Avenue
2. Shelton Avenue to Bristol Avenue
3. Bristol Street to Raitt Avenue

3.1.5.3 Pacific Electric Right-of-Way (PE ROW) Segment

1. Raitt Avenue to Santa Ana River
2. Santa Ana River to Harbor Blvd/Westminster Avenue

Drainage facilities within each of these segments are summarized on the following page.

3.1.5.4 Downtown Segment

The downtown segment of the Study Area consists of various land uses including institutional, industrial, commercial, and residential. The area near the SARTC is considered an industrial zone. The area between SARTC and downtown Santa Ana is primarily residential with small industrial areas. Downtown Santa Ana is characterized by multi-story commercial (including office and retail uses) buildings and residential. The Civic Center area has institutional land uses including federal, State, city, and county government offices. The topography within this segment is flat and grades towards the west and south.

3.1.5.5 Downtown Segment - Streetcar Alternative 1 (Santa Ana Boulevard)

The existing roadway condition along Santa Ana Boulevard from Santiago Street to French Street consists of one or two travel lanes in each direction separated by a striped median; just east of French Street (at Mortimer Street, Santa Ana Boulevard converts to one-way traffic in the westbound direction. An existing 27-inch reinforced concrete pipe (RCP) runs westerly along Santa Ana Boulevard to French Street, where it turns south into a 39-inch RCP. The storm water runoff north of Santa Ana Boulevard from Washington Avenue runs southwest along the gutter and cross-gutters. Existing catch basins on the northeast corners of the perpendicular streets intercept water flowing south towards Santa Ana Boulevard which tie into the existing 27-inch RCP. At the northeast corner of the French Street/Santa Ana Boulevard intersection, shallow parkway culverts (1 to 5-ft wide) convey water from French Street to a low point on Santa Ana Boulevard.

From French Street to Ross Street: Santa Ana Boulevard has three lanes in the westbound (one-way) direction. The roadway profile varies due to cross gutters carrying flow along the perpendicular streets from north to south especially between French Street and Broadway. Along this segment, no major existing drainage facilities exist except for a 33-inch RCP which flows south on Spurgeon Street and then turns east on Santa Ana Boulevard to tie into the junction chamber at the intersection of French Street and Santa Ana Boulevard. Parkway culverts are located at Spurgeon Street and Broadway intersecting with Santa Ana Boulevard.

On Ross Street: several laterals are located between Civic Center Drive and Santa Ana Boulevard. A total of five catch basins are within this area. In addition, an existing 24-inch RCP crosses Santa Ana Boulevard and heads south to an existing 33-inch RCP at the intersection of Third Street.

Between Ross Street and Flower Street: water is conveyed along the curb and gutter with existing catch basins at the northeast corner collecting the storm runoff. Flower Street has an existing 33-inch RCP crossing Santa Ana Boulevard which runs south towards Pine Street and then turns westerly on Pine Street towards Shelton Avenue.

Fourth Street: Along Fourth Street, the roadway profile varies especially at the intersections where cross gutters convey the runoff from north to south. Cross gutters are located on the east side of each intersection. From Ross Street to Mortimer Street, concrete V-gutters exist on both sides of the street adjacent to the parking. The runoff flows westerly and south along these existing V-gutters and cross gutters.

3.1.5.6 Downtown Segment - Streetcar Alternative 2 (Brown/6th Street, Civic Center Drive, and Flower Street)

Brown and Sixth Street: From Santiago Street to Poinsettia Street, Brown Street is an access way to existing commercial buildings. Under this alternative, the access way will need to be dedicated as a public ROW for transit use. In general, the runoff is conveyed along curb and gutter, and cross gutters as it flows westerly along Brown Street/Sixth Street, then south along Minter Street. The existing roadway conditions along Brown Street/Sixth Street from Santiago Street to French Street consist of one lane in each direction carrying two-way traffic. At the

intersection of French and Sixth Streets, an existing 27-inch RCP from Santa Ana Boulevard and an existing 33-inch RCP from Spurgeon Street connect to a 39-inch RCP which runs south on French Street.

Civic Center Drive: Civic Center Drive is a major east-west arterial consisting of three lanes in each direction west of Main Street. The existing drainage areas impacting Civic Center Drive along the proposed alignment extend north to Washington Avenue. The storm water runoff is collected along the existing concrete curb and gutters, and cross gutters, and then runs along the north side of Civic Center Drive. Various existing catch basins on Civic Center Drive convey the storm water runoff to existing storm drain systems. The following is a summary of existing drainage facilities:

- 24-inch RCP runs west from Broadway to Ross Street, then turns south along Ross Street
- 18-inch RCP from Main Street to Spurgeon Street
- Three (3) existing catch basins near intersection at Main Street and at Bush Street
- 21-inch RCP north-south direction on Broadway ties into 24-inch RCP on Civic Center Drive
- 18-inch RCP lateral for catch basin connects at Broadway/Civic Center Drive Intersection

Flower Street: Flower Street is a major north-south arterial consisting of three lanes in each direction between Civic Center Drive and Santa Ana Boulevard. The pavement along Flower Street is concrete. Flower Street conveys most of the storm water runoff from as far north as Seventeenth Street. The existing parcels and streets bounded by Ross Street on the east, Flower Street on the west, Seventeenth Street on the north, and Civic Center Drive on the south have minimal drainage facilities to convey or collect the runoff. Runoff flows westerly towards Flower Street and then south towards the intersection of Flower/Civic Center Drive. At the intersection, storm water runoff is collected by existing catch basins which connect to an existing 33-inch RCP running south along Flower Street to Pine Street. Flower Street also has existing catch basins on the west side of the street at its intersections with Sixth Street and with Santa Ana Boulevard.

3.1.5.7 Raitt to Flower Segment (Streetcar Alternatives 1 and 2)

The Raitt to Flower Segment of the Study Area is a land use mixture of commercial, schools, and residential. The topography within this segment is a flat grade towards the west and south.

The street segment slope varies from a 0.5% to a 2.0% grade. The drainage areas for this segment are bounded by Fifth Street on the north and Santa Ana Boulevard on the south. Storm water runoff from existing streets and parcel areas north of Fifth Street are conveyed in existing drainage systems not impacted by the streetcar alignments. The eastbound side of the streetcar alignment has only on-site street flow, and no off-site drainage.

Along Santa Ana Boulevard between Flower Street and Shelton Avenue: storm water runoff is conveyed along concrete curb and gutter and then intercepted in a catch basin at the northeast corner of the Shelton Avenue and Santa Ana Boulevard intersection. The lateral connects to an existing north-south 27-inch drainage system. Between Shelton Avenue and Bristol Street, storm water runoff is conveyed along concrete curb and gutter and then intercepted with parkway culverts at the intersection of Bristol Street and Santa Ana Boulevard. The runoff continues southerly along Bristol Street.

From Bristol Street to Raitt Street: Santa Ana Boulevard consists of one lane in each direction with street parking on each side. The existing streets and curbs, gutters and sidewalks are in poor condition with various cracking. The storm water runoff is conveyed along the curb and gutter with cross gutters at the intersection of perpendicular streets. The runoff flows westerly to Raitt Street and then turns southerly through existing parkway culverts.

3.1.5.8 PE Right-of-Way Segment (Streetcar Alternatives 1 and 2)

The PE ROW segment is an existing 100-foot ROW corridor with minimal existing land uses. Most of the corridor is either vacant or public streets. The corridor extends from Raitt Street in Santa Ana to the vicinity of the I-710 in Los Angeles County. Within Orange County, it is substantially owned by the Orange County Transportation Authority. In some areas along the PE ROW, OCTA has allowed conditional interim use of the ROW; otherwise, within the Study Area, the corridor is vacant.

The segment is divided by the Santa Ana River. Between Raitt Street and Fairview Street, some existing tenants, mainly industrial, conditionally occupy portions of the PE ROW. The segment west of the Santa Ana River is vacant and composed of dirt and gravel. Minimal as-builts were available within this segment. The assumption is storm water runoff flows to both sides of the ROW and is conveyed through natural ditches.

3.2 PROJECT IMPACTS – HYDROLOGY

3.2.1 HYDROLOGY IMPACTS TO THE EXISTING CITY DRAINAGE FACILITIES

The following discussion evaluates the proposed Project's potential hydrology impacts by segment. This project consists of a streetcar system that is to be constructed within existing paved and developed properties. There are two possible maintenance yard locations; the remaining proposed Project area consists of alignment track.

From an overall evaluation, the delta between the pre- and post-project runoff flows are minimal as the project will be constructed within existing ROW and nominal changes to existing impervious area are anticipated. There may be localized areas where an increase in flow will occur due to changes in grading and water directional flow design.

After reviewing the existing drainage facilities and hydrology reports for the proposed Project, the change in impervious area added by the alternatives for the proposed Project would not affect the existing drainage facilities, given that the land use throughout this portion of the Study

Area was assumed to be commercial for the hydrology analysis and sizing of the City's drainage facilities. The commercial land use designation assumes the area is 90% impervious.

3.2.1.1 Initial Operable Segment

As identified in Section 1.1.4 of this document, Streetcar Alternatives 1 and 2 may be constructed in shorter segments due to funding constraints. Under this scenario, both Streetcar Alternatives 1 and 2 will terminate at the Raitt Street and Santa Ana Boulevard station rather than extending further west to Harbor Boulevard and Westminster Street. Under this alternative, existing facilities within the PE ROW segment, as identified in Section 3.1.5 above, will not be impacted.

3.2.2 TRACK DRAINAGE

Track drainage includes both drainage of water from top surface of the track and the subsurface support system. The objective is to avoid accumulation of standing water or trapped water pockets along the tracks. The storm water runoff within the track envelope will be contained and collected with track drains installed at low points and in areas required to drain water from the track envelope so as not to affect the streetcar operation. Track drain inlets will be of sufficient size to allow water to enter without ponding. Track drains will be installed to minimize the amount of water that may enter the sub-grade of the streetcar envelope. Water from the surface drains will be conveyed underground to the nearest storm drain facility.

3.2.3 IMPACTS TO EXISTING DRAINAGE PATTERNS

The drainage patterns for the proposed Project were analyzed and compared to the existing conditions.

Existing drainage patterns would not be altered and the affected city drainage facilities would still drain to the same watersheds. The two streetcar alignments would not significantly alter the existing drainage patterns as the tracks would be constructed at the same or similar grades as the existing roadway and/or ROW.

Impacts to and by the proposed O&M facilities will be non-significant. The proposed locations are currently developed therefore there is significant change in runoff or water flow management. As stated in Section 3.3.4, there will be localized changes to some catch basins, however, the drainage patterns would not be significantly altered and the City drainage facilities along the alignment would still drain to the same watersheds as identified under the background cumulative condition.

3.3 CUMULATIVE CONDITION WATERSHED ASSESSMENT

3.3.1 CUMULATIVE LAND USE PLAN

As described in previous sections of this report, the proposed Project alternatives are aligned through existing urbanized areas within Santa Ana and Garden Grove. Under the Cumulative condition, proposed maintenance yard locations and alignment land uses in the Study Area would be redeveloped slightly from their existing condition. The maintenance yard locations are to be located within existing developed sites; the primary effect of these yards is from the long

term activities that occur on the site (which in itself is also minor). The track alignment and stations would be developed with minor changes to land use. It is necessary to take these new land uses into account to gauge the potential impacts of the proposed Project as it relates to hydrology. The future hydrology in the Study Area was reviewed to characterize the cumulative condition for the proposed Project's No Build Alternative, and to provide the basis for the analysis of the Project alternatives.

3.3.2 CUMULATIVE CONDITION WATERSHED DESCRIPTION

The existing conditions reflect similar runoff conditions as are expected for the proposed Project. As the proposed Project and future local projects all must meet the same regulatory conditions for both drainage and water quality impacts, the cumulative impacts would be minimal.

3.3.3 HYDROLOGY IMPACTS TO REGIONAL DRAINAGE FACILITIES - CUMULATIVE CONDITION

The potential impacts to the cumulative condition for 100-year peak flows associated with the proposed Project are discussed in this section.

The proposed Project alignments lie within existing commercial land use and mixed use development. These land use designations will not change under the cumulative condition. Commercial development land uses presume 90% impervious areas for the hydrology calculations; therefore, the addition of the proposed Project is consistent with these land uses under the cumulative condition. For all Project alternatives, the small increase in impervious area associated with the proposed Project would still be below the original 90% threshold assumptions and would not increase the downstream 100-year flow rates for the hydrology model. As such, the proposed Project is not predicted to adversely impact the capacity of regional drainage facilities that serve the Study Area.

3.3.4 IMPACTS TO DRAINAGE PATTERNS FOR THE CUMULATIVE CONDITION

The various Project alternatives were assessed to determine if the proposed alignments would result in a change to future drainage patterns for the cumulative condition. There will be localized changes to some catch basins, however, the drainage patterns would not be significantly altered and the City drainage facilities along the alignment would still drain to the same watersheds as identified under the background cumulative condition.

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CHAPTER 4 FLOODPLAIN

4.1 REGULATORY REQUIREMENTS

The term "floodplain" refers to the lowland and relatively flat areas adjoining inland waters, including at a minimum areas subject to a 1% (100-year flood) or greater chance of flooding in any given year. The following paragraphs present the current regulations or managing agencies concerning floodplain management.

4.1.1 EXECUTIVE ORDER 11988/FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Federal agencies consult with FEMA concerning implementation of the Executive Order and base their decision on a set of guidelines to decide if a project will have any potential impacts to or within the floodplain. Executive Order 11988 applies to acquisition, new construction, and most rehabilitation activities that are undertaken with Federal assistance within special flood hazard areas designated by FEMA.

4.1.2 NATIONAL FLOOD INSURANCE PROGRAM (NFIP) REGULATIONS (44 CFR PARTS 59-78) EMERGENCY MANAGEMENT AND ASSISTANCE

Any projects within a floodplain require following the NFIP regulations:

U.S. DEPARTMENT OF TRANSPORTATION ORDER 5650.2 FLOODPLAIN MANAGEMENT AND PROTECTION:

Any projects within a floodplain require a detailed analysis in the environmental document as specified in the U.S. Department of Transportation Order 5650.2 Floodplain Management and Protection (April 23, 1979). The analysis is to discuss any risk to or resulting from the action; the impacts on natural and beneficial floodplain values; the degree to which the action provides direct or indirect support for development in the floodplain; and measures to minimize harm or to restore or preserve the natural and beneficial floodplain values affected by the cumulative project.

STATE REGULATIONS:

California Environmental Quality Act (CEQA) compliance is required for all projects to regulate activities which may affect the quality of the environment so that major consideration is given to preventing damage to the existing environment. As such, the following CEQA regulations have been considered in this analysis with respect to the floodplain:

California Environmental Quality Act (CEQA) Chapter 17. (This chapter discusses the Title 14. California Code of Regulations, responsibilities of Federal Highway Administration (FHWA), Caltrans and local agencies when projects encroach on a 100-year base floodplain).

CITY OF SANTA ANA REGULATIONS:

All cities and counties participating in the NFIP have floodplain regulations for activities within the floodplain. Floodplain regulations are intended to ensure that floodplain development is safe from flooding and causes no adverse impact on adjacent property and generally includes floodplain mitigation. Floodplain mitigation refers to the measures a community takes to correct and prevent flood risks. These efforts generally include zoning, subdivision, rules for building in floodplains, and special-purpose floodplain ordinances. The following city regulations and provisions have been considered in the analysis with respect to the floodplain:

City of Santa Ana Municipal Code – Part II, Chapter 7, Articles 1 -5 adopted July 20, 2009.

4.2 EXISTING CONDITION FLOODPLAIN ASSESSMENT

FEMA has conducted floodplain analysis studies throughout California that have resulted in the development of Flood Insurance Rate Maps (FIRMs) for affected areas. FIRMs identify the estimated limits of the 100-year and 500-year flood event in each watershed. The current FIRMs for the proposed Project area were accessed and reviewed from the FEMA website (FEMA, 2011). The Study Area of the proposed Project is located within FIRM numbers 06059C0163J, 06059C0144J, 06059C0143J, 06059C0276J, 06059C0257J, 06059C0256J dated December 3, 2009.

FEMA has defined certain geographic areas as flood zones according to varying levels of flood risk that are depicted on a community's FIRM by varying shades and patterns of color. Each zone reflects the severity or type of flooding in the area. For example: the 100-year flood (or 1% annual chance flood) boundary is defined as a flood level with a one percent chance of being equaled or exceeded in any given year.

Flood Hazard Zone "X (unshaded)" corresponds to areas outside the 500-year floodplains or 0.2% annual chance floodplain. This flood zone has the least risk of flooding and base flood elevations are not shown on the FIRMs in these areas of lower risk. However, buildings in this zone could be flooded by severe, concentrated rainfall coupled with inadequate local drainage facilities. City drainage facilities are not normally considered in the community's Flood Insurance Study. The failure of the local drainage facilities can create areas of high flood risk within this zone.

Flood Hazard Zone "X (shaded)" has been identified in the community flood insurance study as an area of moderate or minimal hazard from the principal source of flooding in the area (roughly speaking, outside the 100-year flood limits but inside the 500-year flood limits). Base flood elevations are not shown on the FIRMs in these areas of low to moderate risk. According to FEMA flood zone designations, these are the flood zones that correspond to areas outside the 100-year floodplains, areas of 100-year sheet flow flooding where average depths are less than 1 foot, areas of 100-year stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 100-year flood by levees. Since these areas are not expected to flood during the 100-year flood, floodplain construction rules are not applicable to structures in a flood zone "X (shaded)".

Flood Hazard Zone “A” has been identified in the community flood insurance study as an area subject to inundation by the 100-year flood event. On the referenced maps, this is a Special Flood Hazard Area Subject to Inundation by the 1% (100-year) Annual Chance Flood. These areas are not subjected to detailed hydraulic analyses; therefore, no base flood elevations or depths are shown within this zone. In these areas, the general contour and topography of the drainage basin is used to estimate flood areas. Any development in this area has to follow the regulations provided under State and federal regulatory requirements.

The floodplain limits and zoning designations in the Study Area are shown on Figure 4-1, Flood Hazard Zones.

The FIRMs that were analyzed for this analysis reflect that there are portions of Flood Hazard Zones “X (shaded and unshaded)” within the Project Study Area. However, the Project alternatives only cross over flood zones “X” (unshaded) and a small portion within flood zones “X” (shaded). There are also Project locations mapped within Zone A both at channel crossings and within the western portion of the proposed Project.

4.3 EXISTING CONDITION FLOODPLAIN IMPACTS

The floodplains for the 100-year storm events within the Study Area are shown on Figure 4-1, Flood Hazard Zones. The regional channels within the Study Area are Santa Ana Delhi, Santa Ana River and East Garden Grove Wintersburg Channels. The major drainage course through the Study Area is the Santa Ana River.

To the east of Harper Street (approximately) in Santa Ana, both of the proposed Project alignments would generally be outside the 100-year floodplain zones for the existing condition; only crossing the flood plains at the channel locations. These alternatives include proposed bridge structures for the segment of the Project crossing the channels, and therefore would not impact the floodplain zone. Both alternatives are partially within the 500 year flood plain (“X” shaded) which would be managed by the local drainage systems. There are no construction requirements within this flood plain designation.

To the west of Harper Street (approximately), which is primarily the PE ROW segment, the entire alignment is within the 100 year flood plain (Mapped Zone A). The flood elevations have not been analyzed by FEMA; the current data is based on existing topography and local drainage designs. It is expected that the alignment and structures within this area would be impacted by a 100-year flood event. Additional analysis will be necessary for this portion of the project during final design including but not limited to scour, grading analysis and location/structure specific hydrology analysis.

4.3.1.1 Initial Operable Segment

As identified in Section 1. 1.4 of this document, Streetcar Alternatives 1 and 2 may be constructed in shorter segments due to funding constraints. Under this scenario, both Streetcar Alternatives 1 and 2 will terminate at the Raitt Street and Santa Ana Boulevard station rather than extending further west to Harbor Boulevard and Westminster Street. Under this alternative, the project would not extend to the area within the 100-year floodplain.

4.4 CUMULATIVE CONDITION FLOODPLAIN ASSESSMENT

There are no proposed channel modifications with this project. As currently proposed, the Project's structures will have no impact to the floodplains. Modifications to protect the proposed Project within the western portion of the alignment will be necessary but the impacts should be slight with mitigation.

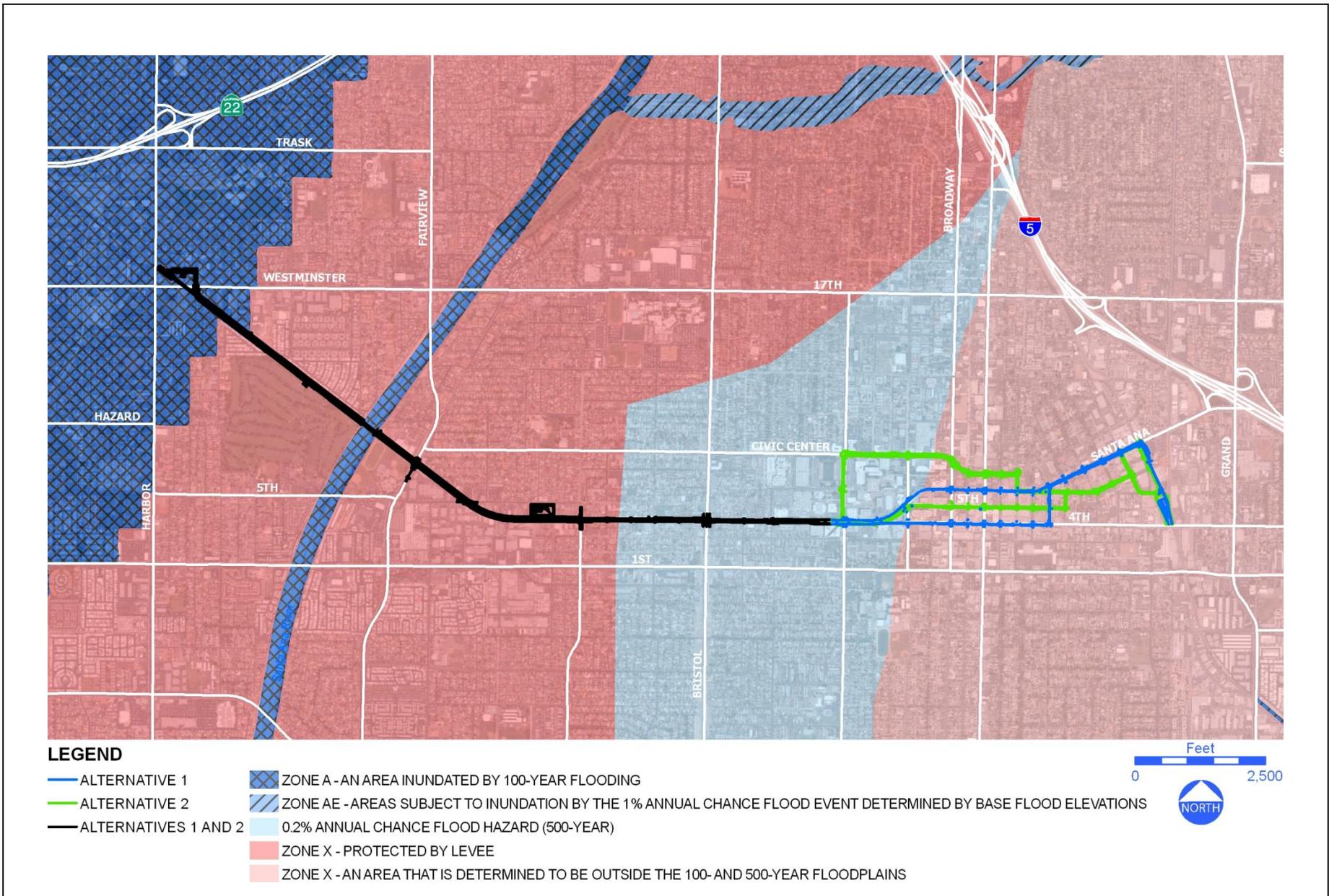
4.5 CUMULATIVE CONDITION FLOODPLAIN IMPACTS

It has been established that the eastern portion of the proposed Project's alternative alignments would be located outside the 100-Year and partially within 500-Year floodplain zones for the cumulative condition.

As previously stated, since the Flood Hazard Zone "X" (shaded) is not expected to flood during the 100-year flood, floodplain construction rules are not applicable to structures in this "X (shaded)" flood zone. Therefore the proposed Project alternatives would not affect cumulative condition floodplains.

The western portion, specifically the PE ROW Segment, is within a 100-year flood zone. Construction regulations and additional hydrologic analysis will be required to mitigate impacts. The project is not likely to impact the cumulative condition, but there may be isolated locations where additional drainage will be necessary.

Note that the focus of the cumulative floodplain impact analysis is on site design conditions. It is expected that the construction process will have little to no impact on the flood plain.



Source: FEMA, December 3, 2009, Panels: 06059CO143J, 06059CO144J, 06059CO256J, 06059CO257J, 06059CO163J, 06059CO276J,

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CHAPTER 5 WATER QUALITY

5.1 REGULATORY REQUIREMENTS

5.1.1 FEDERAL CLEAN WATER ACT

The Clean Water Act (CWA) is the principal federal law that addresses aquatic resources and water quality. The primary objectives of the CWA are to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters,” and to make all surface waters “fishable” and “swimmable.” The following paragraphs present the water quality requirements that will affect this Project.

- **Compliance with Water Quality Standards.** The CWA requires States to adopt water quality standards for water bodies subject to review and approval by the United States Environmental Protection Agency (USEPA). In California, the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs) set water quality standards under authority established by the California Porter-Cologne Water Quality Act (See Section 5.1.3). Water quality standards consist of designated beneficial uses for a particular water body, along with water quality criteria necessary to support those beneficial uses (40 CFR §131.3[i]). Designated beneficial uses describe the appropriate uses of that water body, such as water contact recreation, commercial or sport fishing, wildlife habitat, agricultural supply, groundwater recharge, and municipal water supply. Water quality criteria are established for in-stream conditions expressed either as numeric limits or as narrative statements, and represent the quality of water that support a particular beneficial use. The proposed Project/s Study Area is located within the jurisdiction of the Santa Ana RWQCB.
- **CWA Section 303(d).** Where water quality standards are not being achieved, Section 303(d) of the CWA requires identifying and listing that water body as “impaired.” This listing of impaired water bodies is typically referred to as the “303(d) List”. A water body can be listed for one or more impairments. Once a water body has been included on a 303(d) List, a Total Maximum Daily Load (TMDL) for the pollutant causing the impairment must be developed for that water body. A TMDL is the allowable total pollutant load that can be discharged from all sources, and still ensure that water quality standards are achieved (e.g., water quality objectives are met and beneficial uses are protected). The TMDL must also include a margin of safety. TMDLs are established by RWQCBs under the Porter-Cologne Act (CA Water Code §§ 13000 et seq.) through amendment of the Basin Plans. A Basin Plan is a document designed to preserve and enhance water quality and protect beneficial uses of all regional waters. The Basin Plan designates beneficial uses for surface and groundwater, sets narrative and numerical water quality objectives, and describes the implementation of programs to protect water regionally. Once established, the TMDL is allocated among current and future dischargers into the water body. Established TMDLs applicable to the Watershed are discussed in Section 5.2.1, Surface Water Quality Existing Conditions.

- **CWA Section 404.** Section 404 of the CWA, administered by the U.S. Army Corps of Engineers (ACOE) regulates the discharge of dredged and/or fill material into waters of the United States including wetlands. The term “waters of the U.S.” generally defines ACOE jurisdiction, and is fully defined in 33 CFR Part 328. Projects that require the discharge of dredged or fill material into ACOE jurisdictional waters require the issuance of a CWA Section 404 permit, that demonstrates proper avoidance, minimization and compensation of impacts to ACOE jurisdictional resources. Since the proposed Project includes crossings over the Santa Ana River and other channels, a Section 404 permit may be required for each crossing of Waters of the U.S.
- **CWA Section 401.** In accordance with Section 401 of the CWA, an applicant for a Section 404 Permit must obtain certification from the RWQCB stating the proposed fill does not violate water quality standards and criteria specified in the Basin Plan. A request for certification of Waste Discharge Requirements (WDRs) is submitted to the RWQCB as the same time that an application for a Section 404 permit is filed with the ACOE. Because no ACOE permit is valid under the CWA unless certified by the State, the RWQCB may effectively “veto” or add conditions to any ACOE permit through the 401 certification process.

5.1.2 CALIFORNIA PORTER-COLOGNE WATER QUALITY ACT

California’s Porter-Cologne Water Quality Control Act established the SWRCB and the nine RWQCBs. Each RWQCB is required to adopt a Basin Plan that describes the existing water quality conditions and problems in the region, and establishes beneficial uses of the surface waters and groundwaters in the region (Receiving Waters) along with defining water quality objectives to protect the beneficial uses of the Receiving Waters. The following paragraphs present the implementation of the Porter- Cologne act in California.

5.1.2.1 Water Quality Objectives and Beneficial Uses

SURFACE WATER

The proposed Project is located within the jurisdiction of the Santa Ana RWQCB and is subject to the provisions of the Santa Ana River Basin Water Quality Control Plan (Basin Plan) which identifies the water quality objectives and beneficial uses for waters within its jurisdiction. Surface water runoff from the Study Area drains to Newport Bay, the Santa Ana River and Anaheim Bay-Huntington Harbour. Table 5.1 shows the present and potential beneficial uses for these receiving waters and their tributaries.

WATER QUALITY OBJECTIVES

Water quality objectives identified in the Basin Plan are based on the established beneficial uses, and are defined as “the limits or levels of water quality constituents or characteristics, which are established for the reasonable protection of beneficial uses.” In addition, the USEPA established numeric water quality criteria for toxic substances in certain designated Receiving Waters of California based on beneficial uses relating to aquatic life or human health. This is known as the California Toxics Rule (CTR) (40 CFR §131.38). The SWRCB adopted a State Implementation Plan (SIP) for the CTR. The CTR criteria do not apply to storm water

discharges; instead, those discharges are regulated through various NPDES storm water permits. Applicable numeric water quality objectives for surface water as well as the CTR standards are shown in Table 5.2. Applicable groundwater beneficial uses for groundwater are shown in Table 5.3. The Basin Plan also references California Drinking Water Standards as additional objectives that are sometimes applied to surface and groundwater.

303(d) LIST

The Newport Bay (Lower), East Garden Grove Wintersberg Channel and Huntington Harbour have been determined to be impaired by the SWRCB and are included on the 2010 CWA 303(d) list of impaired water bodies since they do not meet established water quality standards. The water quality objectives these three water bodies must meet are in varying stages of development. The listings for Wintersberg Channel and Huntington Harbour are proposed objectives not currently developed into impairments or enforced. While not all objectives are included in the objective regulations, these water bodies (Newport Bay only at this time) are considered impaired from pathogens (fecal coliform), sediment toxicity, chlordane, PCBs, Ammonia as well as metals (copper, lead, and nickel). These contaminants have impacted Newport Bay in the form of excessive sedimentation, eutrophication, bacterial contamination, and toxic contamination. The County of Orange regularly monitors surface water quality in Newport Bay including many of the constituents for which these water bodies are impaired. The 303(d) objectives are presented in Table 5.4 including proposed objectives for Huntington Harbour and East Garden Grove Wintersberg Channel.

Table 5-1 Beneficial Uses List

Water Body	BENEFICIAL USE																				Hydrologic Unit
	MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	LWRM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST	Primary
Lower Newport Bay	+					X		X	X	X					X	X	X	X	X		801.11
Santa Ana River – Reach 1	+							X	X		I				I						801.11
Anaheim Bay	+							X	X					X	X	X	X	X			801.11

Source: Santa Ana River Basin Water Quality Control Plan, 1995

X = Present or Potential Beneficial Use for listed water body

I = Intermittent Beneficial Use

+ = Exempted from MUN (see text)

**Table 5.2 Water Quality Objectives and CTR Standards
Applicable to Surface Water**

Constituent	Units	Basin Plan Objectives a	California Toxics Rule a,b	
			(CMC)c	(CCC)d
Inorganic Chemicals				
Aluminum	mg/L	--	--	--
Antimony	mg/L	--	--	--
Arsenic	mg/L	--	0.34	0.15
Asbestos	MFL	--	--	--
Barium	mg/L	--	--	--
Beryllium	mg/L	--	--	--
Boron	mg/L	0.75	--	--
Cadmium	mg/L	--	0.0043	0.0022
Chromium	mg/L	--	0.016	0.011
Chloride	mg/L	--	--	--
Copper	mg/L	--	0.013	0.009
Cyanide	mg/L	--	--	--
Fluoride	mg/L	San Diego Creek 0.7-1.2 (depending on air temp.) Upper Newport Bay Basin Plan Objectives not established	--	--
Iron	mg/L	---	--	--
Lead	mg/L	--	0.065	0.0025
Manganese	mg/L	---	--	--
Mercury	mg/L	--	--	--
Nickel	mg/L	--	0.47	0.52
Nitrate + Nitrite (as N)	mg/L	-- ^b	--	--
Nitrite (as N)	mg/L	--	--	--
Selenium	mg/L	--	--	0.005
Silver	mg/L	--	0.0034	--
Sodium	%	--	--	--
Sulfate	mg/L	--	--	--
Thallium	mg/L	--	--	--
Zinc	mg/L	--	0.12	0.12
Others				
Ammonia (as N) ^e	mg/L	San Diego Creek Table 4.2 of Basin Plan	--	--
Chlorine, Residual	mg/L	0.1	--	--
Chemical Oxygen Demand (COD)	mg/L	San Diego Creek Reach 1: 90 Reach 2: --- Upper Newport Bay Basin Plan Objectives not established	--	--
Fecal coliform bacteria	Organisms/ 100mL	San Diego Creek MUN: < 100 REC-1: < 200 REC-2: < 2000 Upper Newport Bay REC-1: < 200 SHEL: 14 MPN	--	--

Santa Ana and Garden Grove Fixed Guideway Project

Constituent	Units	Basin Plan Objectives a	California Toxics Rule a,b	
			(CMC)c	(CCC)d
pH	pH Units	San Diego Creek 6.5-8.5 Upper Newport Bay 7.0-8.6	--	--
Specific Conductance	(μ s)	--	--	--
Temperature	$^{\circ}$ F	San Diego Creek < 90 June through Oct < 78 Nov through May	--	--
Total dissolved solids (TDS)	mg/L	San Diego Creek Reach 1: 1500 Reach 2: 720 Upper Newport Bay Basin Plan Objectives not established	--	--
Total Inorganic Nitrogen (TIN)	mg/L	San Diego Creek Reach 1: 13 Reach 2: 5 Upper Newport Bay Basin Plan Objectives not established	---	---
Turbidity	NTU	0-50 NTU: max. incr. 20% 50-100 NTU: max. incr. 10 NTU > 100 NTU: max. incr. 10%	---	---

Source: Santa Ana River Basin Water Quality Control Plan, 1995; California Toxics Rule, May 2000.

Notes:

- ^a California Toxics Rule (CTR) freshwater aquatic life criteria.
- ^b Certain CTR criteria (e.g., copper, lead, zinc) are hardness dependent and can vary depending on the hardness of the Receiving Water at a given time.
- ^c Criteria Maximum Concentration (CMC) equals the highest concentration to which aquatic life can be exposed for a short period of time not to be exceeded more than once every three years on average.
- ^d Criteria Continuous Concentration (CCC) equals the highest concentration to which aquatic life can be exposed for an extended (4-days) period of time not to be exceeded more than once every three years on average.
- ^e Un-ionized ammonia is toxic to fish and other aquatic organisms.

- Not applicable at this time

Mg/L = milligrams per liter

mL = milliliters

NTU = Nephelometric Turbidity Unit

MFL = million fibers per liter

(μ s) = microSiemens

Table 5-3 Groundwater Beneficial Use

	BENEFICIAL USE																			Hydrologic Unit	
	MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	LWRM	COLD	BIOL	WILD	RARE	SPWN	SHEL	EST	Primary	
Main (Orange)	X	X	X	X																801.11	801.13, 801.14, 845.61, 845.63

Source: Santa Ana River Basin Water Quality Control Plan, 1995
 X = Present or Potential Beneficial Use for listed groundwater body

Table 5-4 Current and Proposed 303(d) Water Body Listings

Water Body	Pollutant								
	Bacteria Indicators/Pathogens	Metals	Nutrients	Pesticides	Toxicity	Trash	Salinity/ TDS/ Chlorides	Turbidity	Other Organics
Huntington Harbor*	X	X	X	X	X	X	X	X	X
Newport Bay, Lower		X	X	X	X				X
Wintersburg Channel**					X				

Source: SWRCB 2010 303(d) listing; http://www.swrcb.ca.gov/water_issues/programs/tmdl/integrated2010.shtml.

Notes:

* to be developed in 2019

** to be developed in 2021

5.1.3 NPDES STORM WATER PERMITS

Direct discharges of pollutants into waters of the U.S. are not allowed (e.g., end of pipe discharges), except in accordance with the permitting program of the CWA, NPDES (33 U.S.C. §1342(p)). The SWRCB and RWQCBs implement and administer the NPDES program in the California. Pursuant to the NPDES program, permits have been issued that apply to storm water discharges from large municipal separate storm sewer systems (MS4), specific industrial activities, and construction activities of one acre or greater.

NPDES permits require water quality-based limitations for pollutants that may cause or contribute to an exceedance of a State water quality standard (40 CFR §122.44). NPDES permits may establish enforceable effluent limitations on discharges, require monitoring of discharges, designate reporting requirements, or require the discharger to implement best management practices (BMPs). BMPs are activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs may be used in addition to numeric effluent limitations, or, in some cases, in lieu of numeric effluent limitations (40 CFR §122.44(k)).

The three storm water NPDES permits that are applicable to the proposed Project are the:

1. General Permit for Storm Water Discharges Associated with Construction Activities, NPDES No. CAS000002, as amended (Construction General Permit);
2. Santa Ana RWQCB Municipal Separate Storm Sewer System (MS4) NPDES Permit for the County of Orange, OCFCD, and incorporated cities, NPDES Permit No. CAS618030 (MS4 Permit); and
3. General Permit for Storm Water Discharges Associated with Industrial Activities NPDES No. CAS000001 (for the O&M facilities).

The Statewide General Industrial Permit (No 3. above) is under revision at this time. The State Water Resources Control does not have a current timeline for when this revised Permit will be adopted. The following paragraphs present the details of the applicable statewide general permits.

5.1.3.1 General Permit for Storm Water Discharges Associated with Construction Activities

Storm water discharges from construction activities disturbing one acre or more of soil are regulated by the SWRCB under the Construction General Permit. The Construction General Permit is a risk based permit requiring implementation of a SWPPP (including Risk Analysis), Rain Event Action Plans, specific training and a Construction Site Monitoring Program (CSMP). A SWPPP identifies the BMPs that will be implemented to reduce or eliminate sediment and other construction material pollutants in storm water and non-storm water discharges from the construction site. BMPs implemented under the Construction General Permit must meet the technology standards of Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology. Under the Construction General Permit, the SWPPP and CSMP must describe the anticipated construction activities and potential

pollutants, select BMPs to control the anticipated pollutants (including erosion, sediment, materials, and waste management controls), establish processes for inspection and maintenance of BMPs, and include reporting provisions. The CSMP inspections must be conducted to identify areas contributing to storm water discharges; to evaluate whether BMPs identified in the SWPPP are adequate, properly installed, and functioning to meet the requirements of the Construction General Permit; and to identify additional BMPs or corrective maintenance activities that are needed. The Construction General Permit requires that the SWPPP for any project must be designed and implemented such that discharges from construction sites do not to cause or contribute to exceedances of Receiving Water quality standards. On an annual basis, construction activities must be certified to be in compliance with requirements of the Construction General Permit.

5.1.3.2 Municipal Separate Storm Sewer System (MS4) Permit and the Orange County Drainage Area Management Plan

Beginning in 1990, the County of Orange, the OCFCD and the central and northern incorporated cities in Orange County collectively were issued their MS4 Permit for storm water discharges from their MS4s within the jurisdiction of the Santa Ana RWQCB. The MS4 Permit was re-issued in 1996, 2002, 2009 and again in 2010. The MS4 Permit requires implementation of storm water management practices, control techniques, system design and engineering methods to protect beneficial uses of Receiving Waters to the maximum extent practicable. The MS4 Permit governs storm water and urban runoff discharged into the MS4, operated by the County and cities, and provides conditional approval of certain non-storm waters to be discharged through the MS4 as long as such discharges are not identified as a significant source of pollutants.

The Orange County Drainage Area Management Plan (DAMP) describes the programs and activities that are implemented by the County and the cities for compliance with the MS4 Permit. The County and cities, including the City of Santa Ana, have developed Local Implementation Plans (LIPs) for implementation of the DAMP program elements within their respective jurisdictions. One program element of the DAMP, as required by the MS4 Permit, is to minimize the short- and long-term impacts on Receiving Water quality from new development and significant redevelopment¹.

¹ New Development is defined as land disturbing activities; structural development, including construction or installation of a building or structure, the creation of impervious surfaces; and land subdivision. Significant Redevelopment is defined as the addition or the replacement of 5,000 or more square feet of impervious surface on an already developed site.

Under this program element, Project Water Quality Management Plans (WQMPs) must be prepared and implemented for “priority projects²” to minimize the effects of development on site hydrology, runoff flow rate and velocities, and pollutant loads to the maximum extent practicable.

The WQMP for a new development or significant redevelopment project must incorporate a variety of post-development BMPs that collectively address pollutants of concern and hydrologic conditions of concern for the project’s storm water runoff. [Note: A Preliminary Storm Water Data Report (SWDR) has been developed for this Project and is attached as Appendix Ô to this Water Resources Technical Report. This document can be used as a precursor to the WQMP.]

The six categories of BMPs that must be addressed by a proposed Project as specified in the Model WQMP that was approved by the Santa Ana RWQCB in March 2011 include:

- Site design measures
- Implementing LID BMPs on-site
- Constructing or participating in sub-regional/regional LID BMPs
- Implementing hydromodification control BMPs
- Utilizing alternative programs or treatment control BMPs
- Employing applicable source control BMPs

As required by the Model WQMP new development and significant redevelopment projects must meet specific volume-based and/or flow-based numerical sizing criteria for treating storm water runoff. The City of Santa Ana has incorporated the Model WQMP and associated guidance documents into their LIPs for use by public and private sector applicants.

Both the MS4 Permit and the Model WQMP encourage the use of regional or Watershed management programs to address runoff from new development and significant redevelopment. Participation in RWQCB-approved regional treatment systems, such as Irvine Ranch Water District’s (IRWD) Natural Treatment System (NTS), can fulfill the treatment control requirements of the DAMP/LIPs, if certain criteria are met.

5.1.4 GENERAL NPDES PERMIT/WASTE DISCHARGE REQUIREMENTS FOR SHORT-TERM GROUNDWATER DISCHARGES AND DE MINIMUS WASTEWATER DISCHARGES

The Santa Ana RWQCB’s Order No. R8-2004-0021 is a NPDES general permit for short-term groundwater discharges and *de minimus* wastewater discharges to surface waters within the San Diego Creek/Newport Bay Watershed (Dewatering General Permit). Dewatering is the

2 Priority Projects include: residential development of 10 units or more, commercial and industrial development greater than 100,000 square feet including parking areas; automotive repair shops; restaurant where land area of development is 5,000 square feet or more including parking areas; hillside development on 10,000 square feet or more which is located on areas with known erosive soil conditions or where natural slope is 25 percent or more; impervious surface of 2,500 square feet or more located within, directly adjacent to (within 200 feet), or discharging directly to receiving water within Environmentally Sensitive Areas; parking lot area of 5,000 square feet or more, or with 15 or more parking spaces, and potentially exposed to urban runoff; and all significant redevelopment projects, where significant redevelopment is defined as the addition or the replacement of 5,000 or more square feet of impervious surface on an already developed site.

process of removing groundwater from the construction area. This Dewatering General Permit covers:

- Short term (one year or less duration) discharges from activities involving groundwater extraction and discharge such as wastes associated with well installation, development, test pumping and purging; aquifer testing wastes; dewatering wastes from subterranean seepage; and groundwater dewatering wastes at construction sites; and
- Discharges that pose a minimal (de minimus) threat to water quality such as, but not limited to, construction dewatering wastes not involving groundwater or storm water, discharges resulting from diverted stream flows, discharges resulting from hydrostatic testing, non-contact cooling water, etc.

The Dewatering General Permit establishes numeric effluent limitations for oil and grease, sulfides, total suspended solids, total residual chlorine, and total petroleum hydrocarbons for authorized groundwater discharges and de minimus wastewater discharges. Additionally for groundwater discharges, the Dewatering General Permit establishes effluent limitations for total nitrogen and total recoverable selenium in support of the nutrient and selenium TMDLs. The Dewatering General Permit also requires development and implementation of an effluent monitoring program, with monitoring reports submitted to the RWQCB on a monthly basis.

5.2 EXISTING CONDITIONS

The Project's site is regionally located within the Santa Ana River Basin (SARB) as presented in the Santa Ana River Basin Plan and the OC Watersheds Basin Maps. The SARB is a group of connected inland basins and open coastal basins drained by surface streams flowing generally southwestward to the Pacific Ocean. The proposed Project area is located within the Newport Bay, Santa Ana River and the Anaheim Bay- Huntington Harbour Watersheds.

The largest existing storm drain system adjacent to and serving this area is the Santa Ana River. The Newport Bay is a secondary system. Smaller tributaries include the East Garden Grove Wintersburg and the Santa Ana Delhi Channels. The Santa Ana Regional Water Quality Control Board (RWQCB) has identified Newport Bay as impaired by nutrients, sediment, pathogens, pesticides, metals, and priority organics. The United States Environmental Protection Agency, Region IX established Total Maximum Daily Loads (TMDLs) for nutrients (nitrogen and phosphorus), pathogens and pesticides for the Lower Newport Bay watershed. In addition, it is generally recognized that Newport Bay is significantly impaired by trash. Both the Huntington Harbour and East Garden Grove Wintersburg water bodies are listed to have TMDLs developed within the next 8 to 10 years respectively. The expected TMDLs include 1) Ammonia for Wintersburg Channel (2021) and 2) Chlordane, Copper, Lead, Nickel, PCBs, Pathogens, and Sediment Toxicity (2019 for all affected waterbodies).

5.2.1 SURFACE WATER QUALITY EXISTING CONDITIONS

Surface water in Newport Bay has been determined to be impaired by various pollutants as listed in Table 5.5. Total Maximum Daily Loads (TMDLs) have been developed, or are being developed, to manage pollutant loading to the creek from various sources in the Watershed.

The Santa Ana RWQCB has developed the TMDLs in an effort to address and manage water quality issues for the water bodies designated as impaired by the 303(d) List.

Table 5-5 Current Water Quality Impairments of Local Water Bodies

Water Body	303(d) Impairment/TMDL Listing
Lower Newport Bay	Pesticides, Pathogens, Nutrients

Source: Santa Ana RWQCB. 2010 CWA 303(d) List of Water Quality Impaired Segments and TMDL Projects in the Santa Ana Region. <http://www.waterboards.ca.gov/santaana/>

5.2.2 GROUNDWATER QUALITY EXISTING CONDITIONS

The Coastal Plain of Orange County Groundwater Basin (Orange County Basin) underlies a coastal alluvial plain in the northwestern portion of Orange County. The basin is bounded by consolidated rocks exposed on the north in the Puente and Chino Hills, on the east in the Santa Ana Mountains, and on the south in the San Joaquin Hills. The basin is bounded by the Pacific Ocean on the southwest and by a low topographic divide approximated by the Orange County - Los Angeles County line on the northwest. The basin underlies the lower Santa Ana River watershed. The Coastal Basin groundwater system is analogous to a bowl filled with sediment and water, the central part of which contains freshwater-bearing deposits up to 4,000 ft. thick (California Department of Water Resources, 1967). Deposits along the margins of the basin, in the Irvine and Yorba Linda subbasins and the La Habra Basin, are less thick and less permeable than in the main part (Main Basin).

The Main Groundwater Sub-basin that underlies the Santa Ana Watershed area is located in an area that is characterized by a deep structural alluvial basin containing a thick accumulation of interbedded sand, silt and clay. The Orange County Basin contains three defined aquifer units: the Upper, Principal (or Middle) and Lower aquifers. In the northern portions of the Orange County Basin, referred to as the Forebay area, many of these aquifers are merged and allow for direct recharge into the deeper aquifers. In the area referred to as the Pressure Area, these aquifers are less hydraulically connected and create confined aquifer conditions.

In general, groundwater in the main producing aquifers of the basins is of good quality with an average concentration of total dissolved solids (TDS) in the basin of 441 mg/L (OCWD, 2006). Ninety to 95 percent of basin pumping is from the main aquifers. A few localized areas of shallow contamination exist in the basin; however, very little water is pumped from the shallow aquifers.

5.2.2.1 Existing Groundwater Contamination

Key constituents of concern for the Main Basin include: total dissolved solids, nitrate, volatile organic compounds (VOCs), perchlorate, colored water, and N-Nitrosodimethylamine (NDMA). The nitrate and VOC contaminants are located in the shallow aquifers and none of these contaminants have significantly impacted the groundwater basin's operation. In many portions of the groundwater basin, shallow water is prevented from migrating into deeper aquifers due to aquitards (impervious formations). Additionally, OCWD has aggressively initiated programs to address contaminants of concern before they become larger issues.

Increasing TDS concentrations in forebay areas of the Main basin have led to management approaches such as using low TDS groundwater replenishments and desalters.

Nitrate concentrations generally range from 4 to 7 mg/L in the Forebay and 1 to 4 mg/L in the Pressure area, with an average of about 2.2 mg/L (OCWD, 2004; OCWD, 2006). Areas with concentrations above 10 mg/L are located in inland areas. Nitrate concentrations that exceed the MCL occur only in a small number of areas in the Orange County Basin (OCWD, 2004). Nitrate plumes are generally located in the shallow aquifers in the basin.

Localized shallow aquifer areas are also affected by high concentrations of volatile organic compounds (VOCs), most notably trichloroethylene (TCE) and tetrachloroethylene (PCE). OCWD has active remediation projects to remove these VOC and nitrate contaminants before they reach the Principal aquifer system. Perchlorate has primarily been detected in the Forebay area and in only one well in the Main Basin at concentrations at or below the current State notification level of 6 µg/L.

As discussed above, the presence of discolored water is significant in the Main Basin. However, discolored groundwater is limited to the Lower aquifer system primarily near the coast and ranges from 25 color units to 230 color units. Most production wells along the coast pump from the Principal aquifer, which is located above the discolored water.

5.2.3 EROSION AND SEDIMENTATION EXISTING CONDITIONS

The largest source of sediment is erosion from open space near the foothills, grading for development, and increased runoff and erosion as a result of conversion of agricultural land to urban land. Channelization of streams has also led to increased volumes of surface water that erodes sediment and then transports it to Newport Bay. The largest sedimentation occurs during large storm events, although lower level sediment transport occurs year-round. It is expected that for this proposed Project, erosion and sediment control BMPs will be utilized and will adequately mitigate this condition.

5.3 PROJECT IMPACTS

5.3.1 PROPOSED PROJECT POLLUTANT SOURCES

The proposed Project includes the development of a modern streetcar system. A modern streetcar runs on its own separate track (steel wheel on steel rail) either within its own dedicated alignment or integrated within a street system, and derives its power electrically from an overhead catenary system. Two Project alternatives that encompass modern streetcars were assessed.

The proposed Project alternatives would potentially generate pollutants in storm water runoff that would be reduced through project features designed to prevent and treat runoff from the Project. The alignments would be a form of modern transit that would partially run on existing streets as part of the proposed Project. Storm water along these roadway portions of the alignment would flow into a series of curb inlets, and then would flow to a proprietary treatment control BMP (e.g. Filterra StormFilter). From there, storm water would be conveyed to the City

storm drain. Storm water from non-street portions of the alignment may be directed to vegetated swales for treatment before conveyance to the City storm drain. The streetcar alignments would be largely double-tracked and would include stations at identified locations. The stations would be similar to a traditional bus stop with a bench and covered awning for passengers. These stations would not include parking lots. Typically, any storm water runoff that falls within the track system would be collected and conveyed into the storm drain system by inlets similar to inlets found on traditional roads. The storm water runoff would be treated before entering into the city or regional drainage systems, by different methods, depending on the location along the proposed Project alignment.

The Project Alternatives include the construction of an O&M Facility. If used by Orange County Transportation Authority (OCTA), it is presumed that the modern transit alternatives (clean-fuel bus) would use existing (OCTA) maintenance facilities for the transit vehicles. The O&M facility for the streetcar concepts provides an area for vehicle and system inspection, cleaning, repair, maintenance, and storage. The following activities would typically occur at streetcar O&M facilities:

1. Streetcar service, inspection, painting and component change-out
2. Fare collection equipment maintenance
3. Streetcar parts and component storage
4. OCS and traction power substation (TPSS) parts storage
5. Maintenance-of-way storage for small and large items
6. Air conditioning unit removal, replacement and repair
7. Truck repair and storage
8. Battery charging and storage
9. Propulsion and auxiliary inverter service and repair
10. Electronic component repairs
11. A designated area for interior cleaning of streetcars
12. Streetcar storage and circulation (8 cars initially, 14 to 15 ultimately)
13. Yard storage for large items such as OCS poles
14. An automatic drive-through wash facility
15. Interior and exterior cleaning
16. Sand box filling
17. Body repair and paint booth (in a separate building on the site)

There are two proposed locations for the Maintenance and Storage Facility. These proposed locations are described in Section 1.1, Project Description of this report.

The project incorporates structural and non-structural features or measures designed to minimize and treat potential pollutants in storm water runoff from the project during both construction and post-construction. These features or measures are known as BMPs, and are required as part of compliance with the MS4 Permit and Construction General Permit. Both construction phase and post-construction phase BMPs have been incorporated into the project to reduce pollutants in storm water discharges and reduce potential water quality impacts to downstream receiving waters to less than significant. These BMPs are described under

Construction Best Management Practices and Post-Construction Site Design BMPs, Post-Construction Source Control BMPs, and Post-Construction Treatment Control below.

5.3.2 IMPACTS TO WATER QUALITY

5.3.2.1 Construction Phase Surface Water

Construction of the proposed Project alignments, including the O&M facility, would entail soil disturbance activities such as grading and excavation, and may create the potential for sediment to be transported with storm water runoff. Additionally, materials storage stockpiles and construction materials (e.g., asphalt, paving materials, concrete, etc.) could be transported into surface waters during storm events. Other effects could occur as a result of:

- Potential discharge of construction-related pollutants (e.g., concrete, waste oil, solvents, debris, etc.) that may be spilled, leaked or transported via storm runoff into receiving waters); and
- Discharge of dewatered groundwater that may contain high levels of nitrates, phosphorous, and other naturally occurring pollutants as well as pesticides from previous agricultural activities in the area.

However, proper implementation of construction BMPs as specified in the following subsections of this report would minimize water quality impacts during construction activities. Also, compliance with the Dewatering General Permit, described in Section 5.1.5, would minimize water quality impacts from dewatered groundwater.

It is important to note here that both streetcar alignments cross over the Santa Ana River. The proposed Project would cross over the channel on a new structure. However, columns for the new structure will be placed so as to straddle the Santa Ana River to avoid potential impacts to channel hydrology and surface flows.

5.3.2.2 Construction Phase Groundwater

Specific construction methods have yet to be determined; however, the construction of overpasses at the river and channel could require pile driving activities up to 60 feet in depth. In this case, actual soil disturbance would only occur in approximately the upper 4-6 feet of ground surface. Although depth to groundwater is estimated at 40-50 feet within the proposed Project area, pile driving activities would not result in impacts to groundwater quality, as any excavation or dewatering activities would occur well above the depth of groundwater.

5.3.2.3 Applicable Construction Phase Regulatory Requirements

The Project would be required to comply with the Construction General Permit (NPDES No. CAS000002). As discussed in Section 5.1.4, the Construction General Permit requires that construction sites over one acre implement measures to reduce storm water runoff and non-storm water discharges that contribute pollutant loading to receiving water bodies. Prior to construction activities, a construction SWPPP (with Risk Analysis) and a Construction Sampling and Monitoring Program would be developed for the project. The construction phase SWPPP is designed to identify potential pollutant sources associated with construction activities; identify

non-storm water discharges; identify, implement, and maintain BMPs to reduce or eliminate pollutants associated with the construction site; and identify a sampling and analysis strategy for monitoring potential pollutants associated with the construction site. The construction SWPPP for the Project would be developed during the environmental determination phase, and then would be updated during final design.

5.3.2.4 Post- Construction Surface Water

Once constructed the proposed Project, including the O&M facility, will have minimal operation impacts to the hydrology and water quality. The proposed design includes permanent BMPs such as infiltration trenches, grassy swales, waste management, material delivery and storage management and water conservation practices. The Post-Construction requirements are also presented below.

DRAINAGE PATTERNS

During construction, short-term impacts to drainage patterns would be managed on a case-by-case basis by the contractor.

During post-construction, both of the proposed streetcar alignments would not significantly alter the existing drainage patterns as the tracks would be constructed at the same or similar grades as the existing roadway and/or ROW.

5.3.2.5 Post - Construction Phase Groundwater

During post-construction the proposed Project will not have any impacts on the groundwater. The Project does not include significant water uses and does not include water discharges to the groundwater table.

FLOOD CONTROL

During construction, the Project will be scheduled and managed such that flood control facilities will not be affected. In the post-construction condition, there will be no flood control impacts.

5.3.2.6 Initial Operable Segment

As identified in Section 1.1.4 of this document, Streetcar Alternatives 1 and 2 may be constructed in shorter segments due to funding constraints. Under this scenario, both Streetcar Alternatives 1 and 2 will terminate at the Raitt Street and Santa Ana Boulevard station rather than extending further west to Harbor Boulevard and Westminster Street. Under this alternative, construction will not occur west of Raitt Street and drainage facilities in this area – including the Santa Ana River, will not be impacted.

5.4 PROPOSED BEST MANAGEMENT PRACTICES

5.4.1 CONSTRUCTION BEST MANAGEMENT PRACTICES

For the proposed Project, various construction activities would be required for the implementation of the streetcar alternatives. Neither the No Build Alternative nor the TSM Alternative would require widening of any existing streets and therefore BMPs are not necessary for these alternatives. Construction activities that would be required for Streetcar

Alternatives 1 and 2 that would have the potential to contribute sediment to storm water discharges include:

- A. Removal and transport of portions of existing road surface
- B. Grading operations
- C. Laying and spreading of base materials
- D. Laying and spreading of asphalt
- E. Material stock piles

Typical pollutants from construction materials and activities include:

- A. Metals from grading and paving equipment leaks and spills
- B. pH from concrete pours and washouts
- C. Oil and grease from grading and paving equipment leaks and spills
- D. Asphalt emulsions associated with asphaltic paving operations
- E. Dust control operations

There are several options for erosion and sediment control and non-storm water management BMPs. The measures described below are BMPs typically used to reduce pollutant loading from construction sites. During the final design phase, and after the environmental determination, BMPs for the proposed Project will be finalized. The City of Santa Ana shall determine the appropriate construction BMPs for the final project.

Sufficient quantities of temporary erosion, sediment, and stabilization control materials shall be maintained on-site throughout the duration of the project, to allow for implementation of temporary sediment controls in the event of predicted rain, and for rapid response to failures or emergencies, in conformance with other requirements of the General Permit.

5.4.1.1 Erosion Control

Erosion control, also referred to as soil stabilization, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in storm water runoff. Erosion control BMPs protect the soil surface by covering and/or binding soil particles. Based on the types of construction activities associated with the project, implementing the following types of BMPs would be effective for temporary and final erosion control during construction:

- A. **Scheduling** - Construction activities shall be properly sequenced and scheduled to reduce erosion potential during the lifetime of the project
- B. **Slope Drains** – Slope drains would be appropriate for locations along the alignment where surface water may accumulate at the top of a sloped area (e.g., drainage swale, earthen berm or dike) and/or where flows should be diverted to prevent cut and erosion on the slope.
- C. **Preserving Existing Vegetation** – Where feasible, existing vegetation shall remain in place, reducing bare soils with the potential to be transported with storm water flows.
- D. **Stabilizers** - There are a variety of products available to stabilize slopes and graded areas of a construction site to prevent erosion. Polyacrylamide, hydraulic mulching,

hydroseeding, soil binders, straw mulch, geotextiles and mats are applications that can be applied on top of graded or exposed soil areas to protect from water or wind erosion. Depending on the extent of exposed soil and steepness of slope determined in the final design phase, these options would be incorporated to prevent erosion, reducing the potential for pollutants to leave the construction site.

5.4.1.2 Sediment Controls

Sediment controls are structural measures that are intended to complement and enhance the selected erosion control measures and reduce sediment discharges from active construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water.

Based on the types of construction activities associated with the proposed Project, implementing the following types of BMPs would be effective for temporary and final sedimentation control during construction:

- A. **Silt Fence** – A silt fence could be placed at the perimeter of the project construction area to capture sediment- laden sheet flow before it is transported off-site. The silt fence as well as other sedimentation control BMPs could be used in combination with erosion control BMPs.
- B. **Storm Drain Inlet Protection** – Storm drains within the project construction area would be protected so that sediment laden surface flows do not enter the storm drain. Temporarily ponding the sediment laden flows would allow sediment to settle out before entering the storm drain.
- C. **Sediment Basin or Trap** – A sediment basin or sediment trap is either excavated or formed with temporary embankments and is used to direct sediment-laden runoff to an area where sediment can settle out before discharge. These BMPs shall be used in areas where a small temporary ponding structure can be placed to allow sediment to settle before discharge.
- D. **Check Dams, Gravel Bag Berms, Sandbag Barriers, Straw Bale Barrier, and Fiber Rolls** – There are several mechanisms to create temporary barriers at the construction site that would create slower runoff flows, allowing sediment to settle before leaving the site or entering a storm drain. Check dams can be constructed of gravel bags, fiber rolls, sandbags, or other similar materials. Check dams would create a temporary barrier that slows surface flows, allowing sediment to settle out before discharge. Fiber rolls consist of straw, flax, or other similar material that is bound into a tubular roll. The fiber roll would be placed at the toe or face of slopes, around the perimeter of other BMPs (e.g. silt fence, sediment trap), and in other areas where surface flows contain sediment providing flow reduction and sediment capture.
- E. **Street Sweeping and Vacuuming** - Street sweeping and vacuuming would be performed during soil hauling and as necessary to keep street surfaces clear of soil and debris. Washing of sediment tracked from streets into storm drains would not occur.

5.4.1.3 Stabilization

Ensuring that construction equipment does not track soils and debris off site would be important for the proposed Project. Providing a stabilized construction site entrance and exit equipped with a tire washing station would prevent equipment from tracking soils and debris offsite. In addition, areas on site where construction equipment would be continually operating or driving (e.g. roads within the project site, parking lots) would also be stabilized to prevent erosion and dust problems.

5.4.1.4 Non-Storm Water Management

Managing non-storm water discharges from the construction site would also be required as some construction activities would have the potential to create non-storm water discharges. The following BMPs, as appropriate, would be utilized to manage non-storm water discharges from the construction site:

- A. **Water Conservation Practices** – During dust control operations, the contractor would utilize water conservation practices in a manner that would avoid causing the discharge of dust control water offsite. For example, any leaks on the water tank truck would be repaired promptly and water tank valves would be locked to prevent unauthorized use.
- B. **Concrete Curing and Finishing** – The portion of the track that does not run on existing roads would be constructed of concrete. Concrete curing and finishing operations would involve the use of chemicals, water, and blasting operations. Storm water exposed to concrete curing and finishing operations may contain elevated levels of chemicals, metals, and fines. Avoiding spraying concrete curing and finishing agents and proper application, handling, and storage of concrete materials would reduce the chance of discharging polluted runoff to the storm drain.
- C. **Dewatering Operations** – During final design, if dewatering is deemed necessary, the City of Santa Ana shall comply with all applicable permits and shall get prior approval from the RWQCB. Dewatering BMPs would be similar to those for sedimentation control, providing temporary flow impoundments or structures that allow water to pond, allowing particles to settle out before discharge.
- D. **Illicit Connection/Illegal Discharge Detection and Reporting** – Prohibited (illicit) discharges are non-storm water discharges into storm drainage systems or waterways, which are not authorized under the General Permit or authorized under a separate NPDES permit. Prior to construction activities, existing hazardous materials or wastes would be identified in the SWPPP. During construction activities proper site security would be implemented to limit non-project parties. The construction site would be inspected periodically to identify any unauthorized materials that might have been illegally dumped. Reporting procedures would also be outlined in the proposed Project's SWPPP.
- E. **Material Delivery, Storage, Use and Spill Prevention and Control** – There would be a variety of materials delivered, used, and stored at the construction site and laydown areas. Minimizing the storage of hazardous materials onsite, storing materials in designated areas, conducting regular inspections, and the training of employees and subcontractors are all means to reduce the risk of pollutant discharge from the

construction site. Storage of construction materials would be away from vehicle traffic; Materials Safety Data Sheets (MSDSs) would be supplied for all materials used onsite; and, designated areas for materials use, delivery, and storage would be determined and clear signage posted. Materials would be used and disposed of according to the manufacturer's specifications and spill kits would be made available in designated materials use, storage, and delivery areas. All employees and contractors involved in construction activities would be educated on procedures and practices for spill management.

- F. **Stockpile Management** – The proposed Project will require various construction materials. It is possible that stockpiles of soil, paving materials, asphalt, concrete, rubble, aggregate base, and other materials could be stockpiled onsite. To prevent potential stockpile runoff from entering channels or storm drains, stockpiles shall be located at least 50 feet away from drainage courses and inlets. Stockpile perimeters would be lined with a sediment barrier to prevent run-on. Stockpiles would also be managed to prevent wind erosion (e.g. secured cover on the stockpile when conditions are appropriate). Bagged materials would be placed on a pallet and have a canopy cover.
- G. **Waste Management** – Various materials would be used during construction activities. To prevent potential impacts to local water bodies and storm drains, the following measures would be considered with regard to waste management:
- Create designated waste collection areas.
 - Utilize only watertight waste dumpsters to prevent potential leaks.
 - Locate waste collection containers in a covered area with secondary containment.
 - Provide waste collection containers with lids and clean up dumpster spills immediately.
 - Arrange for the collection and transport of waste by a licensed waste hauler.
 - Educate employees and contractors on all waste procedures and practices.
 - Recycle or salvage waste when appropriate.
 - Store hazardous wastes and disposed of them in compliance with applicable hazardous waste regulations.
 - Perform washout of concrete activity wastes offsite, if feasible. Perform onsite washout in designated areas and provide training to all employees and contractors.
 - Avoid discharge of wastewater from any sanitary facilities. A licensed waste hauler service should be contracted to dispose of these wastes.

5.4.2 POTENTIAL WATER QUALITY IMPACTS DURING POST-CONSTRUCTION PHASE

The alternatives for the proposed Project are classified as transportation development. Typically, pollutants of concern from transportation projects include: total suspended solids (TSS), nutrients, heavy metals, bacteria/virus, pesticides, organic compounds, trash and debris, oxygen demanding substances, and oil and grease. These constituents are typically found in runoff from transportation developments. The streetcar alignments for the proposed Project would comply with all applicable water quality regulations to prevent or minimize impacts to water quality. This includes proper development and implementation of BMPs to prevent transport of pollutants of concern to receiving water bodies. The BMPs would be included as

Project design features to reduce potentially significant impacts to water quality, thereby eliminating the need for separate CEQA mitigation measures.

For both of the Streetcar alternatives, the proposed Project entails the construction of an overcrossing at the Santa Ana River. Since permanent structures would be placed adjacent to the existing channel, there could be a loss of aquatic habitat under the existing conditions. Such impacts, if jurisdictional to the ACOE, would be addressed in a CWA Section 404 permit.

Both Streetcar alternatives also include a Maintenance and Storage Facility, where potential spills and leaks could result in impacts to receiving waters. However, with implementation of post-construction BMPs described in this Section, the potential impacts to receiving waters would be reduced.

5.4.2.1 Applicable Post-Construction Phase Regulatory Requirements

The proposed Project would be subject to the new development/significant redevelopment requirements of the County DAMP/City of Santa Ana Local Implementation Plan (LIP) (See discussion in Section 5.1.4). The DAMP/LIP requires implementation of post-construction BMPs to address pollutants of concern and hydrologic conditions of concern for a project's storm water runoff. Post-Construction BMPs are the practices, procedures, policies, prohibitions, schedules of activities, structures or devices that are implemented to prevent or minimize pollutants coming in contact with precipitation, storm water runoff, or non-storm water flows in the post-construction phase of development. BMPs are also structures or devices that remove pollutants from storm water runoff before it enters a receiving waters or storm drain and sewer systems. Therefore, BMPs are often categorized as either "Source Control" BMPs or "Treatment Control" BMPs.

Source Control BMPs include measures designed to prevent pollution at the source, that is, to prevent storm water from contacting potential pollutants. Source Control BMPs are generally simple, low-maintenance, cost-effective and are broadly applicable. They may be categorized as either non-structural or structural. Good housekeeping is an example of a non-structural Source Control BMP; storm drain stenciling is an example of a structural Source Control BMP.

Treatment Control BMPs remove pollutants from runoff and are typically more costly to design, install, and operate than Source Control BMPs. Additionally, Treatment Control BMPs are generally not as effective as Source Control BMPs, and their effectiveness is highly dependent on regular maintenance. Nevertheless, they can be appropriate and effective under certain conditions.

A WQMP, based on the March 2011 Orange County template, would be prepared for the proposed Project that specifies the types and locations of post-construction BMPs for the proposed Project. These BMPs would be implemented and maintained throughout the life of the Project and would be used by the City, facility operators, tenants, facility employees, and maintenance contractors to prevent and minimize water pollution that could be caused by storm water or urban runoff associated with the proposed Project. [Note: A Preliminary SWDR has been developed for the proposed Project and is attached as Appendix O to this Water Resources Technical Report.]

The WQMP requires the following elements to be included in the project design.

- A. Site design measures
- B. Implementing LID BMPs on-site
- C. Constructing or participating in sub-regional/regional LID BMPs
- D. Implementing hydromodification control BMPs
- E. Utilizing alternative programs or treatment control BMPs
- F. Employing applicable source control BMPs

Several steps must be followed in order to determine what performance criteria will apply to a project. These steps include:

1. Determining if the project is a street, road, highway, or above-ground lined drainage facility with similar characteristics. If the project is determined to be a street, road, highway, or above-ground lined drainage facility, then alternative compliance requirements would be followed, by incorporating US EPA guidance “Managing Wet Weather with Green Infrastructure: Green Streets.”
2. Determining site design and LID performance criteria.
3. Determining treatment control BMP performance criteria.
4. Calculating the LID design storm capture volume.
5. Determining hydromodification control performance criteria.
6. Completing the LID BMP selection process.

Once the performance criteria have been established, the next step is to develop and select site design practices and on-site LID BMPs and hydromodification control BMPs based on these project-specific criteria. Hydromodification is defined as the modification of a stream’s hydrograph, caused in general by increases in flows and durations that result when land is developed (e.g., made more impervious). The effects of hydromodification include, but are not limited to, increased bed and bank erosion, loss of habitat, increased sediment transport and deposition, and increased flooding.

Because the proposed Project is a “roadway-type project,” it would follow the USEPA Green Infrastructure “Managing Wet Weather with Green Infrastructure: Green Streets” as detailed in the 2011 WQMP Manual. Post-construction BMPs applicable to the proposed Project alternatives are described in the following subsections.

5.4.3 POST-CONSTRUCTION SITE DESIGN BMPS

Site design BMPs incorporate design features that reduce the potential for runoff. Site design BMPS include:

- A. Minimize impervious area/maximize permeability (C-factor reduction)
- B. Minimize directly connected impervious areas (DCIAs) (C-factor reduction)
- C. Create reduced or “zero discharge” areas (runoff volume reduction)
- D. Conserve natural areas (C-factor reduction)

Where the C-factor is “cover management” and represents the effects of plants, soil cover, soil biomass, and soil disturbing activities on erosion.

The proposed Project would incorporate the following design features:

- A. Minimize Directly Connected Impervious Areas (DCIAs)
 - Natural channels and swales would be used where feasible alongside each Project alignment.
- B. Create Reduced or “Zero Discharge” Areas
 - The first flush runoff from the proposed Project would drain to natural treatment systems within the Study Area of the Project.
- C. Minimize Impervious Area/Maximize Permeability
 - The proposed Project would consider a permeable surface to reduce impervious surface. Stations along the alignments would consider permeable pavers to reduce impermeable surfaces.
- D. Conserve Natural Areas
 - The alternative alignments would use existing roadways or parallel proposed roadways to the greatest extent feasible to conserve natural areas.

5.4.3.1 Post-Construction Source Control BMPs

Tables 5.6 and 5.7 list routine non-structural and structural BMPs designed to prevent storm water runoff from contacting potential pollutants. These BMPs are described in further detail following the tables.

ROUTINE NON-STRUCTURAL BMPs

The following table presents the regionally required non- structural BMPs that all projects are to include if applicable

Table 5-6 Routine Non-Structural BMPs

Identifier	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
N1	Education for Property Owners, Tenants and Occupants		X	No tenants/occupants
N2	Activity Restrictions	X		
N3	Common Area Landscape Management	X		
N4	BMP Maintenance	X		
N5	Title 22 CCR Compliance	X		
N6	Local Water Quality Permit Compliance		X	The County of Orange, City of Garden Grove and the City of Santa Ana do not issue water quality permits.
N7	Spill Contingency Plan	X		
N8	Underground Storage Tank Compliance	X		
N9	Hazardous Materials Disclosure Compliance	X		
N10	Uniform Fire Code Implementation	X		
N11	Common Area Litter Control	X		
N12	Employee Training	X		
N13	Housekeeping of Loading Docks	X		
N14	Common Area Catch Basin Inspection	X		
N15	Street Sweeping Private Streets and Parking Lots	X		
N17	Retail Gasoline Outlets		X	No retail gas outlets

Source: Orange County Model WQMP; Water Quality Management Plan information: <http://www.ocwatersheds.com/WQMP.aspx>

N2, ACTIVITY RESTRICTIONS

The proposed Project will be operated by City staff (or designee) who would be made aware of the following activity restrictions:

- A. Trash receptacles would remain closed at all times except when being emptied by maintenance staff.
- B. Trash receptacles at the proposed Project stations would be covered or sheltered by a roof or overhang whenever possible.
- C. Vehicle washing, maintenance, and repair would be limited to specified areas in the Maintenance and Storage Facility.

These activity restrictions would be communicated to proposed Project operations and maintenance staff upon hire and annually thereafter to prevent potential impacts to receiving waters.

N3, COMMON AREA LANDSCAPE MANAGEMENT

Fill slopes would be landscaped for permanent erosion control. The following measures would be implemented to manage those landscaped areas:

- A. Irrigation systems would be inspected, adjusted, repaired and maintained for proper functioning and water use.
- B. Vegetated areas would be inspected for erosion and repaired promptly.
- C. Dead vegetation would be removed and replaced.
- D. Organic fertilizers such as compost, peat, and mulch would be applied wherever possible to increase soil porosity and water retention.
- E. Only the minimum amount of fertilizer needed would be applied and incorporated directly into the soil around plants, where possible, to minimize potential surface runoff.
- F. Pesticides would be used only according to manufacturer recommendations.
- G. Proper licensing for supervision and training would be required of staff to use and apply pesticides.
- H. Integrated Pest Management practices would be used to control insects.

N4, BMP MAINTENANCE

BMP maintenance, implementation schedules, and responsible parties would be included with each specific BMP narrative.

N5, TITLE 22 CCR COMPLIANCE

All hazardous waste would be stored at the Maintenance and Storage Facility (Streetcar Alternatives 1 and 2) and would be properly containerized, labeled, and stored in the 90-day hazardous waste storage area. Appropriate advisory signs would be posted at the hazardous materials storage area and the 90-day hazardous waste storage area. The City of Santa Ana Maintenance and Storage Facility Manager would arrange for pick-up of hazardous waste as needed for site operations and allow only properly trained personnel to have access to hazardous waste containers. Once a week, the Maintenance and Storage Facility Manager would inspect the 90-day hazardous waste storage area to verify no residues, trash, or spills were present. If a leak or spill was detected, it would be immediately cleaned using spill kit supplies located at the facility. The 90-day hazardous waste storage area would be swept as needed to prevent trash and debris from accumulating. The Maintenance and Storage Facility Manager would be responsible for implementation of this BMP.

N7, SPILL CONTINGENCY PLAN

A Spill Contingency Plan for lubrication oils would be prepared for the Maintenance and Storage Facility upon final alternative selection for the proposed Project. The Spill Contingency Plan provides guidelines that would be adhered to by onsite employees for the prevention, containment, clean up, and disposal of lubrication oil spills. These plans would be provided to new employees within four weeks of startup and would be reviewed annually. The Spill Contingency Plan would be kept current and would be updated as necessary to reflect the nature of materials being used, stored, or handled on the premises. The Maintenance and Storage Facility Manager would be responsible for ensuring implementation of this BMP, and for keeping the Spill Contingency Plan current.

N8, UNDERGROUND STORAGE TANK COMPLIANCE

Although final design of the proposed Project would be completed after the environmental review process, an underground storage tank (UST) containing petroleum products might be located at the Maintenance and Storage Facility. Any UST developed for the proposed Project would be in accordance with Title 23 of the California Code of Regulations, Chapter 16, providing both product-tight primary containment as well as secondary containment with sufficient thickness, density and corrosion resistance to prevent structural weakening or damage as a result of contact with the tank's contents. Secondary containment would be constructed to contain 100 percent of the usable capacity of the primary containment system.

The City of Santa Ana would be responsible for implementing a monitoring program that would be reviewed and approved by the County of Orange Environmental Health Department (OC/EHD). The City of Santa Ana would also be responsible for regular inspection and maintenance of the monitoring system in accordance with the manufacturer's recommendations.

N9, HAZARDOUS MATERIALS DISCLOSURE COMPLIANCE

Various quantities of hazardous materials would be used at the Maintenance and Storage Facility. These materials would likely include lubrication oils, hydraulic oils, diesel fuel, and other flammable materials. The Maintenance and Storage Facility Manager would be responsible for making appropriate disclosures of the on-site storage of hazardous materials in accordance with the Orange County Fire Authority, the administering agency for hazardous materials disclosure for the City of Santa Ana. A Hazardous Materials Disclosure Chemical Inventory and Business Emergency Plan and a list of all hazardous, flammable, and combustible liquids, solids, and gases to be stored, used, or handled on-site would be submitted to the Orange County Fire Authority. On an annual basis, the Maintenance and Storage Facility Manager would ensure that the list and associated plans are amended as necessary to include the current status of hazardous materials being used, handled, or stored on-site.

N10, UNIFORM FIRE CODE IMPLEMENTATION

The Maintenance and Storage Facility required for the Project would potentially have various hazardous materials in quantities up to 55 gallons stored on-site. To conform to the Uniform Fire Code, the Maintenance and Storage Facility Manager would maintain an inventory of all hazardous materials stored on-site. All new hazardous materials brought on-site in quantities greater than 55 gallons would be added to the inventory and reported to the County Fire Authority within thirty days. Material Data Safety Sheets (MSDSs) would be available at the Facility for all hazardous materials used on-site. All hazardous materials stored on-site would be labeled according to the US Department of Transportation and County Fire Authority guidelines.

N11, COMMON AREA LITTER CONTROL

Covered trash receptacles would be maintained at common station areas for litter collection. Trash receptacles would be emptied weekly by City of Santa Ana maintenance personnel or more frequently if necessary.

N12, EMPLOYEE TRAINING

The Maintenance and Storage Facility Manager would ensure that employees are trained to properly implement, operate, and maintain all BMPs. The Maintenance and Storage Facility Manager would instruct new employees of their duties with regard to BMP maintenance and annually thereafter. The Maintenance and Storage Facility Manager would train employees to:

- A. Report spills, leaks, or litter that have the potential to enter the receiving waters.
- B. Inform the Maintenance and Storage Facility Manager when violations of water quality occur.
- C. Inspect structural BMPs on a fixed schedule (e.g., monthly) as well as during and after storm events.
- D. Schedule a maintenance contractor to clean the on-site treatment control BMPs.
- E. Ensure the on-site catch basin is maintained and inspected in accordance with the maintenance schedule.

Appropriate educational materials shall be chosen from the materials available through the following websites:

- A. http://www.ocwatersheds.com/StormWater/documents_bmp_existing_development.asp
- B. http://www.ocwatersheds.com/PublicEducation/pe_introduction.asp

N13, HOUSEKEEPING OF LOADING DOCKS

Good housekeeping practices include activities that are intended to maintain a clean site and keep equipment in good working order to prevent storm water quality problems from occurring. Daily cleanup and inspections are the most effective means of achieving good housekeeping. For the most part, good housekeeping is a day-to-day activity that does not require a large expenditure of time or expense, and would be implemented on an ongoing basis. Good housekeeping practices would be implemented in the Maintenance and Storage Facility.

These practices include ensuring that:

- A. Waste materials are collected and properly disposed after the completion of each job, shift, or day as appropriate;
- B. The parts and equipment loading dock are kept in a clean and orderly condition through a program of sweeping and litter control and immediate cleanup of spills and leaks.
- C. Indoor work areas are neat, uncluttered, and well-ventilated to discourage outdoor work and to allow leaks and spills to be quickly detected and controlled; and
- D. Paved outdoor work areas are mechanically swept every 2 to 3 months (not hosed) and kept neat and clean.

Good housekeeping practices that would be implemented at the proposed Project's stations include ensuring that:

- A. Outdoor waste or trash receptacles are covered and emptied regularly and the adjacent areas are inspected for misplaced or wind-blown litter.

N14, COMMON AREA CATCH BASIN INSPECTION

Storm water flows deriving from portions of the proposed Project along Santa Ana Boulevard would flow to curb inlets which would flow to a proprietary treatment control BMP (e.g. Filterra, StormFilter) and then to the City storm drain. Storm water for the portions of the alignment that run through the non-paved areas would flow through a vegetated swale BMP, would be collected through an inlet, and would then be conveyed to the storm drain. The streetcar tracks do not have gutters like a traditional road, but any water that falls onto impervious surfaces associated with the track system would be collected and conveyed into the storm drain system by inlets similar to roadway inlets. The City of Santa Ana would ensure that the on-site drain inlets, drainpipes, and treatment control BMPs are periodically inspected. This would consist of monthly inspections by trained city personnel. The curb inlets would be visually inspected from the surface. When sediment and debris levels are determined to be impeding conveyance, sediment and debris accumulated inside the chamber would be removed. For additional information see manufacturers’ specifications at time of final design.

N15, STREET SWEEPING

The streetcar alignments for the proposed Project would operate on public roadways that would be swept with traditional street sweeping equipment. The City of Santa Ana would be responsible for implementing this BMP and determining the frequency of street sweeping activities. Streetcar tracks would not have a curb and gutter separation from the roadway and would not be swept. Private streets that are part of the project (within the maintenance yards and stations) would be required to have street sweeping services.

ROUTINE STRUCTURAL BMPs

The following table presents the regionally required structural BMPs that all projects are to include if applicable.

Table 5-7 Routine Structural BMPs

Identifier ^(a)	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
SD-13	Provide storm drain system stenciling and signage	X		
SD-34	Design and construct outdoor material storage areas to reduce pollution introduction	X		
SD-32	Design and construct trash and waste storage areas to reduce pollution introduction	X		
SD-10 and SD-12	Use efficient irrigation systems and landscape design, water conservation, smart controllers, and source control	X		
SD-10b	Protect slopes and channels and provide energy dissipation	X		
<i>Incorporate requirements applicable to individual features:</i>				
SD-31	Dock areas and maintenance bays	X		
SD-33	Vehicle wash areas	X		
SD-36	Outdoor processing areas		X	
--	Equipment wash areas		X	
SD-30	Fueling areas		X	

Identifier ^(a)	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
SD-10a	Hillside landscaping		X	None included in Project.
--	Wash water control for food preparation areas		X	None included in Project.
--	Community car wash racks		X	None included in Project.

Source: Orange County Model WQMP; Water Quality Management Plan information:
<http://www.ocwatersheds.com/WQMP.aspx>

Note:

The BMP Identifier corresponds to those used in the California Storm Water BMP Handbook – New Development and Redevelopment (January 2003).

SD-13, STORM DRAIN STENCILING AND SIGNAGE

A stencil reading “NO DUMPING DRAINS TO OCEAN” would be placed on all drain inlet curbs associated with the Project. The Maintenance and Storage Facility Manager would inspect the stencils annually to make sure the lettering is legible. If the lettering is not legible, the signage would be re-stenciled or replaced as needed.

SD-34, DESIGN OF MATERIALS STORAGE AREAS

Hazardous materials which are stored in the hazardous materials storage would be stored in a properly vented room in the Maintenance and Storage Facility. During the final design phase, appropriate containment for the hazardous waste storage area would be developed (e.g. berming, diking, canopies, etc.). The Maintenance and Storage Facility Manager would arrange for hazardous materials delivery as required for site operations. Once a week, the Maintenance and Storage Facility Manager would inspect the hazardous materials storage area and the other areas where flammable materials are stored to verify that no residues, trash, or spills are present. If a leak or spill is detected, it would be immediately cleaned using spill kit supplies located in the Facility. The hazardous materials storage area would be swept as needed to prevent trash and debris from accumulating. The Maintenance and Storage Facility Manager would be responsible for implementation of this BMP.

SD-32, DESIGN OF WASTE STORAGE AREAS

Any hazardous waste generated at the Maintenance and Storage Facility would be stored in a designated 90-day hazardous waste storage area. The 90-day hazardous waste storage area would have appropriate containment (e.g. concrete pad, canopy, berms, dikes) to ensure that any accidental leaks or spills were contained. The Maintenance and Storage Facilities Manager would arrange for pick-up of hazardous waste as required for site operations. Once a week, the Maintenance and Facilities Manager would inspect the 90-day hazardous waste storage area to verify no residues, trash, or spills were present. If a leak or spill was to be detected, it would be immediately cleaned using spill kit supplies located in the Facility. The 90-day hazardous waste storage area would be swept as needed to prevent trash and debris from accumulating. The Maintenance and Storage Facility Manager would be responsible for implementation of this BMP.

SD-10 AND SD-12, USE EFFICIENT IRRIGATION SYSTEMS AND LANDSCAPE DESIGN

The landscape plan would be designed utilizing plants with low irrigation requirements and with minimal need of fertilizers and pesticides to sustain growth. Native plant materials would be utilized to the extent possible as recommended by the landscape architect. The irrigation system would be designed to apply the proper volume of water to avoid excess runoff. The project's irrigation system would likely use computer-controlled irrigation equipment that receives daily evapotranspiration data, including an override for periods of rainfall. The irrigation system design would incorporate flow reducers or shutoff valves to control water loss in the event of broken irrigation heads or lines.

SD-10B, PROTECT SLOPES AND CHANNELS AND PROVIDE ENERGY DISSIPATION

Slopes would be protected with vegetation.

SD-31 DOCK AREAS AND MAINTENANCE BAYS

The Maintenance and Storage Facility would likely include maintenance bays equipped to accommodate under-vehicle access for inspection and maintenance, and the removal of under-vehicle equipment for maintenance elsewhere in the Maintenance and Storage Facility. The Maintenance and Storage Facility would also have a loading dock and service access drive for delivery and removal of parts and equipment. Wastewater from within the maintenance bays or loading docks would be directed to the sanitary sewer or to a dead end sump. A dead end sump allows for managed spill control and is typically some type of concrete basin or tank with a pump attached. The loading dock would be swept daily and spills would be cleaned immediately. The storm water runoff from the maintenance yard would be treated before entering into the City or regional drainage facilities. The treatment systems are noted under Treatment Control BMPs below.

SD-33, VEHICLE WASH AREAS

The vehicle washing area in the Maintenance and Storage Facility would be clearly marked as a designated washing area. It would be covered by a permanent canopy and would be surrounded by concrete curb or other containment structure. The area would be sloped such that wash water would be retained within the wash area and flow to a pretreatment system before being discharged to the sanitary sewer. The pretreatment system would be in the form of an oil/water separator. The connection to the sanitary sewer would be properly permitted with the sewerage agency (City of Santa Ana or Irvine Ranch Water District).

Vehicle washing outside the area would be strictly prohibited. Staff would be trained in proper washing procedures upon commencement of employment and annually thereafter. The area would be inspected daily for trash and debris, and swept on an as-needed basis. The pretreatment system would be inspected quarterly and would be cleaned annually at a minimum by a licensed service contractor. The Maintenance and Storage Facility Manager would be responsible for operation and maintenance of all structural and non-structural BMPs.

SD-30, FUELING AREAS

If included in the proposed Project during final design, a small amount of fuel would be stored at the Maintenance and Storage Facility. BMPs would be implemented to reduce the risk of potential impacts from the fueling area. The fuel dispensing area would be located in a designated area in the Maintenance and Storage Facility. The entire fueling area would drain to a dead-end sump and would be covered with a permanent canopy. The fueling area would be graded to prevent ponding and to separate the fueling area from the rest of the Maintenance and Storage Facility. Portland cement concrete would be used to pave the fueling area and should extend from the fuel dispensing area. Any asphalt adjacent to the fueling area would be sealed to protect it from spilled fuel.

The City of Santa Ana and/or Garden Grove would be responsible for the following inspection and maintenance activities for the fueling area:

- A. Fueling areas would be inspected daily for leaks and spills. All leaks would be cleaned and repaired immediately.
- B. The fueling area dead-end sump would be inspected quarterly. The sump would be cleaned if fluid, debris, and/or sediment exceeded 40% of the depth.

5.4.3.2 Post-Construction Treatment Control BMPs

EXISTING CONDITION

The treatment control BMPs that are to be used for the existing condition are shown in Table 5.8. Each BMP is designed to mitigate the pollutants of concern discussed in the previous sections. The treatment control BMP locations have multiple possible options for the same treatment efficiency levels.

Table 5-8 Treatment Control BMPs (Existing Condition)

Name	Included?	
	Yes	No
Vegetated (Grass) Strips	X	
Vegetated (Grass) Swales	X	
Dry Detention Basin	X	
Wet Detention Basin		X
Constructed Wetland		X
Detention Basin/Sand Filter		X
Porous Pavement Detention	X	
Porous Landscape Detention		X
Infiltration Basin		X
Infiltration Trench	X	
Media Filter		X
Proprietary Control Measures	X	

Options for treatment control BMPs are identified and discussed for the proposed Project by segment within the Storm Water Data Report (See Appendix Ô). This document presents the information in summary.

The use of proprietary measures is an option for Santa Ana Boulevard and other roadways associated with the streetcar alignments. Option 1 would be the use of a proprietary storm water bioretention filtration system. The curb inlet system would treat the “first flush,” along with a high-flow bypass inlet. This inlet system could be spaced along the alignments to meet capacity requirements. Option 2 would be to place a proprietary storm water filtration system (designed for larger flows) at the low points or locations of largest discharges along the alignment. Option 2 would be more expensive; however, it would treat a much larger area, including areas outside the Study Area. Options 1 and 2 also could be put in place as a BMP treatment train to increase the percentage of pollutant removal. The storm water runoff from the O&M facility could be treated with Option 2, the proprietary storm water filtration system. Flows from this facility would be treated by some type of treatment BMP before entering the appropriate city-specific MS4 system.

The proposed non-paved sections of the alignments are typically located where there is some room for vegetative strips/swales or infiltration trenches. The vegetated swales would either drain to infiltration trenches or to drainage inlets. The drainage inlets would then drain to city drainage facilities in order to convey the storm water runoff to the regional drainage facilities.

An LID option for use throughout the project would be to add porous pavers and pavement at walkways and parking areas.

CUMULATIVE CONDITION

Background Future Condition

All future development is comprised of residential, commercial, open space, and land uses in accordance with the City of Santa Ana General Plan. Future development in the Watershed will be required to comply with the MS4 Permit and Construction General Permit to help minimize pollutants in storm water discharge.

Streetcar Project

The treatment control BMPs identified for the proposed Project for the cumulative condition are shown in Table 5-9. The proposed treatment control BMPs for the cumulative condition are similar to those identified for the proposed Project condition.

Table 5-9 Treatment Control BMPs (Cumulative Condition)

Name	Included?	
	Yes	No
Vegetated (Grass) Strips	X	
Vegetated (Grass) Swales	X	
Dry Detention Basin	X	
Wet Detention Basin		X
Constructed Wetland		X
Detention Basin/Sand Filter		X
Porous Pavement Detention	X	
Porous Landscape Detention		X
Infiltration Basin		X
Infiltration Trench	X	
Media Filter		X
Proprietary Control Measures	X	

Source: Santa Ana Fixed Guideway Drainage and Stormwater Data Report

EXPECTED POLLUTANT REMOVAL

The average expected pollutant removal rates for a common proprietary storm water filtering system identified in the previous sections are shown in Table 5.10. The percentages are taken from the Filterra information design guide and are just an example of expected efficiencies. Filterra is a proprietary company that manufactures filtration systems.

Table 5-10 Average Expected Pollutant Removal – Storm Water Bioretention Filtration System

Pollutant	Percent Removal
TSS Removal	85%
Phosphorus Removal	73%
Nitrogen Removal	43%
Heavy Metal Removal	33%-82%
Fecal Coliform Removal	57%-76%
Oil and Grease	85%

Source: Filterra website: http://www.filterra.com/images/uploads/2010-09-20_Filterra_High_Flow_Rate_Treatment_Whitepaper.pdf

Table 5.11 shows the general pollutant removal efficiencies for various treatment control BMPs that have been identified (Orange County Model WQMP).

Table 5-11 Treatment Control BMP Selection Matrix

Treatment Control BMP	Sediment/Turbidity	Nutrients	Organic Compounds	Trash and Debris	Oxygen Demanding Substances	Bacteria and Viruses	Oil and Grease	Pesticides
Filters/Swales	H/M	L	U	L	L	U	H/M	U
Detention Basins	M	M	U	M	M	U	M	U
Infiltration Basins	H/M	H/M	U	U	H/M	H/M	U	U
Wet Ponds/Wetlands	H/M	H/M	U	U	H/M	U	U	U
Sand Filter/Filtration	H/M	L/M	H/M	H/M	H/M	H/M	H/M	U
Water Quality Inlets	L	L	L	M	L	L	M	L
Hydrodynamic Separators	H/M	L	L	H/M	L	L	L/M	L

Source: Orange County Model WQMP; Water Quality Management Plan information:
<http://www.ocwatersheds.com/WQMP.aspx>

L=Low Removal Efficiency; M=Medium Removal Efficiency; H=High Removal Efficiency; U=Unknown Removal Efficiency

5.4.4 PROPOSED WATER QUALITY MITIGATION MEASURES

Given that the Project includes various project features to minimize pollutants in storm water runoff, such as a proprietary storm water treatment system and vegetated swales, and also incorporates Low Impact Development and numerous construction and post-construction BMPs in compliance the MS4 permit and Construction General Permit, no significant water quality impacts to downstream receiving waters would occur for existing conditions plus project.

For the cumulative condition, implementation of the MS4 Permit requirements, Construction General Permit requirements, TMDL programs to control sediment and nutrients, and the NTS will help minimize increases in pollutant loading to Newport Bay from future cumulative development in the Watershed, in addition to the project-specific BMPs recommended for the proposed Project. No significant water quality impacts to downstream receiving waters would occur for the cumulative conditions plus the proposed Project.

The project is not anticipated to impact water quality standards. Therefore, no water quality mitigation measures are required.

CHAPTER 6 CUMULATIVE IMPACTS

Cumulative impacts to hydrologic, floodplain or water quality resources are directly related to the proposed changes in topography, land use, end-user activities within the area of direct effect. The hydrologic, floodplain or water quality resources assessments prepared for the proposed Project did not identify any impacted resources within the boundaries of the proposed Project area. Given the lack of direct impacts associated with the proposed Project, and the proposed mitigation measures, no significant cumulative impacts are anticipated as a result of concurrent construction activities in the area.

Cumulative conditions for Hydrology and Floodplains are described in Section 3.2 (Hydrology) and 4.3 (Floodplains) of this report. The cumulative impacts from a hydrologic or floodplain perspective are negligible.

Additionally, given the lack of substantial direct impacts, the proposed Project would not result in substantial impacts to water quality nor would it result in impacts that, when combined with other approved projects in the Study Area, would be cumulatively significant. Overall, this Project, by following the permit requirements and implementing the BMPs, will have less than significant impacts to water quality.

While numerous planned projects could impact the local hydrologic, floodplain and water quality resources (See table below), these projects are subject to CEQA-level environmental review and include provisions to preserve resources. Consequently, impacts to significant or potentially significant resources can typically be mitigated through the avoidance of these resources, and the development and implementation of Best Management Practices. During future project development, these measures could lessen cumulative impacts to resources, and, therefore, cumulatively considerable impacts to hydrologic, floodplain and water quality resources are not expected to occur.

A cumulative projects list is presented in Table 6-1 (Santa Ana and Garden Grove Fixed Guideway - Cumulative Projects List provided by City of Santa Ana Planning Department (Aug. 2011)).

Table 6-1: Santa Ana and Garden Grove Fixed Guideway - Cumulative Projects List

No.	Project	Description/ Land Use	No. of u or square feet (sf)	Location	Primary APN
Approved					
1	Alliance Church of Orange	Church addition (gym/classroom), <i>approved 2009</i>	21,000 sf	2130 N. Grand Ave.	396-191-44
2	Christ Our Savior Cathedral	Sanctuary (2,800-seat), <i>approved 2005</i>		2001 W. McArthur Blvd.	140-061-94
3	Discovery Science Center Ph. II	IMAX theatre (275-seat), <i>approved 2002</i>		2032 N. Main St.	399-102-09
4	Lyon Homes	Residential (Condo), <i>approved 2011</i>	300 u	100-130 E. McArthur Blvd.	411-081-26
5	Promenade Point	Residential (Condo), <i>approved 2005</i>	194 u	200 E. First American Wy.	411-074-03
6	CVS/Sav-On Drug Store	Pharmacy, drive through, <i>approved 2008</i>	15,836 sf	115 N. Harbor Blvd.	198-182-22
7	Skyline Phase II	Residential (Condo), <i>approved 2005</i>	150 u	10 E. Hutton Ctr.	411-081-28
8	Vista Del Rio	Residential, <i>approved 2009</i>	41 u	1600 W. Memory Ln.	101-055-27
9	Xerox Tower II	Office, <i>approved 2001</i>	210,000 sf	200 N. Cabrillo Park Dr.	400-071-03
10	YMCA	Recreational Facility, <i>approved 2007</i>	32,000 sf	2100 W. Alton Ave.	140-061-91
11	1306 W. Santa Ana Blvd.	Medical/Office Building, <i>approved 2011</i>	6,000 sf	1306 W. Santa Ana Blvd.	007-183-08
12	Grand Avenue Widening NOTE: Specifically included in SAFG No Build Description	Roadway Widening		First St. to Fourth St.	Multiple APNS
13	Broadway Reconstruction	Street Reconstruction		Civic Center Dr. to Santa Clara St.	Multiple APNS
14	Bristol Street Widening NOTE: Specifically included in SAFG No Build Description	Street Widening		Warner Ave. to Memory Ln.	Multiple APNS
15	First and Cabrillo Towers	Residential (Condo), <i>approved 2007</i>	374 u	1901 E. First St.	400-081-08
16	Related Co. Apartments	Residential (Apartments)	74 u	611 E. Minter St.	398-301-07
A	First Street Widening Source: RTIP / RTP. Specifically included in SAFG No Build Description	Roadway widening from 4 to 6 Lanes		Susan St. to Fairview St.	Multiple APNS
B	Transit Zoning Code NOTE: Specifically included in SAFG No Build Description	Land Use/Zoning Overlay, <i>approved 2010</i>		eastern third of SAFG Project area	Multiple APNS
Application Under Review					
17	C & C Affordable Housing Project	Residential (Apartments)	36 u	605 E. Washington Ave.	398-151-12
18	Dayton Commercial Center	Commercial	7,275 sf	W. Edinger Ave.	408-273-11
19	Dr. Bui Medical Building	Medical Office	6,500 sf	202 N. Euclid Ave.	099-223-26
20	Francis Xavier	Residential (Affordable/Special Needs)	12 u	801 E. Santa Ana Blvd.	398-303-04
21	Related Co. Apartments	Residential (Apartments)	13 u	714 E. Santa Ana Blvd.	398-312-18
22	Related Co. Apartments	Residential (Apartments)	12 u	801 E. Brown St.	398-312-09
23	Related Co. Apartments	Residential (Apartments)	12 u	806 E. Santa Ana Blvd.	398-313-02
24	Related Co. Site A	Residential (Rowhouse)	6 u	501-515 E. Fifth St.	398-332-06
25	Related Co. Site B	Residential (Rowhouse)	9 u	606-620 E. Fifth St.	398-228-02

Santa Ana and Garden Grove Fixed Guideway Project

No.	Project	Description/ Land Use	No. of u or square feet (sf)	Location	Primary APN
26	Related Co. Site C1 & C2	Residential (Rowhouse and duplex)	6 u	601-607 E. Fifth St.	398-333-01
27	Related Co. Site D	Residential (Rowhouse)	4 u	615-621 E. Fifth St.	398-333-05
28	Related Co. Site E	Residential (Duplex)	2 u	712 E. Fifth St.	398-337-03
29	Santa Ana Blvd. Spec. Plan Area	Mixed-used	600 u	Santa Ana Blvd.	398-311-14
30	The MET at South Coast	Residential (Condo) (five- and six-story over parking)	TBD	200 E. First American Wy.	411-074-03
31	TAVA Homes	Residential (Single Family)	24 u	1584 E. Santa Clara Ave.	396-052-14
32	Town and Country Independent Living	Residential (Condo)	144 u	555 E. Memory Ln.	041-213-04
33	Vista Del Rio	Residential (Apartments/Special needs)	41 u	1600 W. Memory Ln.	101-055-27
34	1100 S. Grand Ave.	McDonald's with drive through	3,838 sf	1100 S. Grand Ave.	011-263-02
35	3312 W. First St.	Office (two-story)	29,000 sf	3312 W. First St.	144-341-07
36	630 S. Hathway St.	Industrial (two-story)	4,100 sf	630 S. Hathway	011-311-04
C	Santa Ana Blvd. Grade Separation NOTE: PSR / conceptual engineering is in process. City of Santa Ana is lead. Not included in SAFG No Build	Reconstruct Santa Ana Blvd. at Metrolink railroad tracks		north of SARTC	Multiple APNS
D	SARTC Expansion / Redevelopment NOTE: Master Planning Stage - Santa Ana is lead, funded by OCTA Go Local. Not included in SAFG No Build	Intermodal Transportation Center / Land Use Development		SARTC and surrounding parcels including east of existing Metrolink tracks	Multiple APNS
E	PE Major Arterial NOTE: RSTIS completed. OCTA to issue RFQ for PSR phase in 2011. OCTA is lead. Project is listed as part of the MPAH. Not included in SAFG No Build	New four-lane roadway in PE ROW / ramps to SR-22		PE ROW, from SR-22 to Raitt St.	Multiple APNS
F	Class II bike lane on Civic Center Dr. NOTE: City of Santa Ana is lead and planning concept for this bike lane has been identified. Not in SAFG No Build, but design for SAFG Streetcar Alternative 2 accounts	Early planning stages (per Citywide bicycle program)		TBD – on Civic Center Dr.	Multiple APNS
G	Class I bicycle facility on PE ROW NOTE: No work has been completed. Not in SAFG No Build list.	OCTA and County of Orange Bicycle Master Plan only.		Harbor Blvd. to Raitt	Multiple APNS
Under Construction					
37	DFCD B	Residential (Single Family)	38 u	3321 S. Fairview St.	414-171-01
38	Wintersburg Presbyterian Church	Classrooms, Gym, Outreach Center	24,348 sf	2000 N. Fairview St.	101-652-13
39	Audi Dealership	Commercial, addition to showroom	7,700 sf	1425 S. Auto Mall Dr.	402-101-37
40	Courtyard by Marriot Hotel	Hotel (155 rooms)	100,000 sf	8 McArthur Pl.	411-081-28
41	Downtown Artist Lofts III	Artist Live/Work Lofts	16 u	SWC Main/Third St.	398-601-02
42	Dr. Do Medical Office	Office (two-story)	6,000 sf	4718 W. First St.	108-101-45
43	Goodwill Industries	Office/Industrial	12,000 sf	410 N. Fairview St.	405-222-04

No.	Project	Description/ Land Use	No. of u or square feet (sf)	Location	Primary APN
44	Latino Health Access	Community Center	3,074 sf	602 E. Fourth St.	398-481-05
45	Santa Ana Express Car Wash	Drive-through car wash		202 E. First St.	398-51-401
46	Olen Properties (Parkcenter)	Office (one and two-story)	29,170 sf	601 N. Park Center Dr.	400-042-04
47	One Broadway Plaza	Office (37-story)	518,000 sf	1109 N. Broadway	398-561-07

Source: City of Santa Ana Planning Department Aug. 2011

Notes:

Unit (u), Not Applicable (N/A)

Projects A - G are reasonably foreseeable, but note that Projects C – F are not yet funded and committed.

Projects A and B have been approved. Projects C - F are in various stages of early project development.

Project Number: 12-14 retrieved from City of Santa Ana Capital Improvement Program FY 09-10 CIP Projects by Category (http://www.ci.santaana.ca.us/finance/budget/1011/10-11_proposed_annual_budget.pdf)

CHAPTER 7 CONCLUSION

No significant impacts were identified relative to hydrology or floodplains as a result of the proposed Project.

The change in impervious area added by the alternatives for the proposed Project would not affect the existing drainage facilities, given that the land use throughout this portion of the Study Area was assumed to be commercial for the hydrology analysis and sizing of the City's drainage facilities. The proposed Project alternatives do not significantly increase the existing hydrologic flows. Existing drainage patterns would not be altered and the affected city drainage facilities would still drain to the same watersheds.

There are no proposed channel modifications with this project. As currently proposed, the Project's structures will have no impact to the regional floodplains. Modifications to protect the proposed Project within the western portion of the alignment, where 100-year floodplain conditions exist, will be necessary but the impacts should be less than significant with mitigation. The goal of these modifications would be to protect the project from flooding.

The proposed Project alternatives, both during the construction and operational phases, would potentially generate pollutants in storm water runoff and impact water quality. Impacts would be reduced through project features designed to prevent and treat runoff from the Project. The implementation of identified best management practices (BMPs), as recommended in this report, during Project construction and operation will further reduce the potential for pollutants to become introduced into storm water runoff. With the proposed BMPs, the project alternatives would cause less than significant impacts to water quality.

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CHAPTER 8 REFERENCES

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City of Santa Ana Transit Zoning Code, Specific Development No. 84, June 7, 2010, http://www.santa-ana.org/pba/planning/Transit_Zoning_Code.asp

Cordoba Corporation, 2011, Final Drainage Technical Report, Santa Ana, Ca., Prepared for City of Santa Ana in cooperation with City of Garden Grove and Orange County Transportation Authority

Cordoba Corporation, 2011, Storm Water Data Report (*Draft Submittal*), Santa Ana, Ca., Prepared for City of Santa Ana in cooperation with City of Garden Grove and Orange County Transportation Authority (July, 2011)

Drainage Area Management Plan information: <http://www.ocwatersheds.com/DAMP.aspx>

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Metropolitan Water District Groundwater Basin Report- Orange County Basins <http://www.mwdh2o.com/mwdh2o/pages/yourwater/supply/groundwater/PDFs/OrangeCountyBasins/OrangeCountyBasin.pdf>, July 2011

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Orange County Department of Public Works - Hydrology Manual; as found at http://www.ocflood.com/Docs_Online_Manuals.aspx

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Santa Ana Regional Water Quality Control Board Basin Plan, 2011 http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/index.shtml

State of California Water Resources Control Board, 2010 Integrated 303(d) listing, http://www.swrcb.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

US Dept. of Interior, Professional Paper 1781, Section 12.—Conceptual Understanding and Groundwater Quality of the Basin-Fill Aquifers in the Santa Ana Basin in Conceptual Understanding and Groundwater Quality of Selected Basin-Fill Aquifers in the Southwestern United States California, Susan A. Thiros, http://pubs.usgs.gov/pp/1781/pdf/pp1781_section12.pdf, July 2011

Water Quality Management Plan information: <http://www.ocwatersheds.com/WQMP.aspx>

Watershed Area information: http://www.ocwatersheds.com/wma_areas.aspx

Appendix A:
Detailed Project Description

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Project Description

The alternatives addressed in this EA/DEIR consist of a No Build Alternative, which is used as a basis for comparing the costs and benefits of the three alternatives, TSM, Streetcar 1 and Streetcar 2, each of which responds to purpose and need, study goals, and community input. Additional details are provided below.

Project Location

The Study Area is located in the Cities of Santa Ana and Garden Grove, in Orange County, California. The transit corridor is regionally located in central Orange County, California and directly accesses both the Los Angeles-San Diego (LOSSAN) rail corridor and the Pacific Electric Right-of-Way (PE ROW) rail corridor. The Study Area is generally bounded by Harbor Boulevard to the west, 17th Street/Westminster Avenue to the north, Grand Avenue to the east, and 1st Street to the south. The approximate four-mile transit corridor extends from the Harbor Boulevard/Westminster Avenue intersection in the City of Garden Grove at its western terminus to the Santa Ana Regional Transportation Center (SARTC) in the City of Santa Ana at its eastern terminus. **Figures A-1** and **A-2** provide the Regional Location and Study Area maps, respectively

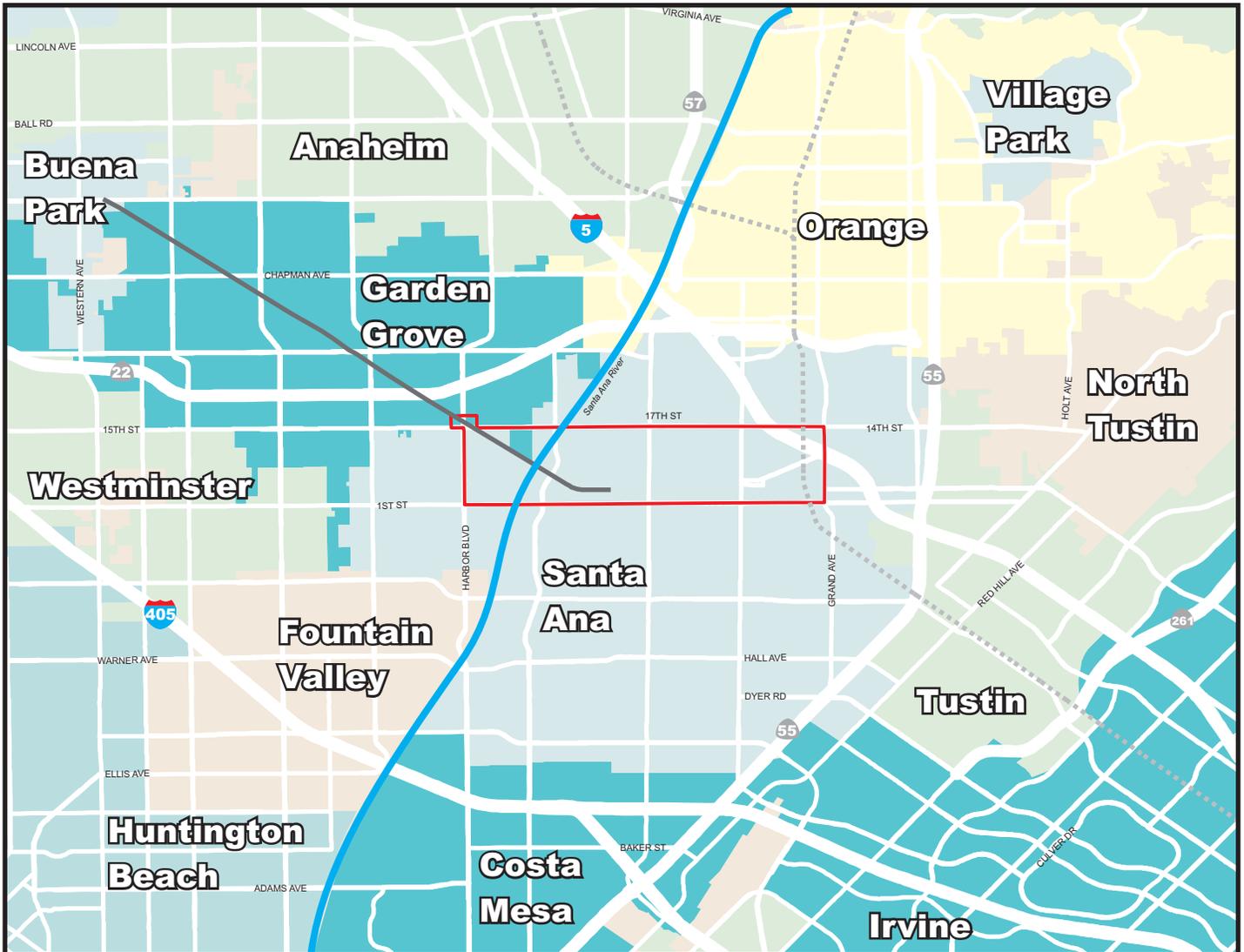
No Build Alternative

The No Build Alternative includes existing conditions, as well as conditions that would be reasonably expected to occur in the foreseeable future without implementation of any of the build alternatives. The No Build Alternative provides the basis for comparing future conditions resulting from other alternatives. Conditions in the foreseeable future (through planning horizon year 2035) include projects that (1) have environmental analysis approved by an implementing agency and (2) have a funding source identified for implementation.

Other projects in the foreseeable future include:

- Implementation of the Transit Zoning Code (SD 84A and SD 84B), both project-level and program-level components, that are anticipated for build-out by 2028
- Implementation of the Station District Development Projects, which consist of a variety of residential develop projects, community open space and some limited neighborhood-serving commercial development
- Transit improvements including modest adjustments to existing local bus routes; and expanded Metrolink service
- Three, new bus rapid transit routes: (1) Harbor Boulevard Bus Rapid Transit Corridor [Costa Mesa to Fullerton, 10-minute headways, peak period]; (2) Westminster/17th Street Bus Rapid Transit Corridor [Santa Ana to Long Beach, 10-minute headways, peak period]; and (3) Bristol Street Bus Rapid Transit Corridor [Irvine Transportation Center to Brea Mall, 10-minute headways, peak period]
- Roadway improvements including the Bristol Street Widening project, which will widen Bristol Street from four to six lanes between Warner Avenue and Memory Lane, and the

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LEGEND:

- Study Area
- PE ROW
- Metrolink/Amtrak Rail Line

0 1.1 2.2 MILES

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LEGEND:

-  Study Area
-  Activity Center
-  PE ROW
-  Metrolink/Amtrak Rail Line
-  Boundary of City of Garden Grove




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- Grand Avenue Widening project, which will widen Grand Avenue from four to six lanes between 1st Street and 17th Street

TSM Alternative

The TSM Alternative enhances the mobility of existing transportation facilities and transit network without construction of major new transportation facilities or significantly, costly physical capacity improvements. Consistent with FTA guidelines, the TSM Alternative emphasizes low cost (i.e., small physical) improvements and operational efficiencies such as focused traffic engineering actions, expanded bus service, and improved access to transit services. Included within the TSM Alternative are modifications and enhancements to selected bus routes in the Study Area including:

- Skip-stop overlay service on 1st Street (Route 64) which includes access to SARTC
- A new route between SARTC and Harbor Boulevard/Westminster Avenue via Civic Center Drive, Bristol Street and 17th Street/Westminster Avenue, providing 10-minute peak and 20-minute off-peak service
- Expanded service span for StationLink service (Route 462) between SARTC and the Civic Center, providing 15-minute service during both peak and off-peak hours.

Figure A-3 is a map of the proposed routes for the TSM bus network enhancements.

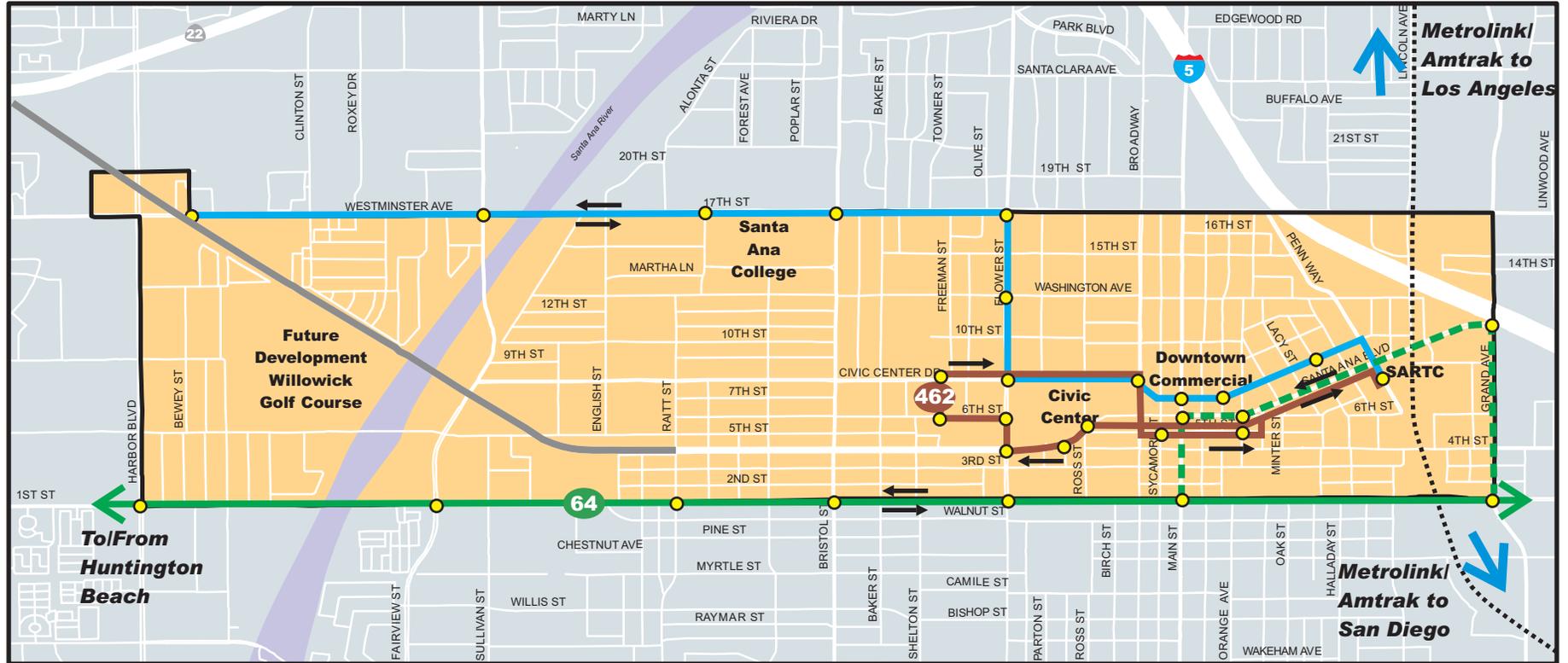
In addition, the following system operational improvements are included in the TSM Alternative:

- Traffic signal timing improvements at select congested locations along Santa Ana Boulevard and Civic Center Drive to provide for enhanced east-west bus flow, potential including but not limited to:
 - Main Street at Civic Center Drive
 - Broadway at Civic Center Drive
 - Flower Street at Civic Center Drive
 - Fairview Street at Civic Center Drive
 - Santa Ana Boulevard at Santiago Street
 - Santa Ana Boulevard at Lacy Street (install traffic signal)
- Real-time bus schedule information at high-volume transit stops (e.g., Flower Street and 6th Street, Santa Ana Boulevard and Main Street)
- Improvements to transit stop amenities (benches, shelters, kiosks, sidewalk connections, etc.) along the Santa Ana Boulevard and Main Street corridors
- Improvements to bicycle and pedestrian circulation to promote safe, convenient and attractive connectivity between the transit system and surrounding neighborhoods and activity centers , including accommodating bicycles on all buses, providing real time bus arrival information via internet and mobile devices, installing bicycle storage facilities at SARTC and the Harbor/Westminster stop, and providing study area maps/walking guides on all buses

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Transportation Systems Management (TSM) Alternative



LEGEND:

- Study Area
- Proposed Stop
- PE ROW
- TSM 1st Street Alignment (OCTA Route 64)
- TSM Civic Center Alignment
- Skip Stop Overlay to/from SARTC
- TSM Station Link Enhancement (OCTA BRT Route 462)

0 1500 3000 FEET

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Streetcar Alternative 1

Streetcar Alternative 1 would utilize the PE ROW through the western half of its alignment and generally operate along Santa Ana Boulevard and 4th Street on the way to SARTC. The 4.1-mile alignment for Streetcar Alternative 1 would include 12 stations. It is anticipated that the streetcar system would operate seven days a week with 10-minute headways during peak periods and 15-minute headways during off-peak periods. The streetcars would be electrically powered using an overhead contact system and a series of TPSS located intermittently along the alignment. Although the specific vehicle has not been selected at this preliminary stage, streetcars generally have a capacity of 30 to 40 seated passengers and 80 to 90 standing passengers for a total of 120 to 130 passengers. **Table A-1** provides a summary description of the key physical and operational attributes of Streetcar Alternative 1 (PE ROW with Santa Ana Boulevard and 4th Street Couplet). **Figure A-4** provides a conceptual illustration of the alignment for Streetcar Alternative 1 relative to the existing street network within the Study Area.

Sasscer Park Alignment

In Streetcar Alternative 1, the Downtown Santa Ana segment features couplet operations with the westbound streetcar alignment on Santa Ana Boulevard and the eastbound streetcar alignment on 4th Street. For the eastbound transition from Santa Ana Boulevard to 4th Street, a direct route from Santa Ana Boulevard along a public easement on the southern edge of Sasscer Park to 4th Street has been identified in **Figure A-5**.

Streetcar Alternative 2

Streetcar Alternative 2 would utilize the PE ROW through the western half of its alignment and substantially operate along Santa Ana Boulevard, Civic Center Drive, and 5th Street along the eastern half of the alignment to SARTC. The operational characteristic of this alternative are identical to Streetcar Alternative 1. The differences between the two streetcar alternatives are the alignment and the fact that Streetcar 2 would have one additional station for a total of 13. **Table A-2** provides a summary description of the key physical and operational attributes of Streetcar Alternative 2 (PE ROW with Santa Ana Boulevard and 5th Street/Civic Center Drive Couplet). This table also includes station locations for comparison to station locations for Streetcar Alternative 1 shown in Table A-1, above. **Figure A-6** provides a conceptual illustration of the alignment for Streetcar Alternative 2 relative to the existing street network within the Study Area.

Civic Center Bike Lane

The Streetcar Alternative 2 alignment travels westbound through the Civic Center along Civic Center Drive between Spurgeon and Flower Streets. As part of the City of Santa Ana's Complete Streets Program, and not as part of the SA-GG Fixed Guideway, the City plans to construct bicycle lanes along Civic Center Drive. Streetcar Alternative 2 would acquire additional ROW (**Figure A-7**) in order not to preclude the westbound bike lane.

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TABLE A-1: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 1

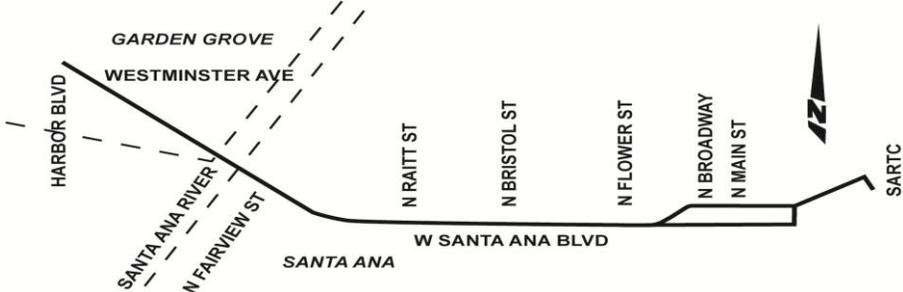
Key Attributes	Descriptions											
Transmit Mode	Streetcar											
Termini	Western Terminus: Harbor Blvd. Eastern Terminus: SARTC											
Alignment Description	<p><u>Routing by Segment:</u></p> <ul style="list-style-type: none"> • PE ROW, from Harbor Blvd. to Raitt St.: streetcars operate at-grade, bi-directionally, in exclusive ROW. • Santa Ana Blvd., from Raitt St. to Ross St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. • 4th St./Santa Ana Blvd. Couplet, from Ross St. to Mortimer St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic. • Santa Ana Blvd., from Mortimer St. to SARTC: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. 											
Length of Alignment	4.1 miles (Harbor Blvd. to SARTC)											
Stations (12 Stations)	<p><u>Station Locations:</u></p> <ol style="list-style-type: none"> 1. Harbor Blvd. and Westminister Ave. 2. Willowick 3. Fairview St. and PE ROW 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd. 6. Flower St. and Santa Ana Blvd. <table border="1"> <thead> <tr> <th><i>Couplet Section (Eastbound)</i></th> <th><i>Couplet Section (Westbound)</i></th> </tr> </thead> <tbody> <tr> <td>7E. Sasser Park</td> <td>7W. Ross St. and Santa Ana Blvd.</td> </tr> <tr> <td>8E. Broadway and 4th St.</td> <td>8W. Broadway and Santa Ana Blvd.</td> </tr> <tr> <td>9E. Main St. and 4th St.</td> <td>9W. Main St. and Santa Ana Blvd.</td> </tr> <tr> <td>10E. French St. and 4th St.</td> <td>10W. French St. and Santa Ana Blvd.</td> </tr> </tbody> </table> <ol style="list-style-type: none"> 11. Lacy St. and Santa Ana Blvd. 12. SARTC 		<i>Couplet Section (Eastbound)</i>	<i>Couplet Section (Westbound)</i>	7E. Sasser Park	7W. Ross St. and Santa Ana Blvd.	8E. Broadway and 4 th St.	8W. Broadway and Santa Ana Blvd.	9E. Main St. and 4 th St.	9W. Main St. and Santa Ana Blvd.	10E. French St. and 4 th St.	10W. French St. and Santa Ana Blvd.
<i>Couplet Section (Eastbound)</i>	<i>Couplet Section (Westbound)</i>											
7E. Sasser Park	7W. Ross St. and Santa Ana Blvd.											
8E. Broadway and 4 th St.	8W. Broadway and Santa Ana Blvd.											
9E. Main St. and 4 th St.	9W. Main St. and Santa Ana Blvd.											
10E. French St. and 4 th St.	10W. French St. and Santa Ana Blvd.											

TABLE A-1: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 1

Key Attributes	Descriptions
Design Options Carried Forward	Santa Ana River Crossing: <ul style="list-style-type: none"> • Adjacent Single Track Bridge Option 4 th Street Parking Scenarios: <ul style="list-style-type: none"> • Scenario A: South side parallel • Scenario B: South side removal • Scenario C: South side and north side removal
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (15 hours)
Transit Vehicle	Streetcar – Vehicle type selection has yet to be determined. The two classifications under consideration include: <ul style="list-style-type: none"> • Classic Modern Streetcar (e.g., Portland, Oregon) • CPUC Compliant Streetcar (e.g., San Diego, California)
Power Source	Electric, Overhead Contact System, Traction Power Substations (TPSS) <u>TPSS Locations:</u> <ol style="list-style-type: none"> a. Northwest of Harbor Boulevard and Westminster Avenue b. Along PE ROW, west of Susan Street c. Along PE ROW, east of Santa Ana River d. North on Santa Ana Boulevard. East of Bristol Street e. North of 5th Street, east of Main Street
Operations and Maintenance Facility Sites	Two Candidate Sites: <ul style="list-style-type: none"> • Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St., and Metrolink tracks. • Site B: West of Raitt St., between the PE ROW and 5th Street
Major Bicycle and Pedestrian Features	<ul style="list-style-type: none"> • Sidewalk and pedestrian improvements in the vicinity of proposed station platforms. • 4th St.: In conjunction with on-street parking modifications, widen sidewalks on 4th St. between Ross St. and French St.: <ul style="list-style-type: none"> – Scenario A: On south side by 8 ft. for a total width of 20 ft. – Scenario B: On south side by 16 ft. for a total width of 28 ft. – Scenario C: On both sides by 16 ft. for a total width of 28 ft.

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011.



Streetcar Alternative 1 Alignment



LEGEND:

- Study Area
- Proposed Stop
- Streetcar Alternative 1

0 1500 3000 FEET

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study*, July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.

Note: Termini for Initial Operable Segment 1 (IOS-1) are located at Raitt Street and SARTC.

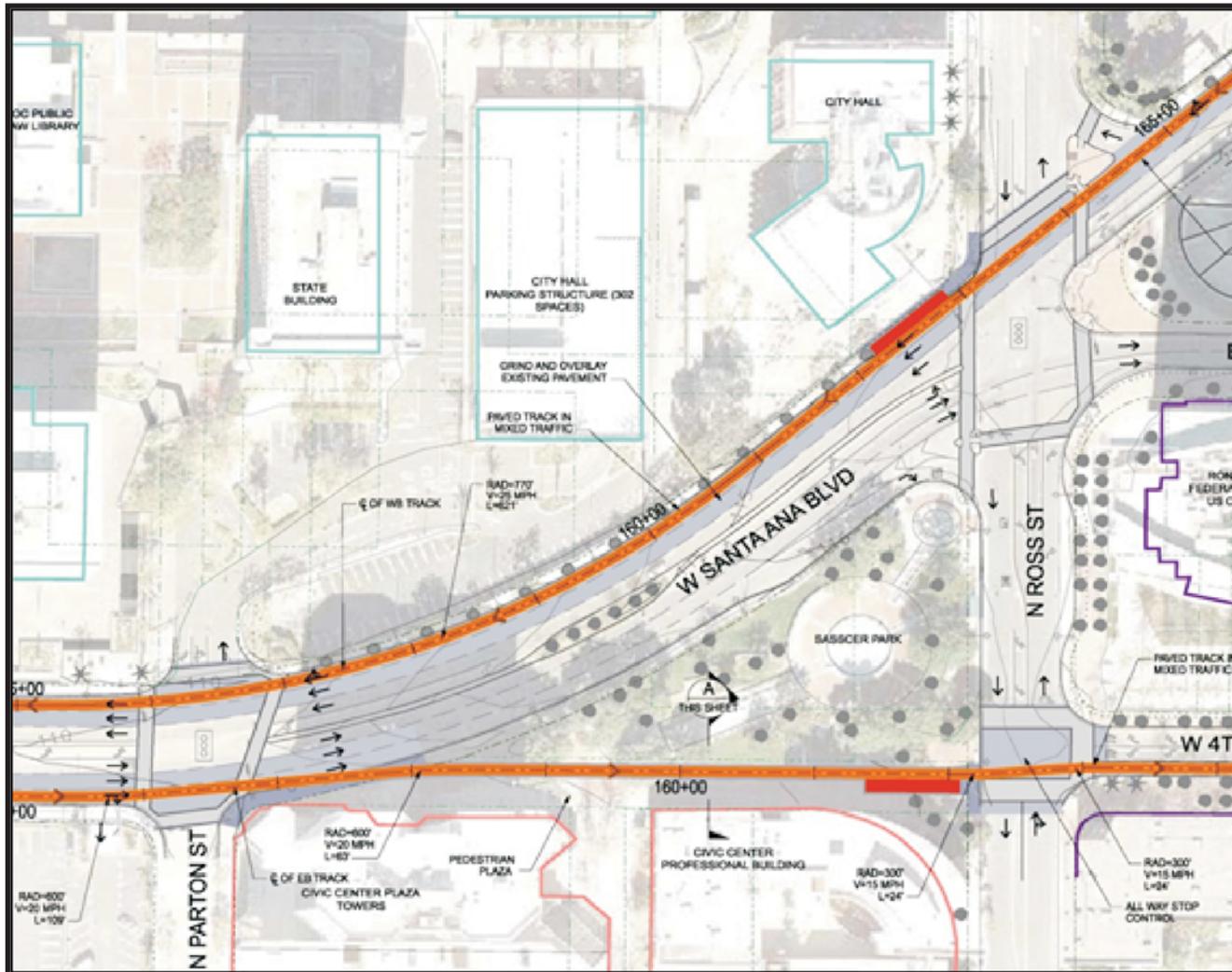


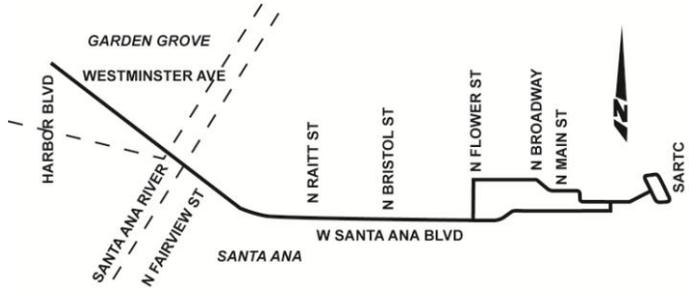
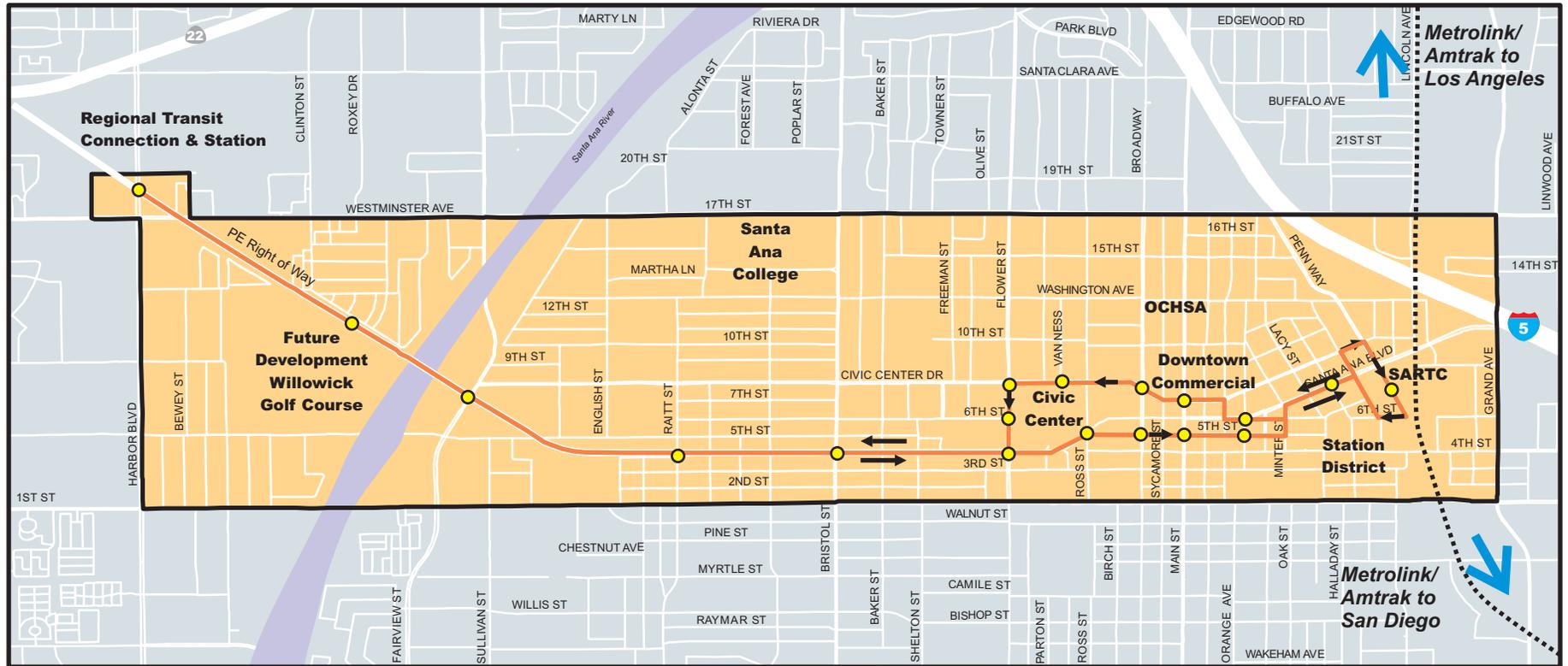
TABLE A-2: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 2			
Key Attributes	Descriptions		
Transit Mode	Streetcar		
Termini	Western Terminus: Harbor Blvd. Eastern Terminus: SARTC		
Alignment Description	<p><u>Routing by Segment:</u></p> <ul style="list-style-type: none"> • PE ROW, from Harbor Blvd. to Raitt St.: streetcars operate at-grade, bi-directionally, in exclusive ROW. • Santa Ana Blvd., from Raitt St. to Flower St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic. • Santa Ana Blvd./5th St. and Civic Center Dr. Couplet, from Flower St. to Minter St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic. • 6th St./Brown St., from Minter St. to Poinsettia St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. • Poinsettia St./Santa Ana Blvd./Santiago St./6th St. (SARTC Loop): streetcars operate in a one-way loop, in the street, at-grade, along with mixed-flow traffic. 		
Length of Alignment	4.5 miles (Harbor Boulevard to SARTC)		
Stations(13 Stations)	<p><u>Station Locations:</u></p> <ol style="list-style-type: none"> 1. Harbor Blvd. and Westminster Ave. 2. Willowick 3. Fairview St. and PE ROW 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd. <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <p><i>Couplet Section(Eastbound)</i></p> <ol style="list-style-type: none"> 6E. Flower St. and Santa Ana Blvd. 7E. ----- 8E. Ross St. and Santa Ana Blvd. 9E. Broadway and 5th St. 10E. Main St. and 5th St. 11E. French St. and 5th St. </td> <td style="width: 50%; vertical-align: top;"> <p><i>Couplet Section(Westbound)</i></p> <ol style="list-style-type: none"> 6W. Flower St. and 6th St. 7W. Flower St. and Civic Center Dr. 8W. Van Ness Ave. and Civic Center Dr. 9W. Broadway and Civic Center Dr. 10W. Main St. and Civic Center Dr. 11W. French St. and Santa Ana Blvd. </td> </tr> </table> <ol style="list-style-type: none"> 12. Brown St. and Lacy St. 	<p><i>Couplet Section(Eastbound)</i></p> <ol style="list-style-type: none"> 6E. Flower St. and Santa Ana Blvd. 7E. ----- 8E. Ross St. and Santa Ana Blvd. 9E. Broadway and 5th St. 10E. Main St. and 5th St. 11E. French St. and 5th St. 	<p><i>Couplet Section(Westbound)</i></p> <ol style="list-style-type: none"> 6W. Flower St. and 6th St. 7W. Flower St. and Civic Center Dr. 8W. Van Ness Ave. and Civic Center Dr. 9W. Broadway and Civic Center Dr. 10W. Main St. and Civic Center Dr. 11W. French St. and Santa Ana Blvd.
<p><i>Couplet Section(Eastbound)</i></p> <ol style="list-style-type: none"> 6E. Flower St. and Santa Ana Blvd. 7E. ----- 8E. Ross St. and Santa Ana Blvd. 9E. Broadway and 5th St. 10E. Main St. and 5th St. 11E. French St. and 5th St. 	<p><i>Couplet Section(Westbound)</i></p> <ol style="list-style-type: none"> 6W. Flower St. and 6th St. 7W. Flower St. and Civic Center Dr. 8W. Van Ness Ave. and Civic Center Dr. 9W. Broadway and Civic Center Dr. 10W. Main St. and Civic Center Dr. 11W. French St. and Santa Ana Blvd. 		

TABLE A-2: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 2	
Key Attributes	Descriptions
	13. SARTC
Design Options Carried Forward	<u>Santa Ana River Crossing:</u> Adjacent Single Track Bridge
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (15 hours)
Transit Vehicle	Streetcar – Vehicle type selection has yet to be determined. The two classifications under consideration include: <ul style="list-style-type: none"> • Classic Modern Streetcar (e.g., Portland, Oregon) • CPUC Compliant Streetcar (e.g., San Diego, California)
Power Source	Electric, Overhead Contact System, Traction Power Substations(TPSS) <u>TPSS Locations:</u> <ol style="list-style-type: none"> a. Northwest of Harbor Boulevard and Westminster Avenue b. Along PE ROW, west of Susan Street c. Along PE ROW, east of Santa Ana River d. North on Santa Ana Boulevard, east of Bristol Street e. North of 5th Street, east of Main Street
Operations and Maintenance Facility Sites	Two Candidate Sites: <ul style="list-style-type: none"> • Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St., and the Metrolink tracks. • Site B: West of Raitt St., between the PE ROW and 5th St.
Major Bicycle and Pedestrian Features	<ul style="list-style-type: none"> • Sidewalk and pedestrian improvements in the vicinity of proposed station platforms. • Civic Center Drive: Provide sufficient street width on Civic Center Drive between Flower Street and Spurgeon Street to support the City’s planned development of a striped bike lane on each side of the street.

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011.



Streetcar Alternative 2 Alignment



LEGEND:

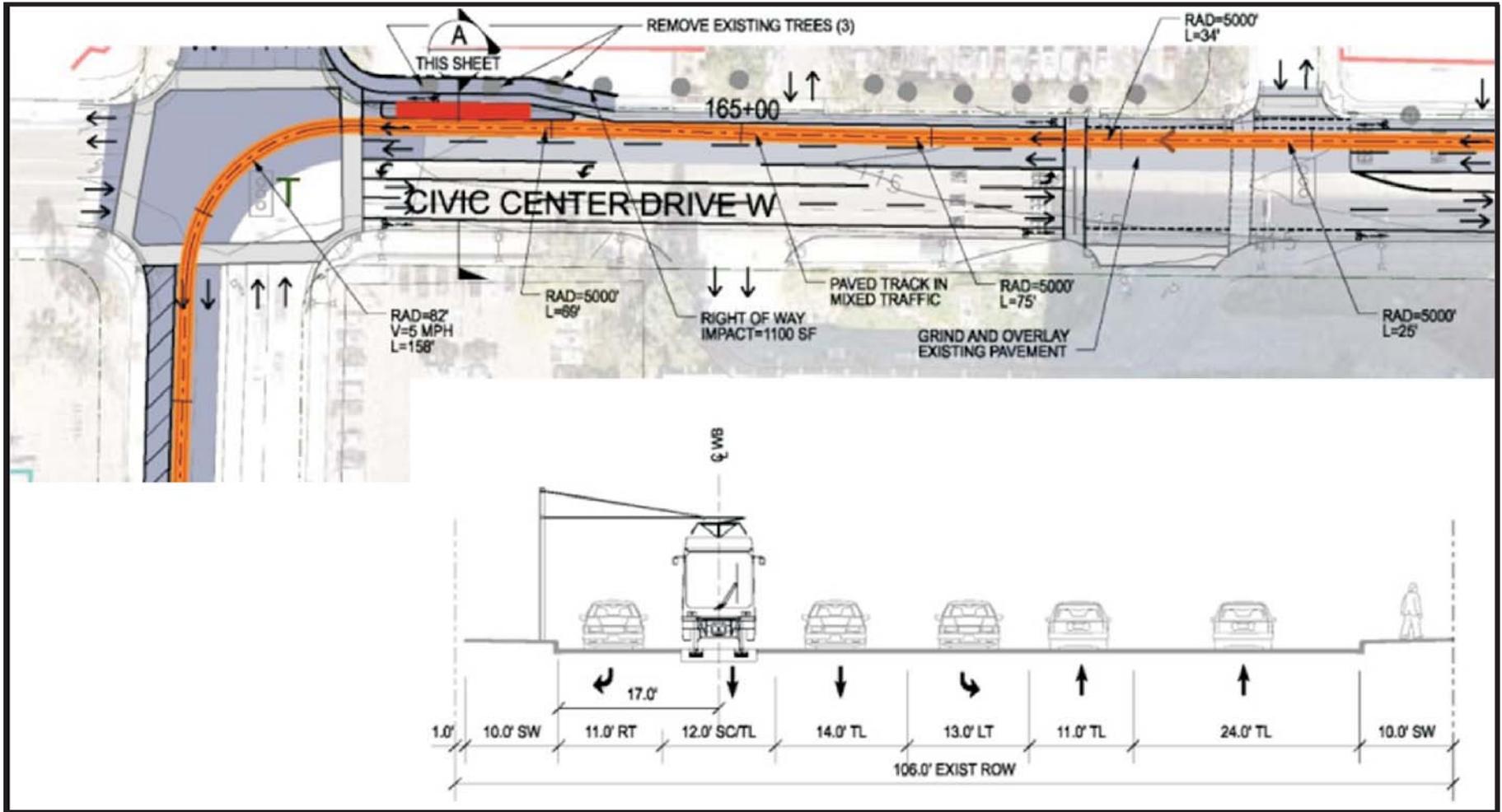
- Study Area
- Proposed Stop
- Streetcar Alternative 2

0 1500 3000 FEET

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study*, July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.
 Note: Termini for Initial Operable Segment 2 (IOS-2) are located at Raitt Street and SARTC.



Civic Center Drive Bike Lane



Streetcar Alternatives Initial Operable Segments

In response to funding and phasing issues raised by fiscal constraints identified during OCTA's long-range transportation planning process, IOSs which are shorter segments of Streetcar Alternatives 1 and 2 were developed for the SA-GG Fixed Guideway Project. The intent of the IOSs was to identify starter segments that could be constructed and operated until funding is assembled to complete the projects. Both IOS-1 and IOS-2 would terminate at Raitt Station (Raitt Street and Santa Ana Boulevard) rather than Harbor Station (Harbor Boulevard and Westminster Avenue). Both would include the same project features and design options as their respective full alignment build alternatives between Raitt Street and SARTC. These tracks would extend another hundred feet west within the PE ROW to reach the O & M Facility Site B should this site ultimately be selected for either IOS-1 or IOS-2.

The configuration of Raitt as an interim terminus station is the same for IOS-1 and IOS-2. Just over 50 spaces would be provided for station parking at Raitt within the PE ROW on an interim basis to be replaced by parking at Harbor Station upon completion of the full Project. Vehicular access to Raitt Station parking would be via Daisy Avenue.

IOS-1 (Santa Ana Boulevard and 4th Street Couplet). IOS-1 follows the same alignment as Streetcar Alternative 1, but terminates at Raitt Station rather than extending to Harbor Station (**Figures A-8** through **A-10**). The IOS-1 streetcar alignment is about 2.2 miles in length. IOS-1 includes the same project features, design options, and parking scenarios as Streetcar Alternative 1 between Raitt Street and SARTC (**Table A-3**).

IOS-2 (Santa Ana Boulevard/5th Street and Civic Center Drive Couplet). IOS-2 follows the same alignment as Streetcar Alternative 2, but terminates at Raitt Station rather than extending to Harbor Station (**Figures A-8** through **A-10**). The IOS-2 streetcar alignment is about 2.6 miles in length. IOS-2 includes the same project features and design options as Streetcar Alternative 2 between Raitt Street and SARTC (**Table A-3**).

Key Attributes

Western Terminus Elevated Crossing

The western terminus for both of the streetcar alternatives is located at the northeast corner of Harbor Boulevard and Westminster Avenue; the transition from the PE ROW to the western terminus site will include an elevated crossing. This crossing is illustrated in **Figure A-11**.

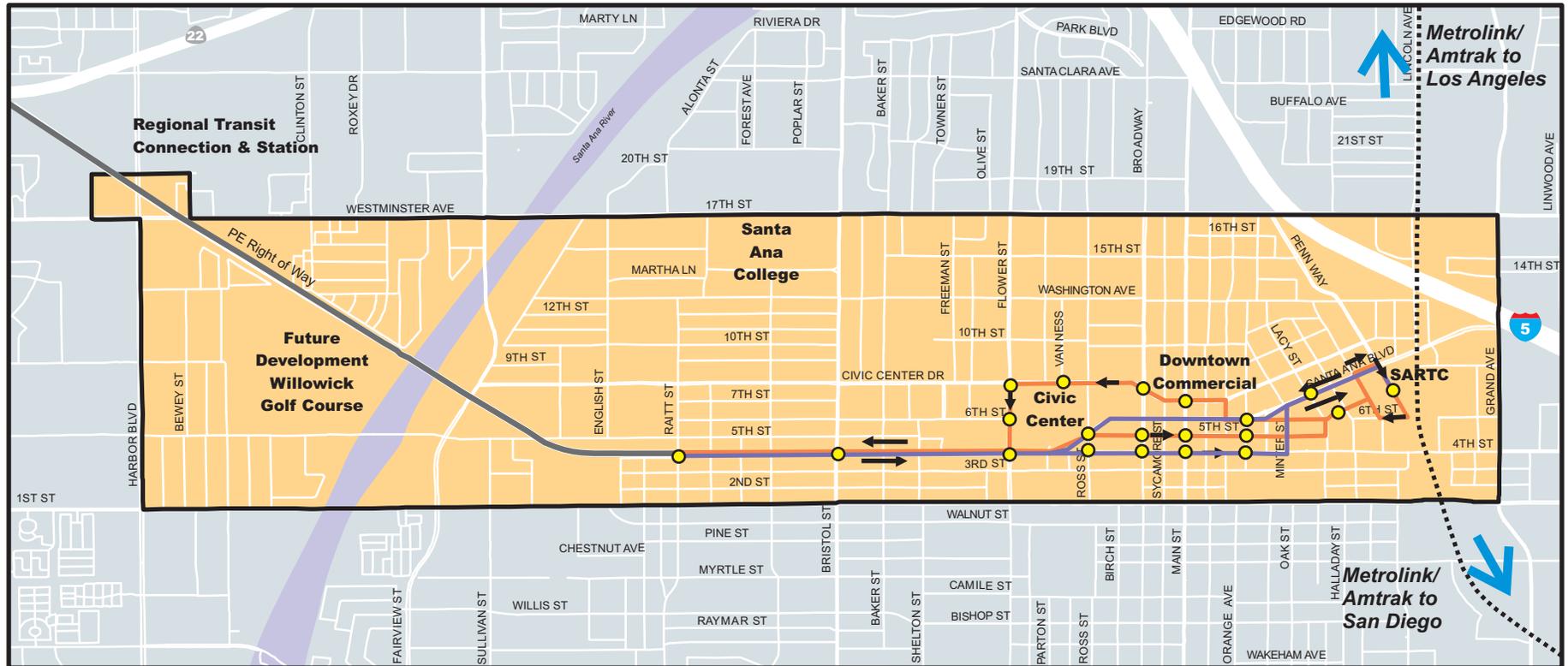
Streetcar Stations

The stations for each streetcar alternative alignment are located curbside adjacent to the platforms within the public ROW. They will consist of a shelter constructed substantially of transparent materials. In addition to seating, the stations will provide traveler information such as estimates of next train arrival time. The two terminus stations will include parking (approximately 52 spaces at the western terminus station; shared-use of SARTC parking for the eastern terminus station). The terminus stations and one inline station in the Downtown

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IOS-1 and IOS-2 Alignments



LEGEND:

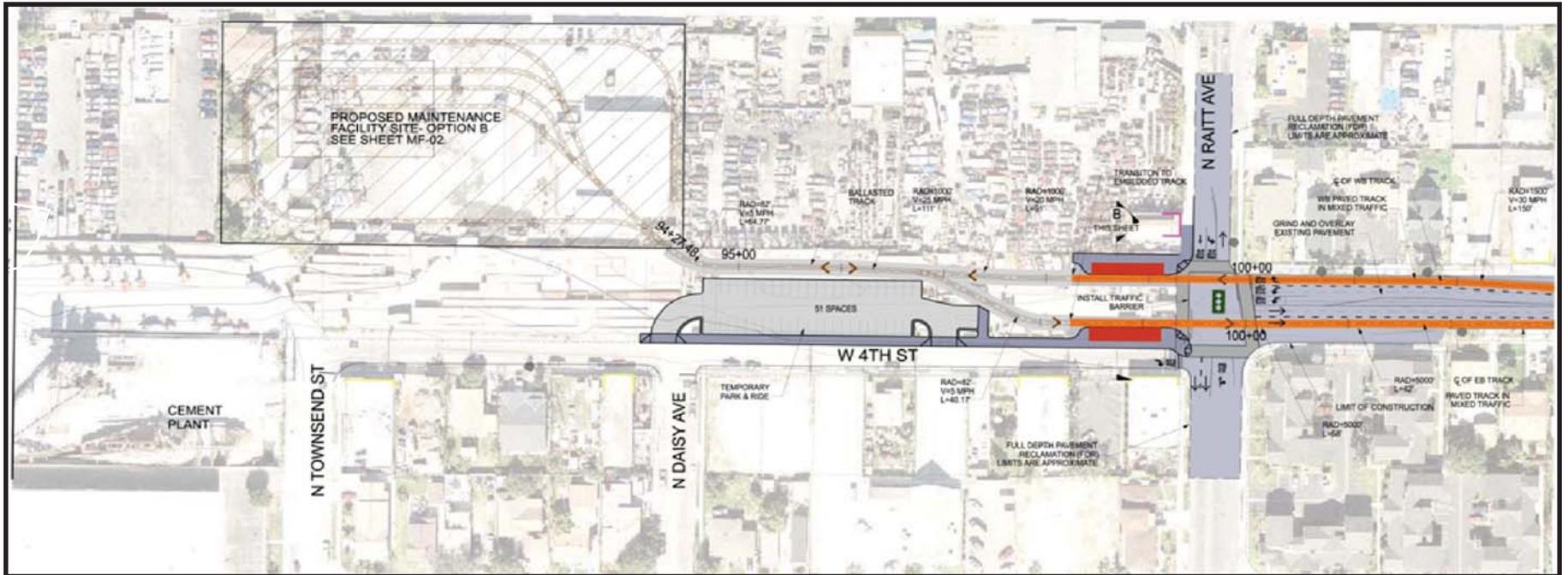
- Study Area
- Proposed Stop
- Streetcar Alternative 1
- Streetcar Alternative 2

0 1500 3000 FEET

Source: Cordoba Corporation, Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study, July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.



IOS-1 and IOS-2 Raitt Street Terminus Configuration with O & M Facility





IOS-1 and IOS-2 - Raitt Street Terminus Configuration without O & M Facility

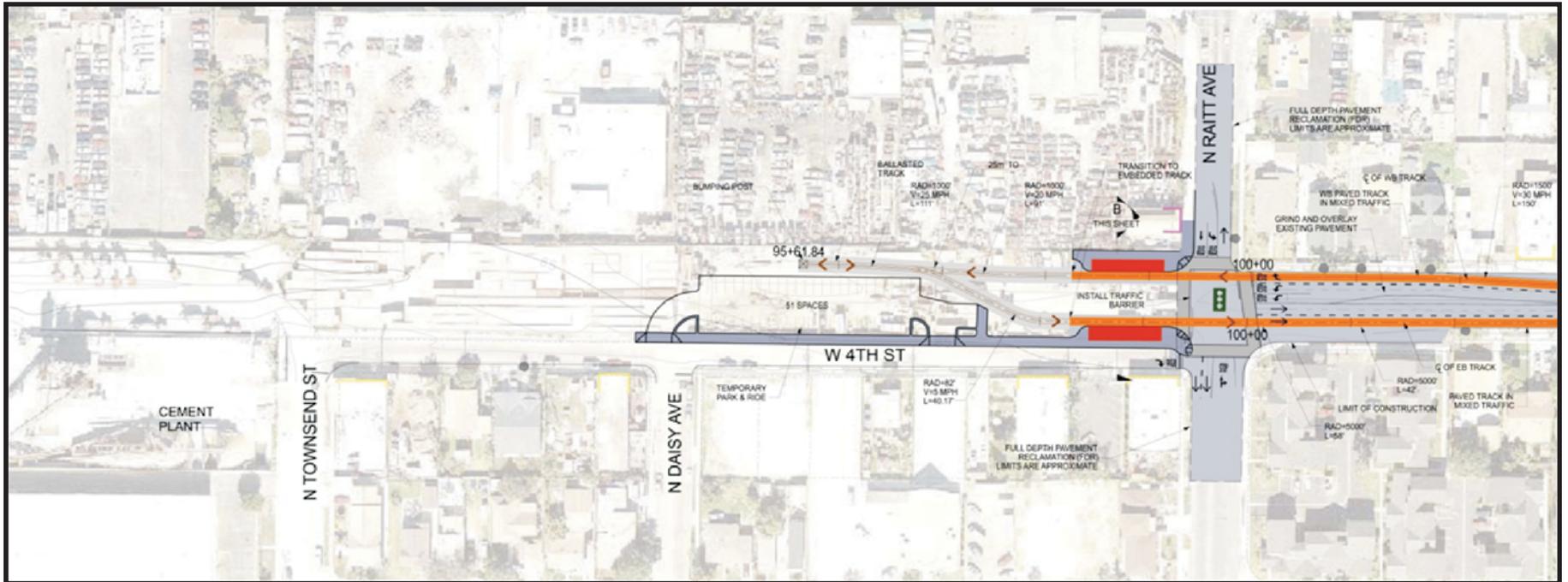


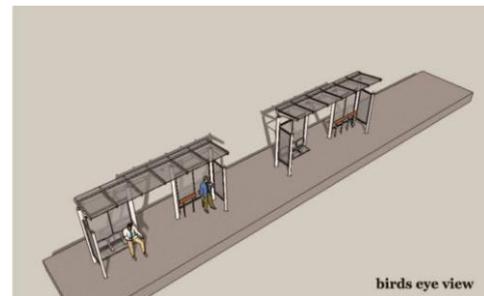
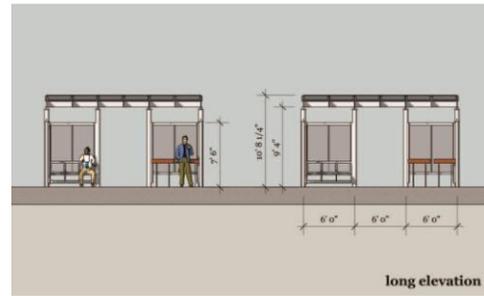
TABLE A-3: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR IOS-1 AND IOS-2

Key Attributes	IOS-1	IOS-2		
Termini	Western Terminus: Raitt St. Eastern Terminus: SARTC			
Alignment Description	<u>Routing by Segment:</u> <ul style="list-style-type: none"> • Santa Ana Blvd., from Raitt St. to Ross St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic. • 4th St./Santa Ana Blvd. Couplet, from Ross St. to Mortimer St.: streetcars operate in the street, at grade, one-way, along with mixed-flow traffic. • Santa Ana Blvd., from Mortimer St. to SARTC: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic. 		<u>Routing by Segment:</u> <ul style="list-style-type: none"> • Santa Ana Blvd., from Raitt St. to Flower St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic. • Santa Ana Blvd./5th St. and Civic Center Dr. Couplet, from Flower St. to Minter St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic. • 6th St./Brown Street, from Minter St. to Poinsettia St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. • Poinsettia St./Santa Ana Blvd./Santiago St./6th St. (SARTC Loop): streetcars operate in a one-way loop, in the street, at-grade, along with mixed-flow traffic. 	
Length of Alignment	2.2 miles (Raitt St. to SARTC)		2.6 miles (Raitt St. to SARTC)	
Stations	<u>Station Locations:</u> 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd. 6. Flower St. and Santa Ana Blvd.		<u>Station Locations:</u> 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd.	
	<i>Couplet Section (Eastbound)</i> 7E. Sasser Park 8E. Broadway and 4 th St. 9E. Main St. and 4 th St. 10E. French St. and 4 th St.	<i>Couplet Section (Westbound)</i> 7W. Ross St. and Santa Ana Blvd. 8W. Broadway and Santa Ana Blvd. 9W. Main St. and Santa Ana Blvd. 10W. French St. and Santa Ana Blvd.	<i>Couplet Section (Eastbound)</i> 6E. Flower St. and Santa Ana Blvd. 7E. ----- 8E. Ross St. and Santa Ana Blvd. 9E. Broadway and 5 th St. 10E. Main St. and 5 th St. 11E. French St. and 5 th St.	<i>Couplet Section (Westbound)</i> 6W. Flower St. and 6 th St. 7W. Flower St. and Civic Center Dr. 8W. Van Ness Ave.* and Civic Center Dr. 9W. Broadway and Civic Center Dr. 10W. Main St. and Civic Center Dr. 11W. French St. and Santa Ana Blvd.
	11. Lacy St. and Santa Ana Blvd. 12. SARTC		12. Lacy St. and Santa Ana Blvd. 13. SARTC	
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)			
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (16 hours)			
Power Source	Electric, Overhead Contact System, Traction Power Substations (TPSS) TPSS Locations: d. North on Santa Ana Boulevard. East of Bristol Street e. North of 5 th Street, east of Main			
Operations and Maintenance Facility Sites	Two Candidate Sites: <ul style="list-style-type: none"> • Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St. and Metrolink tracks. • Site B: West of Raitt St., between the PE ROW and 5th St. 			

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011.

area will also include ticketing machines for the convenience of passengers who may want an alternative to the on-vehicle ticketing during busy peak periods.

Streetcar Alternative 1 includes 12 stations along its 4.1-mile long alignment. Streetcar Alternative 2 includes 13 stations along its 4.5-mile long alignment. An additional station is included in Streetcar Alternative 2 compared to Streetcar Alternative 1. It is located at Flower Street and 6th Street for the westbound streetcar couplet. This is because of the distance between the directional Flower Street stations in Streetcar Alternative 2, with the eastbound stop at Santa Ana Boulevard and the corresponding westbound stop at Civic Center Drive. Additionally, Flower Street, at 6th Street, is a gateway to the Civic Center Plaza with City, County, State and federal offices, as well as the Orange County Sheriff’s Department and jail, and the Santa Ana Police Department.



Views of typical streetcar station structure and platform.

Source: Cordoba Corporation

Streetcar Vehicles



Views of typical streetcar vehicles.

Source: Cordoba Corporation

Two types of streetcar vehicles have been identified for use: classic European style streetcar, and the CPUC-compliant vehicle. The former would be similar to the vehicles currently in service in Portland, Oregon and Tucson, Arizona, manufactured by Oregon Ironworks. Neither the Portland vehicle nor the Tucson vehicle meet all CPUC structural requirements, and would therefore require either a waiver from the CPUC or a revision of the CPUC regulations that specifically acknowledge streetcars operating in mixed flow traffic at lower speed. The CPUC-compliant vehicle is derived from a light rail vehicle design. Light rail vehicles are typically CPUC-compliant and do not require CPUC waivers. The Siemens built “S70 short” is a CPUC-compliant vehicle. Both the Oregon Ironworks vehicle and the Siemens vehicle comply with Section 165: “Buy America” provisions of the Surface Transportation Assistance Act of 1982.

Santa Ana River Crossing

Both streetcar alternatives would utilize the PE ROW and cross over the Santa Ana River. This alignment was once used for the Pacific Electric Railway red car system and the Old Pacific Electric Santa Ana River Bridge still remains.

However, it has long been closed for use and not utilized by vehicles or pedestrians since 1950. The historic bridge is inadequate to accommodate the proposed project due to its age, size, (it was constructed as a single-track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements. Four design options were developed for Streetcar Alternatives 1 and 2 at the Santa Ana River Crossing.

These design options were evaluated against identified criteria (cost, feasibility, and potential impacts) to determine which were to be carried forward for evaluation in the EA/DEIR. As detailed in the Section 4(f) Resources Technical Report, Appendix D, and Bridge Design Options Technical Memorandum, Appendix N, four design options were developed for Streetcar Alternatives 1 and 2 at the Santa Ana River Crossing. One was determined feasible for carrying forward for analysis in the EA/DEIR, as illustrated in **Figure A-12**.

The existing bridge would remain in its current location and condition. A new single-track bridge would be constructed immediately south of the existing bridge for the fixed guideway. Through the use of gates and signaling, the single-track bridge would accommodate bi-directional fixed guideway traffic.

Design Options

During detailed evaluation, design options were developed to avoid identified constraints or to take advantage of specific opportunities presented along the alignments. In most cases the design options are the same for Streetcar Alternatives 1 and 2. However, where the design option is unique to a specific alternative, it is identified in the discussion. The full results of the analysis of the design options are provided in the Detailed Evaluation of Alternatives Technical Report, March 2012. Based on this technical report, the design options that have been carried into the environmental assessment are described below:

Operations and Maintenance (O & M) Facility Site Options

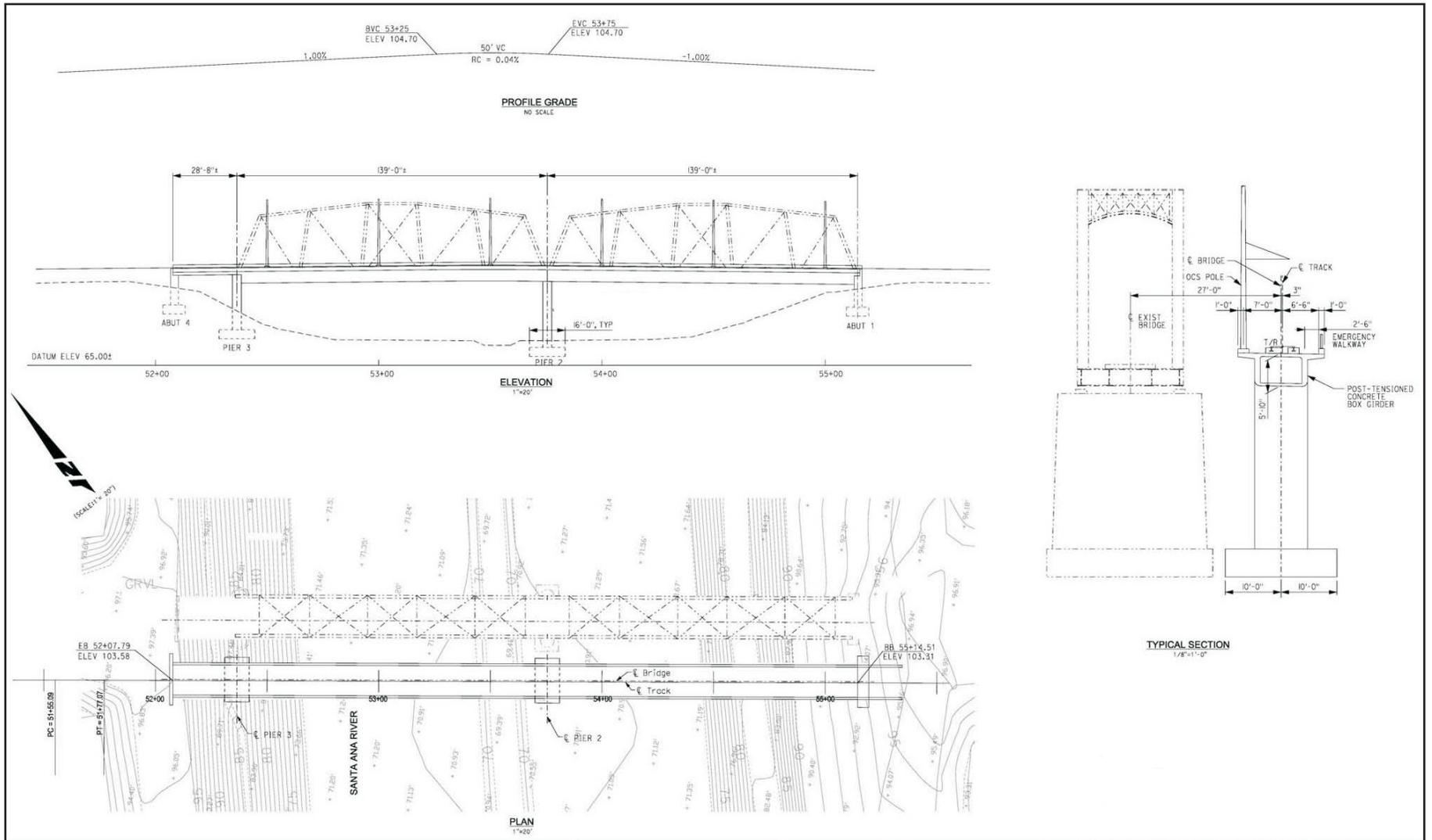
Both Streetcar Alternatives 1 and 2 would require the construction of an O & M Facility for streetcar operations. An O & M Facility is a stand-alone building which would meet the maintenance, repair, operational and storage needs of the proposed streetcar system. The O & M Facility accommodates daily and routine vehicle inspections, interior/exterior cleaning of the streetcars, preventative (scheduled) maintenance, unscheduled maintenance, and component change-outs. The proposed facility would also provide a venue for parking vehicles that are not in use and for rebuilding components.

The site for the O & M Facility would need to accommodate a building that houses both maintenance and administrative functions; provides for off-street employee parking; and provides for various functions such as outside storage of system components, vehicle washing, and local requirements for landscaping and screening. Currently, two candidates O & M Facility sites have been identified for either Streetcar Alternative 1 or 2. See **Figure A-13** for the approximate locations of these sites.

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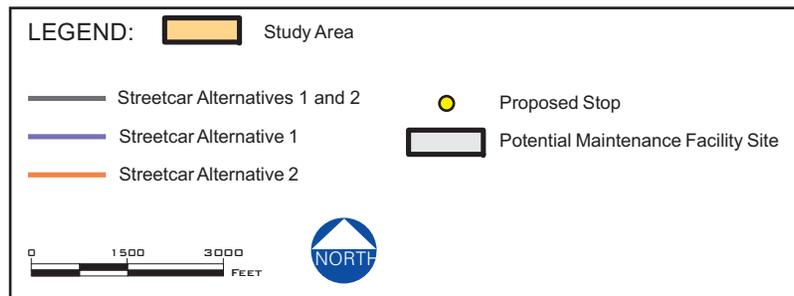
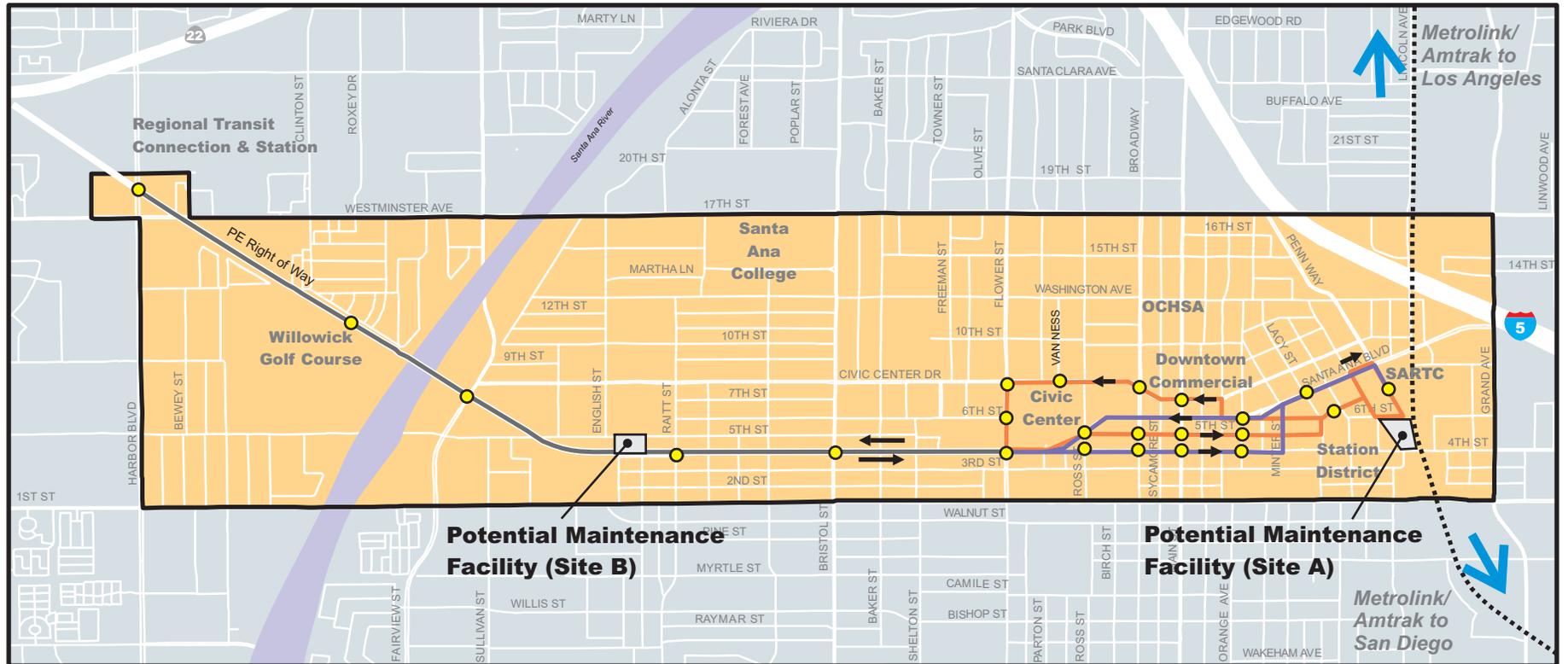


Santa Ana River Crossing





Candidate Sites of Operations and Maintenance Facilities



O & M Facility Site A (near SARTC). O & M Facility Site A is an irregularly shaped parcel slightly larger than 2.2 acres, and bordered by 6th Street to the north, 4th Street to the south, the Metrolink tracks to the east, and various industrial and commercial businesses to the west. Currently used as a waste transfer and recycling center, this site contains one primary structure with the remainder of the site used for receiving and sorting recycling materials, and parking. **Figure A-14** shows the proposed location of Site A and **Figure A-15** shows a conceptual layout of Site A. This site connects to either Streetcar Alternative 1 or 2 via a nonrevenue extension of track on Santiago Street for the equivalent of approximately two city blocks.

O & M Facility Site B (near Raitt Street). O & M Facility Site B is a rectangular site slightly larger than 2.4 acres. It is located west of Raitt Street and is bordered by 5th Street to the north and the PE ROW to the south. Located in an area zoned for industrial and commercial uses, this site is comprised of three parcels, two of which contain existing businesses and a combination of industrial buildings. The third parcel contains several residences. **Figure A-16** shows the proposed location of Site B and **Figure A-17** shows a conceptual layout of Site B. This site connects to the streetcar alignment for Streetcar Alternative 1 or 2 from the PE ROW. Motor vehicle access to the site would be to and from 5th Street.

Fourth Street Parking Scenarios

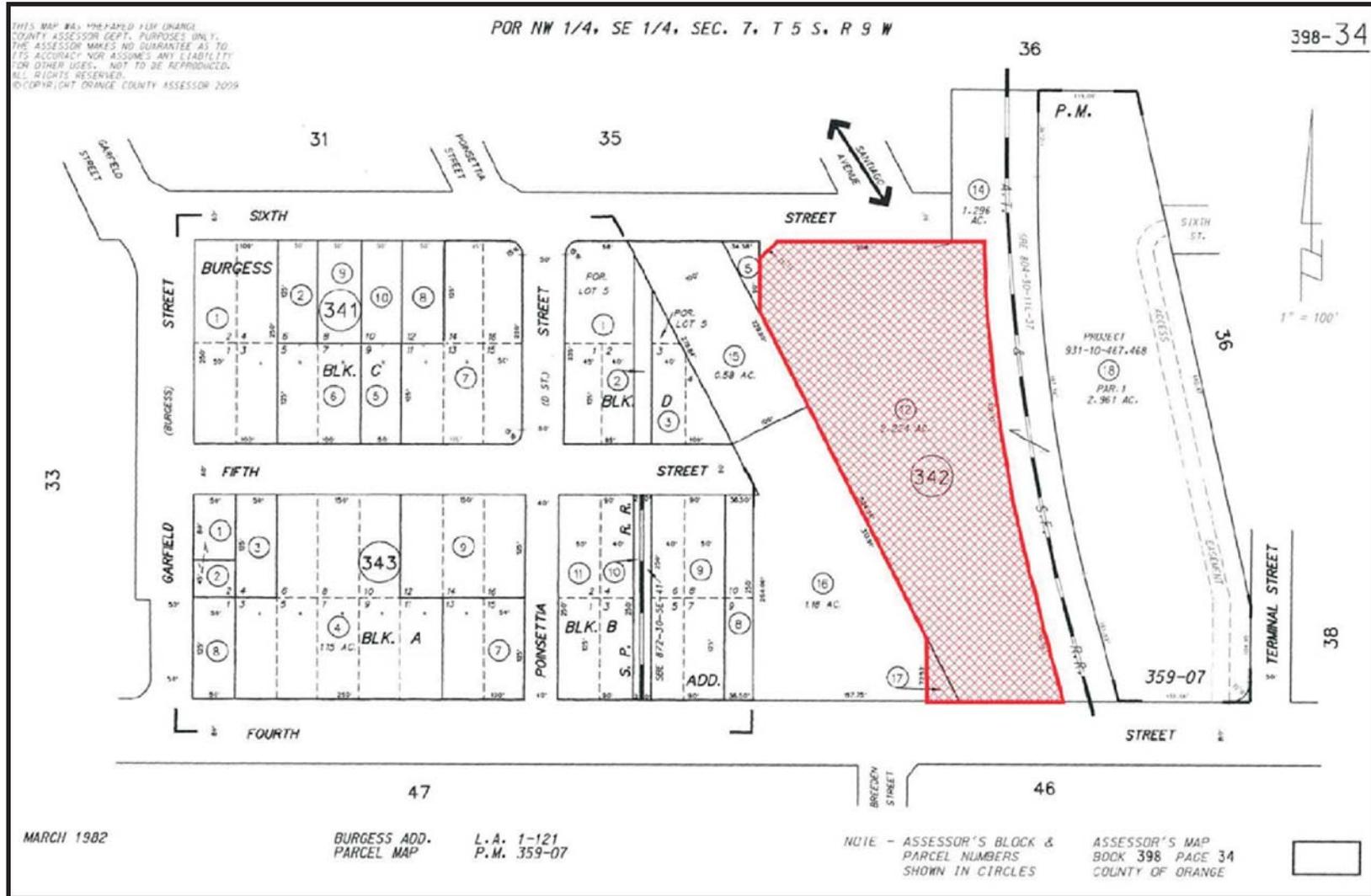
The Streetcar Alternative 1 alignment would utilize 4th Street between Ross Street and Mortimer Street in the westbound direction. From east of Ross Street to French Street, 4th Street has one travel lane in each direction with head-in diagonal parking along each side of the roadway. The diagonal parking, with vehicles exiting parking spaces by backing into the travel lane, is incompatible with reliable streetcar operations. Three design scenarios were identified to address the diagonal parking on 4th Street as described below and shown on **Figure A-18**.

Scenario A: Convert the diagonal parking along the south side of 4th Street, between Ross Street and French Street, to parallel parking and widen the sidewalk along the south side from 12 feet to 20 feet, and replace streetlights and landscaping. A total of 26 on-street parking spaces would be removed under this scenario.

Scenario B: Remove the diagonal parking along the south side of 4th Street, between Ross Street and French Street, and widen the sidewalk along the south side from 12 feet to 28 feet, and replace streetlights and landscaping. A total of 77 on-street parking spaces would be removed under this scenario.

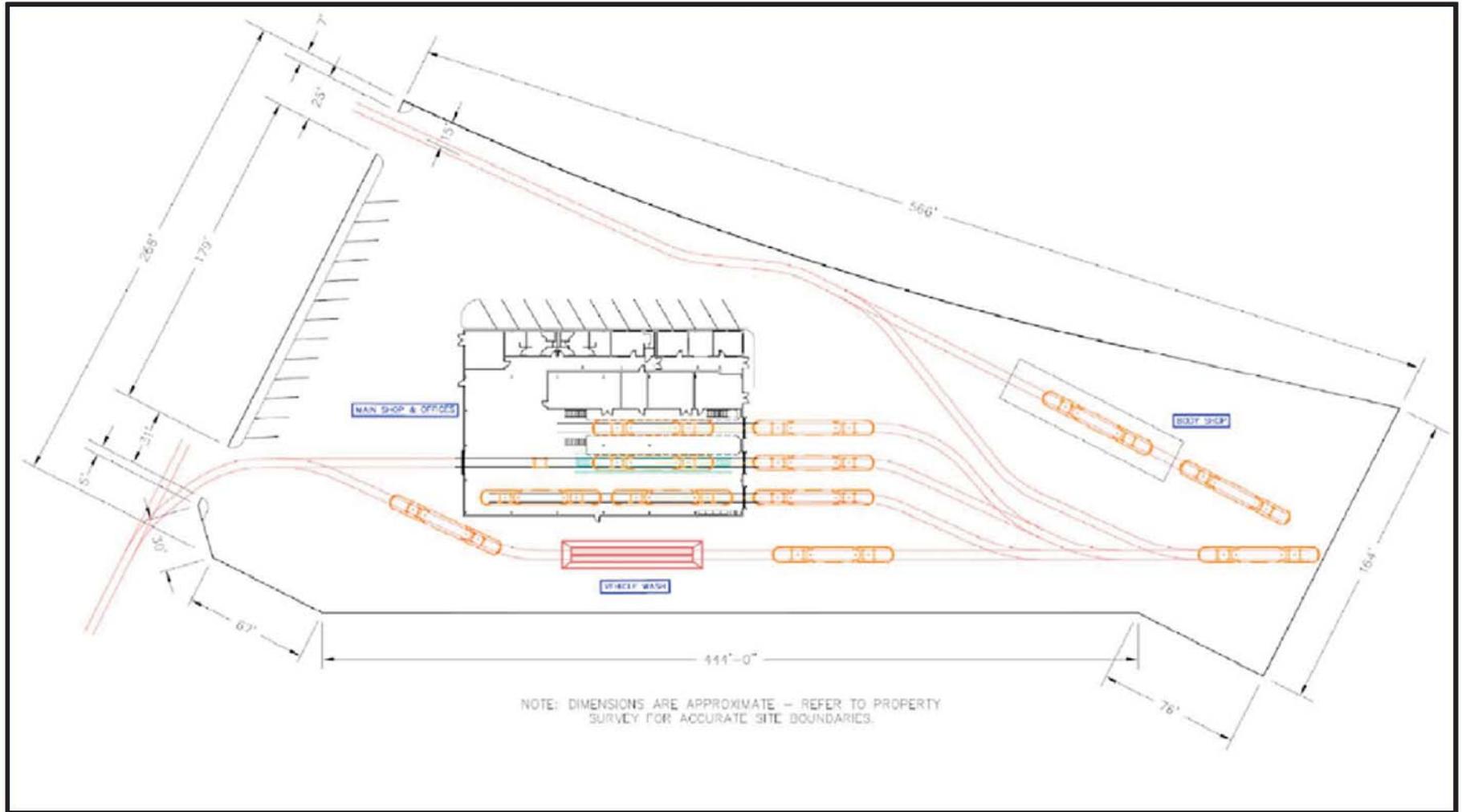


Operations and Maintenance Facility Site A - Location and Configuration





Operations and Maintenance Facility Site A - Conceptual Layout





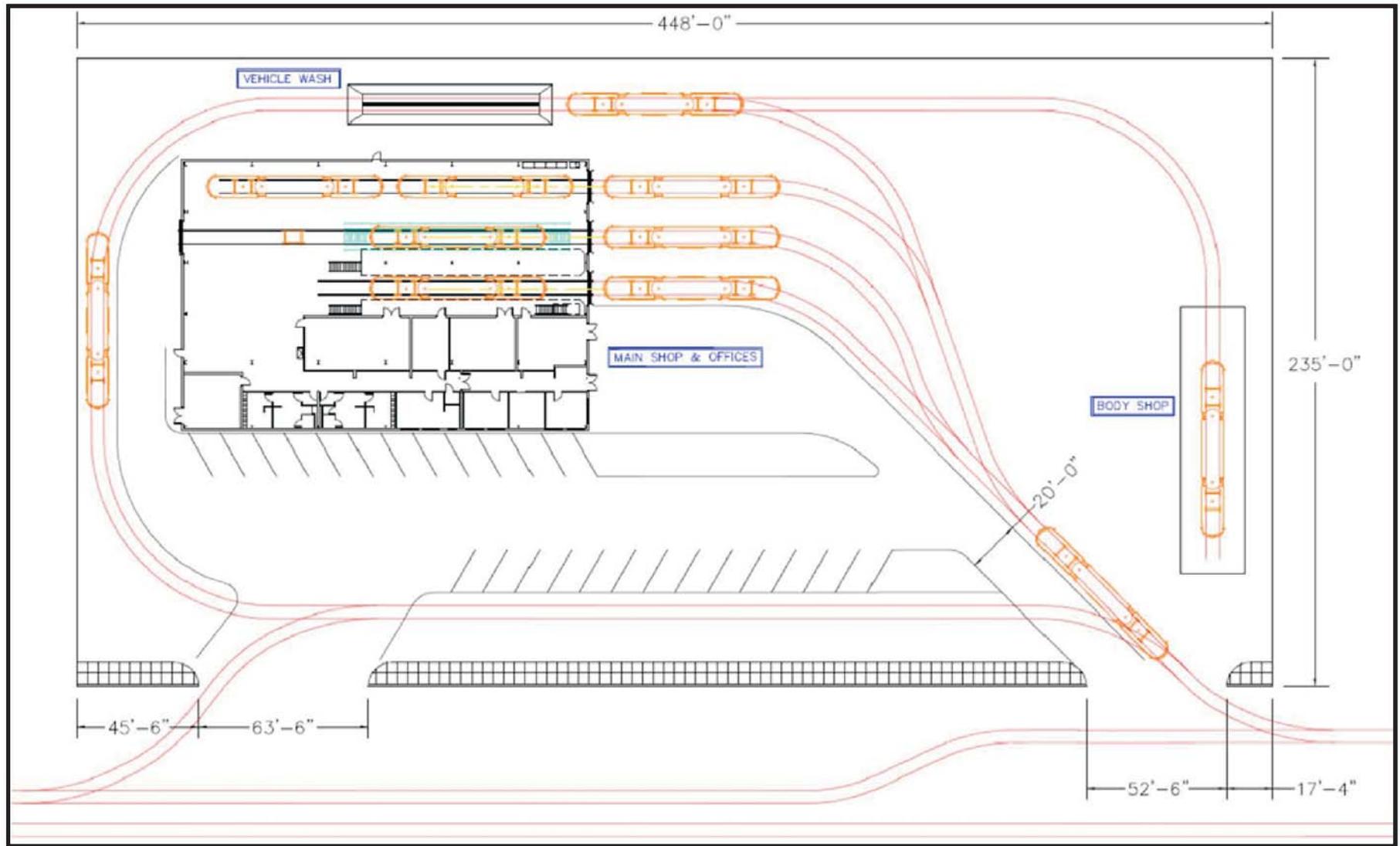
Operations and Maintenance Facility Site B - Location and Configuration



Source: Cordoba Corporation, Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study, July 11, 2012.

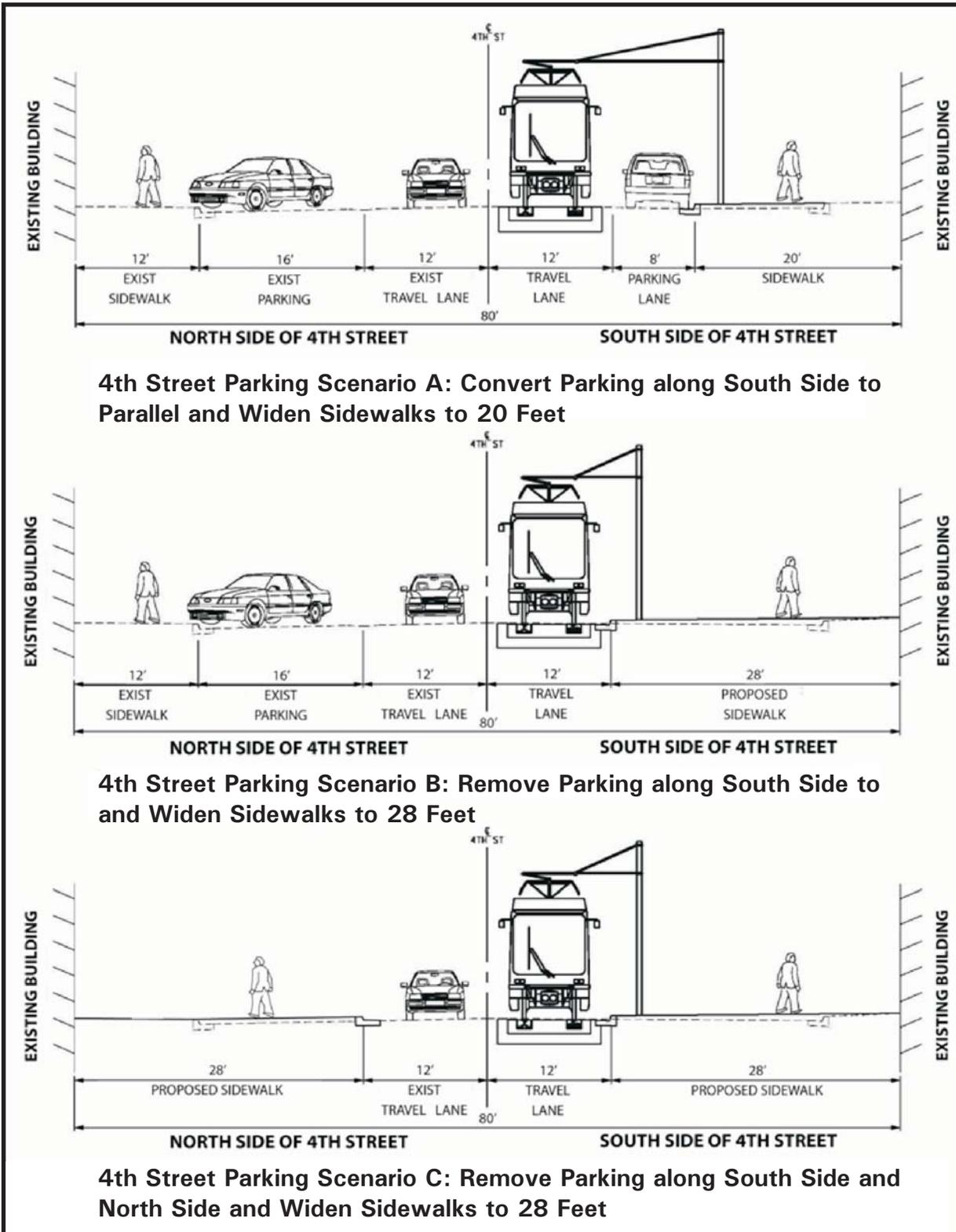


Operations and Maintenance Facility Site B - Concept Layout





4th Street Parking Scenarios



Scenario C: Remove the diagonal parking along both sides of 4th Street, between Ross Street and French Street, widen the sidewalks along both sides from 12 feet to 28 feet. In this scenario, only the parking removal and sidewalk widening along the south side would be included in the cost of the project. The City of Santa Ana would pursue alternative funding to construct the improvements to the north side.

Construction

Construction of either Streetcar Alternative 1 or 2 would take place on a segment-by-segment basis along the streetcar alignment, with the exception of the bridge structures and the O & M Facility. The duration of concentrated construction activities would be no more than six months at one location along the alignment. The construction approach would be the same for Streetcar Alternatives 1 and 2. Construction activities would include, but would not be limited to, site preparation, bridge structure construction, roadway and sidewalk reconstruction, laying streetcar track and embedded trackwork, and construction of an O & M Facility.

Construction hours would generally occur between 7:00 a.m. and 6:00 p.m., Monday through Friday. There are some exceptions, such as nighttime construction, where temporary street lane closures and utility work would be required. Project construction would follow the applicable local, State, and federal laws for building and safety. In addition, standard conditions would be included in project construction contracts to ensure consistency with applicable laws for traffic, noise, vibration, and dust control.

The following description summarizes the construction approach and methods that have been defined for the project at this preliminary stage of conceptual design:

- In general, all construction of tracks would be within the existing PE ROW, existing streets, or proposed future streets;
- Construction of the O & M Facility would be within one of the designated sites along the alignment, as defined in the project description as O & M Facility Sites A and B;
- The construction period is anticipated to be approximately 30 months, with major activities to be completed within the first 24-month period;
- It is anticipated that the construction activities would be staged and sequenced based on location and types of construction. The likely staging of the proposed project would include four to five segments to allow for construction crews to work in sequence, moving one team to a new location, while the next team takes over the next set of activities; and
- Two potential areas are identified as construction staging and track laydown areas:
 - The east end of the PE ROW at Raitt Street would be used as a temporary construction and welding plant and material storage sites. This location would serve as the midpoint of distribution to both east and west directions of the alignment. The welding plant would be a combined operation of flash butt welding and laydown storage to produce designated length of rail ribbons to be dragged or truck-hauled into position for embedment or attachment to ties; and

- The second area is identified as land owned by the City of Santa Ana, located at the corner of 6th and Santiago Streets. Some special trackwork and pre-curved rails could be stored at this location;
- Construction of the proposed project would require the relocation of one catch basin under Alternative 2 at Flower Street and Civic Center Drive in addition to the installations of approximately 50 new catch basins to improve drainage along the alignment.

Construction Scenario

The project would use conventional construction techniques and equipment typical to the Southern California region and follow all applicable federal, State, and local laws for building and safety. Working hours would be varied to meet special circumstances and restrictions. Customary local practices consistent with all applicable laws would be used to control traffic, noise, vibration, erosion, and dust during construction. Design and construction would include mitigation commitments. Generally, construction would be divided into a series of often overlapping activities to minimize the construction duration and associated impacts. **Table A-4** depicts a typical construction activities sequencing for an LRT project of similar scope and complexity.

TABLE A-4: TYPICAL CONSTRUCTION SEQUENCE AND AVERAGE CONSTRUCTION TIME		
Activity/a/	Tasks	Average Time Required (months)
Preconstruction	Locate utilities; establish right-of-way and project control points and centerlines; establish and relocate survey monuments	2 – 4
Site Preparation	Establish environmental controls and install soil and erosion-control measures; relocate utilities and clear and grub right-of-way (demolition); establish detours and haul routes; erect safety devices and mobilize special construction equipment; prepare construction equipment yards, and stockpile materials	3 – 6
Heavy Construction	Construct aerial structure, retaining walls, trackbed drainage, at-grade guideway, soil stabilization, pile caps/foundations, abutments, bents, and dispose of excess material	12 – 16
Medium Construction	Lay track, construct stations, install off-site drainage, and construct elevated station enclosures	6 – 12
Light Construction	Finish work, install systems elements (electrical, signals, and communication), street lighting where applicable, traffic signals, signing and striping, landscaping, close/remove detours, and clean up and test system	3 – 9
Pre-Revenue Service	Test vehicles, power, communication, signaling, train operators and maintenance personnel	1 – 3

/a/ Some of these activities would be conducted in parallel.
 Source: Terry A. Hayes Associates Inc., 2012.

- Some profile grade leveling, clearing, and grubbing of the PE ROW would take place during the early stages to establish grade for the ballast track sections. The duration of this activity would be two to three months;

Construction equipment would include graders, bulldozers, cranes, drill rigs, excavators, concrete-batching equipment, pumping equipment, concrete trucks, flat bed trucks, dump trucks, and rail-mounted equipment. While the final construction approach, including methods, staging, and sequencing coordination, will be determined in detail with the construction contractor, who has yet to be selected, the following describes the likely sequencing of the major construction activities. It should be noted that most of these activities overlap.

- Early work activities would include relocation of some of the private and public underground utilities identified as being in conflict with the track alignment;
- Work on the new bridge structure at Westminster Avenue and for the new Santa Ana River bridge structure would also begin early in the construction period;
- Demolition and clearing of the selected O & M Facility site would begin in the early phase of construction in order to be available for receipt and testing of the vehicles. Construction of the maintenance facility yard would also likely commence at this time;
- Prior to initiating work on the ballast track, overhead contact wire pole foundations and station foundations would be constructed to grade level. In addition, structure approach slabs, underground utilities, or subsurface structures would be constructed prior to the laying of the ballasted sections;
- Track construction would begin next for the in-street and the non-structure ballasted sections of the streetcar trackway. The steps would involve setting up the reinforcement for the concrete slab, placing the rail, boots, and ties and finally pouring track slab concrete. The following construction activities would also occur during the same 24-month timeframe as track construction:
 - Preparation for substation sites and installation of conduits, grounding mats, and substation foundations.
 - Track construction activity, including installation of special trackwork, field welds, installation of insulated joints and other special trackwork material.
 - Sidewalk improvements, platforms, pavement grading and resurfacing to the limits of the project between Raitt Street and SARTC.
 - Foundation work for new traffic signal, lighting, and overhead contact wire poles.
 - Roadway grinding and overlay operations beginning at Raitt Street and advancing eastward along the alignment; and
- The final steps of the construction work would include pavement striping, reestablishing ROW temporarily impacted by construction, landscaping, system testing, lining and surfacing of the ballasted track, and other miscellaneous finishing.

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Appendix B:
Drainage Technical Report

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DRAINAGE TECHNICAL REPORT

in support of the
**SANTA ANA AND GARDEN GROVE
FIXED GUIDEWAY CORRIDOR STUDY**
Santa Ana Regional Transportation Center (SARTC) to Harbor Boulevard

Prepared for
City of Santa Ana
in cooperation with
City of Garden Grove
Orange County Transportation Authority



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EXECUTIVE SUMMARY

The cities of Santa Ana and Garden Grove are considering a fixed guideway project to provide high frequency transit service between the Santa Ana Regional Transportation Center (SARTC) and a new multi-modal transportation center in the city of Garden Grove. The system would provide “last mile” transit service for commuters traveling from SARTC to employment and activity centers in the heart of Orange County, California; function as an urban circulator throughout downtown Santa Ana and the Civic Center; and serve schools, businesses, and densely populated neighborhoods throughout the study area. In addition to maximizing the effectiveness of the regional commuter rail network, the Santa Ana-Garden Grove fixed guideway system would reduce automobile trips and related greenhouse gas emissions, promote livability, and support economic development, land use, and community goals.

The Drainage Technical Report provides hydrology and hydraulic calculations for conceptual engineering of the proposed Santa Ana-Garden Grove Fixed Guideway project. The analysis is based on City of Santa Ana as-built plans, City of Santa Ana Drainage Master Plan, and field investigation. The primary objective of the drainage improvements identified as part of the fixed guideway project is to minimize the incidence of storm/drainage water accumulating within the fixed guideway track envelope.

This report identifies potential impacts of the proposed fixed guideway on the existing drainage system and recommends improvements to minimize the incidence of water accumulating within the fixed guideway track envelope. The proposed drainage improvements are within existing City right-of-way.

This report also describes the potential impacts of the proposed fixed guideway on the Santa Ana River. Both Build alternatives cross the Santa Ana River at the PE ROW, requiring replacement of the existing historic Pacific Electric Santa Ana River Bridge. Four design options were identified to provide for the river crossing. Two of the options were eliminated from further consideration because they would impact the existing historic bridge. The remaining two design options have been evaluated to determine potential impact to the hydrology and hydraulics of the Santa Ana River channel. Based on this preliminary evaluation, neither of the alternatives will significantly alter the hydraulics or hydrology of the river channel nor decrease the capacity of the channel to accommodate a 100-year flood event. Further hydraulic modeling will be required during preliminary engineering and final design.

Determination of watershed areas, and estimation of peak flows are based on a conservative approach; further investigation will be required during preliminary engineering and final design. This data combined with other design criteria stated in the report are used for the spacing of inlets and sizing of drainage facilities.

The proposed improvements are sufficient to minimize flooding within the track alignment segment, however, they will not completely eliminate flooding and/or ponding in certain areas without future drainage facility improvements per the City’s Drainage Master Plan. The improvements are not intended to address current capacity deficiencies in the downtown

drainage system that result in flooded conditions during seasonal storms, only to reduce the incidence. During significant storm events, it is anticipated that even with the identified improvements, prior to the City implementing their Drainage Master Plan, flooding within the fixed guideway corridor may require substituting bus service along the corridor until the fixed guideway tracks are no longer impacted. Historically, Santa Ana averages 34 days of measureable precipitation annually, with far fewer producing sufficient rain to cause measurable accumulations along roadways for durations of a few hours.

1.0 INTRODUCTION

The cities of Santa Ana and Garden Grove are considering a fixed guideway project that would provide high frequency transit service between the Santa Ana Regional Transportation Center (SARTC) and a new multi-modal transportation center in the city of Garden Grove. A “fixed guideway” refers to any transit service that uses exclusive or controlled rights-of-way or rails. The proposed project alignments travel along a major east-west corridor through central Orange County, providing access to Santa Ana’s downtown area and the Santa Ana Civic Center where city, county, state and federal government offices and courthouses are located. It will connect the historic and densely populated neighborhoods east and west of the Downtown and Civic Center with employment and educational opportunities, goods and services, and will also provide access to several redeveloping, transit-oriented areas within both cities.

1.1 General

This report describes the potential impacts of the proposed fixed guideway system on the storm drain systems within the study area, and documents the recommended improvements to the storm drain systems developed as part of conceptual design for the Project. Appendix A shows the alignment alternatives under consideration for the Santa Ana-Garden Grove Fixed Guideway Corridor.

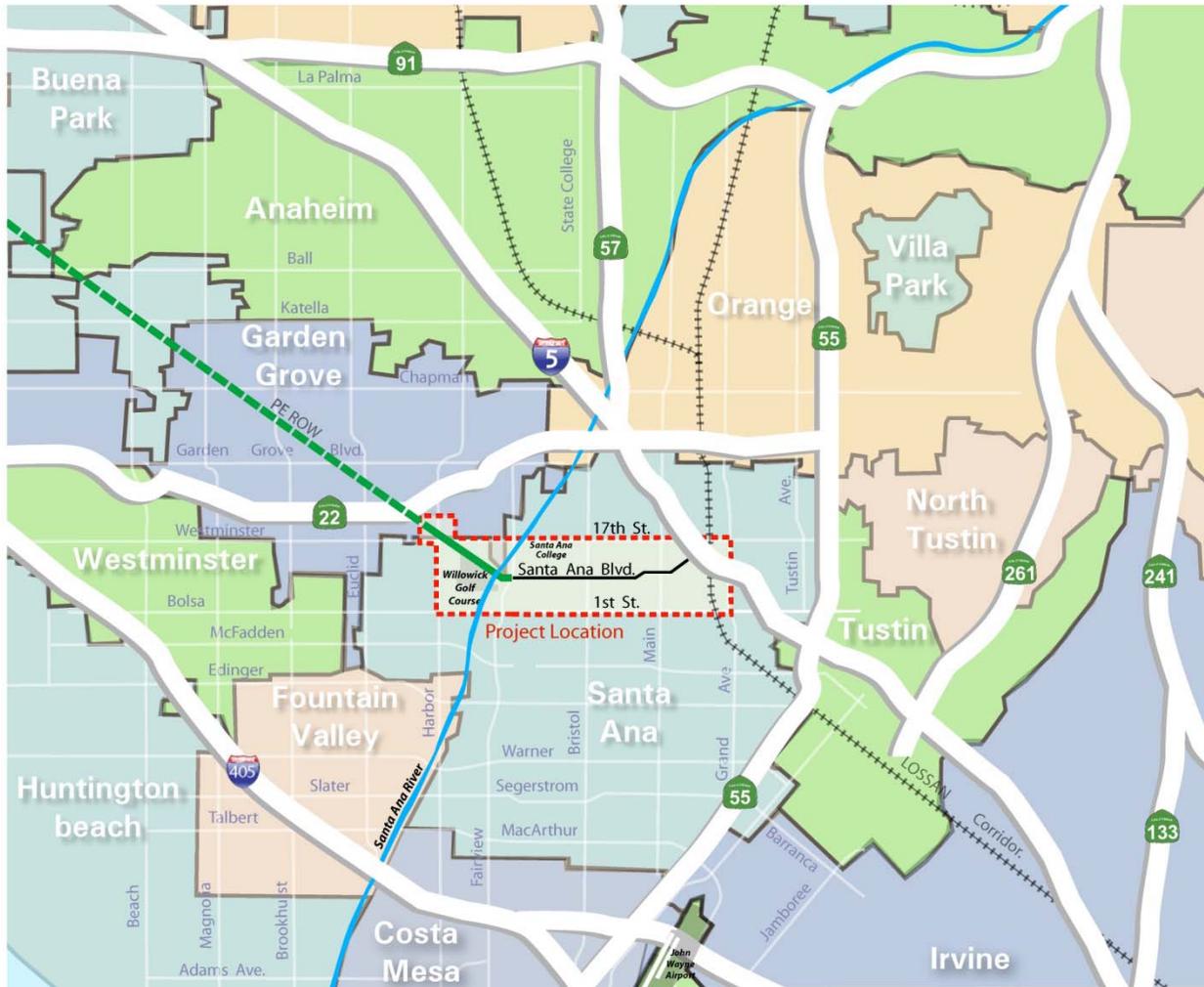
1.2 Objective

The purpose of this technical report is to document drainage system improvements proposed as part of the fixed guideway corridor project. A drainage analysis was conducted for Streetcar Alternatives 1 and 2. The City’s existing drainage systems and the drainage facilities included in the City of Santa Ana Drainage Master Plan (dated May 1994) were considered in the analysis. The drainage systems along each corridor alignment alternative were researched and documented on drainage plans. Drainage maps, analysis, and estimated quantities are presented in the appendices to this report. The objective of the drainage systems design concept for the fixed guideway corridor is to minimize the width of flooded area within the fixed guideway corridor alignment. Modifications to existing drainage systems and new drainage systems have been recommended to meet this objective. It is not anticipated that these improvements will resolve overall deficiencies in the existing drainage systems, which are to be addressed by the City through implementation of the Drainage Master Plan.

1.3 Project Study Area and Build Alternatives

The study area was defined to support the development and evaluation of a broad range of modal alternatives. It encompasses SARTC, existing and planned development surrounding the rail station; employment, government, commercial and cultural activity centers in the Civic Center and downtown Santa Ana; and, existing neighborhoods, businesses, and activity centers in central Santa Ana and east Garden Grove (see Figure 1). Planned development and areas that offer future development and redevelopment opportunities were also considered, as were planned regional transportation system improvements such as OCTA’s Bus Rapid Transit (BRT) program, and Metrolink service expansions. The proposed corridor study area (see Figure 2)

Figure 1: Location Map

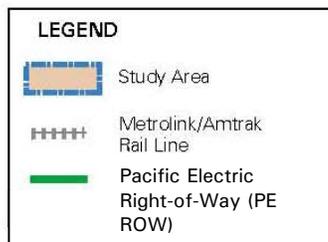
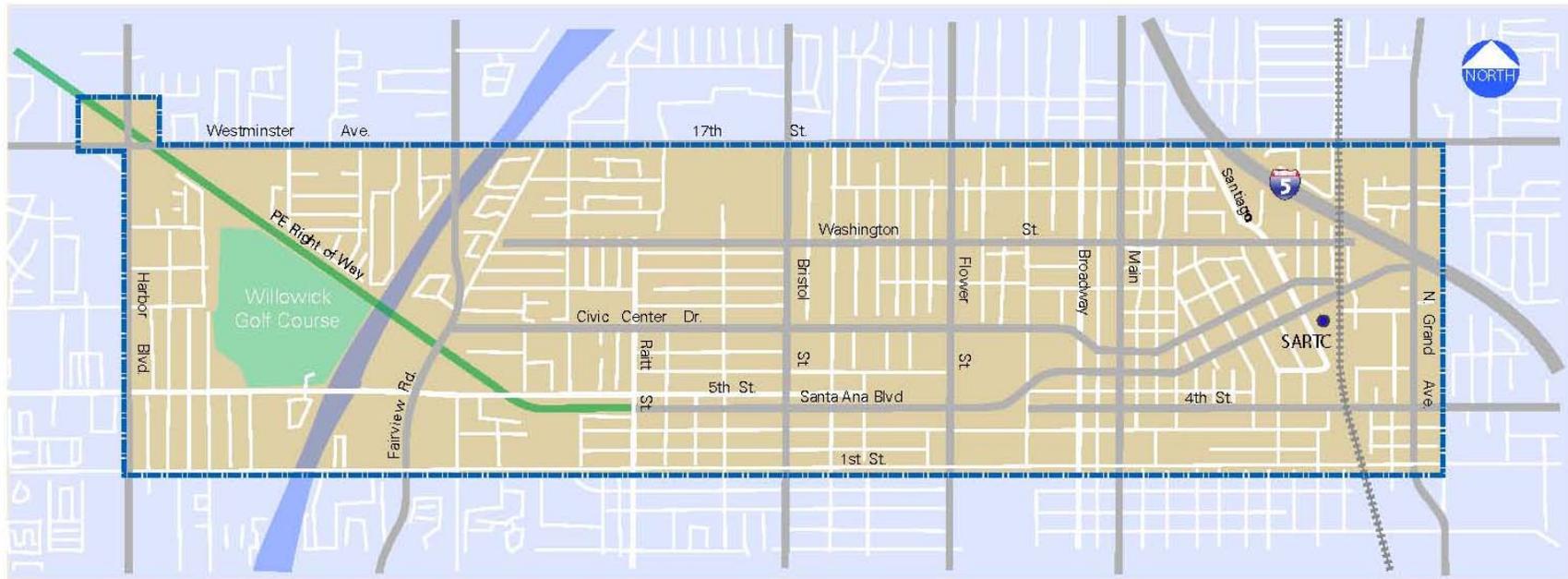


LEGEND

-  Study Area
-  Metrolink/Amtrak Rail Line
-  Pacific Electric Right-of-Way (PE ROW)



Figure 2: Project Study Area



is generally bounded by Harbor Boulevard to the west, 17th Street to the north, Grand Avenue to the east, and First Street to the south.

The Transportation System Management (TSM) Alternative provides for enhanced bus service within the study area, including a new route between SARTC and Harbor Boulevard at Westminster Avenue. Like the proposed Streetcar Alternatives, the new route is intended to serve the need to transportation identified in the Purpose and Need Statement for the project. The TSM Alternative bus element alignments are shown in Appendix A.

Two (2) “build” alternatives for the Santa Ana-Garden Grove Fixed Guideway were analyzed: Streetcar 1 and Streetcar 2. Appendix A shows the alignments of these fixed guideway alternatives. In both alternatives, modern streetcars would operate in mixed flow traffic on tracks embedded within existing city streets, except along the Pacific Electric Right-of-Way (PE ROW) segment where streetcars would operate on tracks dedicated exclusively for streetcar use.

From the western terminus at Harbor Boulevard and Westminster Avenue in the City of Garden Grove, to Flower Street, the alternatives are identical. The fixed guideway alignment runs east/west along the PE ROW across the Santa Ana River to Raitt Street and then continues on Santa Ana Boulevard to Flower Street. East of Flower Street, the alternative alignments vary through the Civic Center and downtown area.

In Streetcar 1, streetcars would travel eastbound on Santa Ana Boulevard, transitioning onto 4th Street in the vicinity of Ross Street; the streetcars would continue eastbound on 4th Street and turn north on Mortimer Avenue to Santa Ana Boulevard to Santiago Street, terminating near the Santa Ana Metrolink station (SARTC). In the westbound direction, the streetcars would travel on Santa Ana Boulevard from Santiago Street to Raitt Street, entering the PE ROW west of Raitt Street and continuing to the western terminus station near Harbor Boulevard at Westminster Avenue.

In Streetcar 2, the streetcars would travel eastbound along the PE ROW to Santa Ana Boulevard, transitioning onto Fifth Street in Downtown Santa Ana; the streetcars would turn north on Minter Street then east on Sixth Street/Brown Street to Poinsettia Street then looping to Santa Ana Boulevard and Santiago Street to access SARTC. In the westbound direction, the streetcars loop clockwise around Santiago Boulevard and Poinsettia Street to travel west along Brown Street/Sixth Street/Santa Ana Boulevard to Spurgeon Street; the streetcars turn north onto Bush Street then west onto Civic Center Drive then south onto Flower Street, returning to Santa Ana Boulevard westbound; they would enter the PE ROW west of Raitt Street and continue to Harbor Boulevard.

2.0 EXISTING DRAINAGE CONDITIONS AND FACILITIES

An inventory of the existing drainage systems within the fixed guideway corridor study area was conducted, by segment, for each of the proposed alignment alternatives. Existing drainage facilities were identified using as-built plans from the City dating back to 1950. In addition, extensive field investigations verified curb inlet openings, parkway culverts, catch basins, cross gutters, flow lines, and drainage area limits.

The City maintains approximately 1,600 storm drain inlets and 34,000 linear feet of open channels that transport urban runoff and discharge to the Lower Santa Ana River, Newport Bay, Bolsa Chica water bodies. Appendix B shows existing drainage flow patterns and facilities within the study area limits.

Santa Ana is a mature city. Based on its adopted General Plan, it is substantially urbanized. There are areas of the City in which historic development constrains opportunities to modify and improve supporting infrastructure, including the drainage systems. Past efforts to improve drainage in these areas have focused on minimizing recurring flooding and ponding without addressing the overall need for expanded system capacity. As a result, flooding occurs in certain areas during significant storm events; flooding will continue to occur in these areas until all of the improvements identified in the City of Santa Ana Drainage Master Plan have been implemented.

For the purpose of this drainage analysis, the fixed guideway corridor was divided into several segments based on existing conditions, and existing or proposed storm drain facilities identified in the City's Drainage Master Plan. The segments were defined as follows:

Downtown Segment

1. Santiago Street to French Street
2. French Street to Ross Street
3. Ross Street to Flower Street

Raitt to Flower Segment

1. Flower Street to Shelton Avenue
2. Shelton Avenue to Bristol Avenue
3. Bristol Street to Raitt Avenue

Pacific Electric ROW (PE ROW) Segment

1. Raitt Avenue to Santa Ana River
2. Santa Ana River to Harbor Blvd/Westminster Avenue

2.1 Downtown Segment

The downtown segment of the study area consists of various land uses including institutional, industrial, commercial, and residential. The area near the SARTC is considered an industrial zone. The area between SARTC and downtown Santa Ana is primarily residential with small industrial areas. Downtown Santa Ana is characterized by multi-story commercial (including

office and retail uses) buildings and residential. The Civic Center area has institutional land uses including federal, state, city, and county government offices. The topography within this segment is flat and grades towards the west and south.

2.1.1 Streetcar 1

Santa Ana Boulevard: The existing roadway conditions along Santa Ana Boulevard from Santiago Street to French Street consists of one or two travel lanes in each direction separated by a striped median; just east of French Street (at Mortimer Street, Santa Ana Boulevard converts to one-way traffic in the westbound direction. An existing 27-inch reinforced concrete pipe (RCP) runs westerly along Santa Ana Boulevard to French Street, where it turns south into a 39-inch RCP. The storm water runoff north of Santa Ana Boulevard from Washington Avenue runs southwest along the gutter and cross gutters. Existing catch basins on the northeast corners of the perpendicular streets intercept water flowing south towards Santa Ana Boulevard which tie into the existing 27-inch RCP. At the northeast corner of the French Street/Santa Ana Boulevard intersection, shallow parkway culverts (1-ft to 5-ft wide) convey water from French Street to a low point on Santa Ana Boulevard.

From French Street to Ross Street, Santa Ana Boulevard has three lanes in the westbound (one-way) direction. The roadway profile varies due to cross gutters carrying flow along the perpendicular streets from north to south especially between French Street and Broadway. Along this segment, no major existing drainage facilities exist except for a 33-inch RCP which flows south on Spurgeon Street and then turns east on Santa Ana Boulevard to tie into the junction chamber at the intersection of French Street and Santa Ana Boulevard. Parkway culverts are located at Spurgeon Street and Broadway intersecting with Santa Ana Boulevard. On Ross Street, several laterals are located between Civic Center Drive and Santa Ana Boulevard. A total of 5 catch basins are within this area. In addition, an existing 24-inch RCP crosses Santa Ana Boulevard and heads south to an existing 33-inch RCP at the intersection of 3rd Street.

Between Ross Street and Flower Street, water is conveyed along the curb and gutter with existing catch basins at the northeast corner collecting the storm runoff. Flower Street has an existing 33-inch RCP crossing Santa Ana Boulevard which runs south towards Pine Street and then turns westerly on Pine Street towards Shelton Avenue.

4th Street: Along 4th Street, the roadway profile varies especially at the intersections where cross gutters convey the runoff from north to south. Cross gutters are located on the east side of each intersection. From Ross Street to Mortimer Street, concrete V-gutters exist on both sides of the street adjacent to the parking. The runoff flows westerly and south along these existing V-gutters and cross gutters.

2.1.2 Streetcar 2

Brown and 6th Street: The runoff is conveyed along curb and gutter, and cross gutters as it flows westerly along Brown Street/6th Street, then south along Minter Street. The existing roadway conditions along Brown Street/6th Street from Poinsettia Street to French Street consist

of one lane in each direction carrying two-way traffic. At the intersection of French and 6th Street, an existing 27-inch RCP from Santa Ana Boulevard and an existing 33-inch RCP from Spurgeon Street connect to a 39-inch RCP which runs south on French Street.

Civic Center Drive: Civic Center Drive is a major east-west arterial consisting of three lanes in each direction west of Main Street. The existing drainage areas impacting Civic Center Drive along the proposed alignment extend north to Washington Avenue. The storm water runoff is collected along the existing concrete curb and gutters, and cross gutters, and then runs along the north side of Civic Center Drive. Various existing catch basins on Civic Center Drive convey the storm water runoff to existing storm drain systems. The following is a summary of existing drainage facilities:

- 24-inch RCP runs west from Broadway to Ross Street, then turns south along Ross Street
- 18-inch RCP from Main Street to Spurgeon Street
- Three (3) existing catch basins near intersection at Main Street and at Bush Street
- 21-inch RCP north-south direction on Broadway ties into 24-inch RCP on Civic Center Drive
- 18-inch RCP lateral for catch basin connects at Broadway/Civic Center Drive intersection

Flower Street: Flower Street is a major north-south arterial consisting of three lanes in each direction between Civic Center Drive and Santa Ana Boulevard. The pavement along Flower Street is concrete. Flower Street conveys the majority of storm water runoff from as far north as 17th Street. The existing parcels and streets bounded by Ross Street on the east, Flower Street on the West, 17th Street on the north, and Civic Center Drive on the south have minimal drainage facilities to convey or collect the runoff. Runoff flows westerly towards Flower Street and then south towards the intersection of Flower/Civic Center Drive. At the intersection, storm water runoff is collected by existing catch basins which connect to an existing 33-inch RCP running south along Flower Street to Pine Street. Flower Street also has existing catch basins on the west side of the street at its intersections with 6th Street and with Santa Ana Boulevard.

2.2 Raitt to Flower Segment

The Raitt to Flower Segment of the study area is a land use mixture of commercial, schools, and residential. The topography within this segment is a flat grade towards the west and south. The street segment slope varies from a 0.5% to 2.0% grade. The drainage areas for this segment are bounded by 5th Street on the north and Santa Ana Boulevard on the south. Storm water runoff from existing streets and parcel areas north of 5th Street are conveyed in existing drainage systems not impacted by the fixed guideway alignments. The eastbound side of the fixed guideway alignment has only on-site street flow, and no off-site drainage.

Along Santa Ana Boulevard between Flower Street and Shelton Avenue, storm water runoff is conveyed along concrete curb and gutter and then intercepted in a catch basin at the northeast corner of the Shelton Avenue and Santa Ana Boulevard intersection. The lateral connects to an existing north-south 27-inch drainage system. Between Shelton Avenue and Bristol Street,

storm water runoff is conveyed along concrete curb and gutter and then intercepted with parkway culverts at the intersection of Bristol Street and Santa Ana Boulevard. The runoff continues southerly along Bristol Street.

From Bristol Street to Raitt Street, Santa Ana Boulevard consists of one lane in each direction with street parking on each side. The existing streets and curbs, gutters and sidewalks are in poor condition with various cracking. The storm water runoff is conveyed along the curb and gutter with cross gutters at the intersection of perpendicular streets. The runoff flows westerly to Raitt Street and then turns southerly through existing parkway culverts.

2.3 PE ROW Segment

The PE ROW segment is an existing 100-foot ROW corridor with minimal land use. The corridor extends from Raitt Street in Santa Ana to the vicinity of the I-710 in Los Angeles County. Within Orange County, it is substantially owned by the Orange County Transportation Authority. In some areas along the PE ROW, OCTA has allowed conditional interim use of the ROW; otherwise, within the study area, the corridor is vacant. The segment is divided by the Santa Ana River. Between Raitt Street and Fairview Street, some existing tenants, mainly industrial, conditionally occupy portions of the PE ROW. The segment west of the Santa Ana River is vacant and composed of dirt and gravel. Minimal as-built plans were available within this segment. The assumption is storm water runoff flows to both sides of the right-of-way and is conveyed through natural ditches.

The historic Pacific Electric (PE) Santa Ana River Bridge is approximately centered within the PE ROW alignment, crossing the Santa Ana River. The historic bridge is inadequate to accommodate the proposed fixed guideway due to its age, size (it was constructed as a single-track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements.

The bridge is a Pegram Truss, built in 1907 as part of the Pacific Electric Railway route that operated between Long Beach and Santa Ana until 1950, when service was discontinued. In the early 1970's, when the PE ROW was acquired by OCTA and the tracks were removed, the bridge was fenced at each end to prevent access. The bridge has therefore been out of operations and unmaintained since 1950. Previous studies including the SR-22/West Orange County Connection FEIR/FEIS have identified the PE Santa Ana River Bridge as eligible for inclusion in the National Register of Historic Places (NRHP).

As-built plans for the Santa Ana River Bridge were unavailable. The bridge is a two-span approximately 302 feet long. The longest span is 147 feet long. The bridge foundation consists of a single pier in the Santa Ana River channel that is approximately 9 feet wide by 27 feet long. A second pier on the west embankment supports the west end of the bridge and timber supports have been used to extend the bridge from the end of the truss structure to connect at-grade with the PE ROW.

As part of the alternatives analysis, design options have been defined and evaluated to address the fixed guideway crossing of the Santa Ana River while minimizing impacts to the historic bridge.

3.0 PROPOSED DRAINAGE SYSTEMS

The City of Santa Ana Drainage Master Plan was used, as a guideline for proposing new drainage systems along the fixed guideway alignment alternatives. The City of Santa Ana's design manual and standard plans were integrated into the analysis to address the City's requirements. In addition, the proposed drainage systems comply with the requirements provided in Chapter 4.6 of the City of Santa Ana Transit Zoning Code EIR. In general, if any portion of an existing, or future storm drain system is being impacted by the fixed guideway alignment improvements, then the storm drain system was included as part of this analysis. Appendix D includes all proposed storm drain systems and facilities for each of the two fixed guideway build alternatives. Proposed storm drain systems along the fixed guideway alignments convey the runoff from the proposed and existing catch basins. Proposed catch basin location and size was determined based on minimizing the flooded width along the curbside in order to not impede into the fixed guideway track envelope.

3.1 Design Basis

Pertinent design criteria are summarized below:

- RCP will be used for all storm drain pipelines
- 18-inch RCP is the minimum pipe diameter proposed
- Rational Method per Orange County Flood Control District was adhered to
- A 10-year storm event for collectors was assumed
- A 25-year storm event for any sump (low point) condition
- Catch basins will be located so as to eliminate whenever possible open concrete cross gutters and parkway culverts
- Catch basins will be spaced to minimize flooded width within the street
- Acceptable clearances from utilities and fixed guideway track envelope will be maintained

3.2 Methodology and Assumptions

The drainage design approach was to provide the required drainage facilities to maintain existing street drainage, drain the track area, and minimize flooded width within the fixed guideway corridor alignments. The minimum open travel lane requirement is 12-feet for a 10-year storm event per City's standard. However, if the track alignment is running curbside within a 12-foot lane, then the flooded width was based on a 2-foot clearance from the track envelope.

The design utilizes as much of the existing drainage system as possible in order to minimize impacts to City streets and overall cost to the project. The preliminary design assumes upgrade of any segment of existing drainage systems where it crosses the fixed guideway alignment corridor, as well as, replacement of catch basins, if needed, based on hydrology calculations. The design is based on the City of Santa Ana Drainage Master Plan which was prepared for a 10-year storm frequency. Appendices E and F present the hydrologic and hydraulic analyses. New east-west drainage systems connect to major north-south drainage systems currently existing or proposed as part of the City's Drainage Master Plan. The major north-south

drainage systems impacted by the project are to be upgraded per the City's Master Plan, extending south, at a minimum, to 1st Street and connecting to an existing drainage facility. New drainage systems will be designed to maintain existing flow patterns. Drainage areas are based on existing street conditions since street widening is not required to accommodate the fixed guideway improvements.

3.3 Hydrologic Analysis

The methodology of hydrology calculations used in the analysis is the Rational Method based on guidelines and procedures outlined in the Orange County Hydrology Manual. Proposed catch basins are designed along the fixed guideway alignment to capture the flow of water over the pavement in order to provide safe passage of vehicles, maintain streetcar operation, prevent inconvenience or hazards to pedestrians, and hydroplaning. The allowable flooded width is based on the City's storm design frequency criteria. For 10-year storm event, the criterion is to maintain at least one travelled lane open (12 foot minimum if not determined). The size and location of the proposed catch basins are based on the spread criteria and will intercept a minimum of 10-year storm frequency. However, catch basins located at low points within the intersection (sump condition) are designed for a 25-year storm event.

The Orange County Hydrology Manual Hydrologic Soil Group Map (Appendix E) was used to obtain the hydrologic soil types for the drainage study area. The project site consisted of Soil Group B which has moderate runoff potential. The hydrologic soil B is described in the manual as follows:

- **Soil Group B:** Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderate deep to deep. Moderately well to well drained sandy-loam soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

The storm runoff discharge was calculated by the Rational Method equation. The equation is expressed as:

$$Q = CIA$$

Where:

- Q = Discharge in cubic feet per second (cfs)
- C = Developed runoff coefficient (dimensionless)
- I = Average rainfall intensity in inches per hour (in/hr)
- A = Drainage area (acres)

According with the Orange County Hydrology Manual, the rational method is used for drainage areas smaller than 1 square mile. The rational method peak flow rates were used to evaluate the proposed drainages facilities. For this drainage study, a 0.90 runoff coefficient, which is conservative in establishing peak flows, was used for all areas.

Design Approach: Utilizing the existing topography survey, proposed track alignments, and the City of Santa Ana's Drainage Master Plan, the following design elements were determined for the proposed drainage facilities:

- Drainage areas (Appendix C)
- Total peak flow to the catch basins/drainage inlets (discharge)
- Intercepted/Bypass Flow
- Depth of flow
- Flooded Width (spread)

The maximum runoff normally occurs when the runoff generated from the whole area contributes to the concentrated point. The rainfall intensities were calculated using the 10-year and 25-year "Mean Precipitation Intensities", Figure B-3 of the Orange County Hydrology Manual.

3.4 Hydraulic Analysis

Drainage design is intended to facilitate removal of storm water runoff from the roadway. The design of the drainage system will reduce the likelihood that water flows or backs up into the roadway causing flooding and hazardous conditions for drivers. Without implementing the complete Drainage Master Plan, or significantly increasing overall drainage system capacity, the drainage design is intended to minimize the water surface depth below top of curb on selected roadways and takes into consideration the maximum allowable flooded width within the roadways. The storm water runoff is conveyed within proposed curb and gutter along the street. The water surface spread is controlled by adding catch basins as necessary.

The hydraulic analyses and calculations were performed using StormCAD V. 5.6 by Bentley. The software uses the methodology of Hydraulic Engineering Circular No. 22 (HEC-22) to model, analyze, and design highway and urban drainage facilities. Refer to Appendix F for the hydrologic calculations of proposed mainline drainage systems.

Proposed drainage systems consist of reinforced concrete pipes. Each of the drainage facility reaches meet the minimum size criteria and were analyzed to determine drainage capacity and design flow rate. The drainage systems were designed with the following minimum slopes and sizes:

1. Laterals - 18" RCP / 1.0 %
2. Main Collectors - 24" / 0.5%
3. Gutters - 0.3%

Design Approach: The design approach follows the guidelines of the Orange County Hydrology Manual. In addition, the City of Santa Ana's Drainage Master Plan was used to determine ultimate drainage facilities, alignments and anticipated flow rates within the Project study area limits. The proposed drainage facilities are consistent with the City's Master Plan study dated May, 1994. For this study, lateral drainage systems were not designed, only

mainline drainage systems were analyzed. However, the drainage laterals will be analyzed during the preliminary design phase in order to establish impacts to underground utilities.

3.5 Impacts on Existing Drainage Systems

The construction of at-grade track for the fixed guideway alternatives will impact several drainage systems. The following summarizes the impacts which may be mitigated:

- Replacement of parkway culverts with proposed catch basins
- Elimination of cross gutters with proposed catch basins
- Replacement of undersized facilities
- Relocation of pipes and catch basins
- Concrete encasement of pipes if necessary
- Connection of new systems to existing ones
- Upgrade of existing drainage systems per City of Santa Ana Drainage Master Plan

3.6 Proposed Drainage Systems

The proposed drainage systems are based on the City's Drainage Master Plan and consistent with the City's future improvements. In general, new drainage systems along the fixed guideway alignments will convey runoff from proposed and existing catch basin laterals. The catch basins are proposed and spaced to minimize the flooded width in order to not impact the fixed guideway track envelope. The new drainage systems will connect to upsized north-south drainage systems along the streets perpendicular to the fixed guideway corridors. The north-south facility improvements will extend to 1st Street in order to mitigate potential flooding in the downtown area due to existing downstream facilities not being upsized with this Project. The proposed drainage systems improvements focus on minimizing flooding within the fixed guideway alignments and, specifically within the track envelope. They do not increase overall system capacity and so to the extent that flooding currently occurs within the downtown area, it will likely continue to occur (although to a lesser degree along the fixed guideway alignments). Further flooding analysis will be required during the next phase of the Project to indicate the extent of flooding and impacts to the downstream facilities due to the upgraded upstream drainage facilities. Appendix D shows the proposed drainage systems for the fixed guideway alternatives.

In addition, catch basins are proposed at street intersections to eliminate cross gutters and/or parkway culverts over the fixed guideway tracks. The proposed improvements specified are sufficient to minimize flooding within the track alignment segment. However, the drainage systems will not be able to completely eliminate flooding and/or ponding in certain areas without future drainage facility improvements per the City's Drainage Master Plan. Table 1 provides a list of intersections which will require reconstruction to eliminate cross gutters to provide for a smoother fixed guideway profile.

Table 1: List of Intersections Requiring Reconstruction to Eliminate Cross Gutters

STREET CROSSING	ALIGNMENT			
	Santa Ana Boulevard	4th Street	5th Street	6th Street/ Brown Street
Minter Street				X
Garfield Street				X
Poinsettia Street				X
French Street	X		X	
Bush Street	X	X	X	
Main Street	X	X	X	
Sycamore Street	X	X	X	
Spurgeon Street		X		
Mortimer Street		X	X	
Broadway	X	X	X	
Bristol Street	X			
Raitt Street	X			
TOTAL	7	6	6	3

Appendix G shows typical intersection reconstruction detail with limits of work.

3.6.1 Drainage System Improvements in Streetcar 1 – Downtown Segment: Within this segment, the improvements consist of a proposed 60-inch RCP along Santa Ana Boulevard from Santiago Street to French Street. This system replaces the existing 27-inch RCP. Along French Street, the existing north-south 33-inch will be replaced with an 84-inch RCP to 3rd Street and connect to existing 39-inch at 3rd Street. Additional improvements consist of 36-inch RCP along Santa Ana Boulevard from Spurgeon Street to Broadway, then south along Broadway to 3rd Street; a 54-inch RCP along Ross Street from Santa Ana Boulevard to 3rd Street with a 36-inch RCP between Ross Street and Broadway.

Along 4th Street, the existing concrete V-gutters will be reconstructed with a ribbon gutter with slotted drain, as shown on the details in Appendix G. Due to the close proximity of the track alignment within this corridor segment, the slotted drain is proposed to rapidly convey storm water runoff in an underground system and minimize impacts to the track due to flooding.

3.6.2 Drainage System Improvements in Streetcar 2 – Downtown Segment: Within this segment, the improvements consist of a new storm drain along the eastbound alignment from Ross Street to Santiago Street. The system flows downstream beginning with a 24-inch at Santiago Street, a 33-inch along Minter, and then a 36-inch along 5th Street. The storm drain system connects to a proposed 54-inch north-south system along Ross Street which replaces the existing 24-inch RCP.

Along Civic Center Drive, a 24-inch storm drain is proposed from Main Street to Spurgeon Street which connects to an existing 33-inch drainage system. Also, a 42-inch drainage system is proposed from approximately Van Hess Street to Flower Street which connects to proposed 42-inch system that replaces the existing 24-inch storm drain along Flower Street.

3.6.3 Drainage System Improvements in Streetcar 1 and 2 – Raitt to Flower Segment: Within this segment, the lateral improvements from the proposed catch basins are conveyed within the following proposed storm drain systems:

- 24-inch RCP from approximately Olive Street to Shelton Street which connects to existing 30-inch RCP along Shelton Street
- 24-inch RCP from approximately Baker Street to Bristol Street which connects to future City improved north-south drainage system along Bristol Street.
- 36-inch RCP from Pacific Avenue to Raitt Street which connects to future City improved north-south drainage system along Raitt Street.

3.6.4 Drainage System Improvements in Streetcar 1 and 2 – PE ROW: Due to minimal drainage as-built information within the PE ROW, the assumption for this segment is drainage improvements will be required to facilitate the streetcar tracks only. The drainage system along the PE ROW will convey the runoff and exit towards the Santa Ana River. Appropriate best management practices will be determined at the preliminary and final design stages. Any future arterial or improvements, other than fixed guideway, will take into account drainage for those improvements.

3.7 Fixed Guideway Track Drainage

Track drainage includes both drainage of water from top surface of the track and the subsurface support system. The objective is avoiding accumulation of standing water or trapped water pockets along the tracks. The storm water runoff within the track envelope will be contained and collected with track drains installed at low points and in areas required to drain water from the track envelope so as not to affect the fixed guideway operation. Track drain inlets will be of sufficient size to allow water to enter without ponding. Track drains will be installed to minimize the amount of water that may enter the sub-grade of the fixed guideway envelope. Water from the surface drains will be conveyed underground to the nearest storm drain facility.

3.8 Santa Ana River Bridge

As described previously, the existing historic Santa Ana River Bridge is inadequate to accommodate the proposed fixed guideway due to its age, size (it was constructed as a single-

track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements.

Four design options were identified to address the fixed guideway river crossing and the historic Pacific Electric Santa Ana River Bridge:

1. Replace the historic bridge with a new bridge that includes decorative treatment to resemble the historic bridge: In Option 1, the historic PE Santa Ana River Bridge would be demolished. A new bridge would be constructed in its place. The new bridge would accommodate double tracks and would include a decorative treatment to resemble the original historic bridge. A concept drawing of Option 1 is included in Appendix A.
2. Leave the historic bridge in place and construct new single-track bridges on each side: In Option 2, the historic PE Santa Ana River Bridge would remain in its current location and condition. New single-track bridges would be constructed immediately north and south of the historic bridge to carry the fixed guideway. Although the historic bridge would remain, the view of the bridge would be obstructed by the new bridges. The concept drawing of Option 2 is included in Appendix A.
3. Relocate and repurpose the historic bridge: In Option 3, the historic PE Santa Ana River Bridge would be detached from its existing foundation and moved approximately 650 feet south of its current location. It would be positioned on a new foundation and piers providing the potential for future repurposing of the bridge for bicyclists and pedestrians. A new double-track bridge would be constructed within the PE ROW to accommodate the fixed guideway. The concept drawing of Option 3 is included in Appendix A.
4. Leave the historic bridge in place and construct a new single-track bridge immediately south: In Option 4, the historic PE Santa Ana River Bridge would remain in its current location and condition. A new single-track bridge would be constructed immediately south of the historic bridge to carry the fixed guideway. Through the use of gates and signaling, the single-track bridge would accommodate bi-directional fixed guideway operations. Although adequate for the proposed fixed guideway project, this will pose some capacity constraints for future expansion of fixed guideway operations. Although the, the view of the historic bridge would be somewhat obstructed by the new bridge when viewed from the south, the view from the north would remain unchanged. The concept drawing of Option 4 is included in Appendix A.

The four design options were evaluated based on five criteria:

1. Feasibility
2. Hydraulic impacts to the Santa Ana River
3. Constructability
4. Compatibility with future plans and improvements
5. Impact to a historical resource.

Based on the results of the evaluation, three design options were eliminated from further consideration. Design Option 1 which would demolish the existing bridge and replace it with a new bridge was eliminated due to its substantial impact to the historic bridge. Option 2 was eliminated because the construction of the two new bridges on each side of the historic bridge would impact the views of the existing bridge. In addition, Option 2 was incompatible with future plans and improvements because it would utilize as much as 63 feet of the 100-foot right-of-way, requiring that considerable additional right-of-way be acquired to accommodate the future multi-modal corridor within the right-of-way. Option 3, which would relocate and repurpose the historic bridge, was eliminated because the relocation of the bridge represented adverse effects to a Section 4(f) impacts because it creates a risk of damage to the historic bridge, and changes the historic setting and the view of the bridge.

Options 4: Leave the historic bridge in place and construct a new single-track bridge immediately south, was identified to be carried forward for further analysis through the environmental review process.

Inadequate information was available to perform hydraulic modeling at this conceptual level of analysis. The potential impacts of Option 4 on the Santa Ana River channel were evaluated based on:

1. The area of the footprint of the piers within the river channel, as a surrogate for the volume of displacement. The larger the footprint of the pier, the greater the potential for displacement and therefore the greater the impact on channel capacity.
2. The width of the pier face. The wider the pier face, the greater the potential impact to river channel hydraulics.

Table 2 shows the dimensions and areas of the piers within the Santa Ana River Channel to support each of the bridges included in the bridge design options.

Table 2: Bridge Options' Pier Dimensions

BRIDGE SCENARIO	PIER DIMENSIONS		
	FACE (feet)	LENGTH (feet)	AREA (square feet)
Existing			
Historic Bridge	9	27	243
Option 4 - Bridge Avoidance B			
Existing bridge	9	27	243
New bridge	4	18*	72

*Includes space between the footing for the existing historical bridge and the immediately proximate new bridge.

Source: Santa Ana-Garden Grove Fixed Guideway Conceptual Design Plans, August 2012.

The area of the center pier of the existing historical bridge is approximately 243 feet with a 9-foot wide pier face. Option 4 leaves the historical bridge in place and adds a second bridge

immediately adjacent and south of the existing bridge. The result is that the area of the footprint for Option 4 is slightly larger (72 square feet larger) than with the existing bridge alone. The will result in a negligible impact to channel capacity. Because the pier face of the new bridge will be approximately 4-feet wide and tucked immediately south behind the existing 9-foot pier face, the impact to channel hydraulics is also projected to be minimal.

Option 4 is not estimated to result in significant impacts to either the 100-year flood capacity of the Santa Ana River channel or its hydraulics. Further hydraulic modeling will be required during preliminary engineering and final design.

4.0 SUMMARY

The improvements recommended in this Drainage Technical Report are all within the City of Santa Ana's right-of-way. The proposed drainage systems are adequate for the fixed guideway improvements only in coordination with the City's future drainage improvements within the Project limits. The improvements are limited to areas crossing the fixed guideway corridors to prevent operations from being disturbed in the future as the City implements the Drainage Master Plan. No offsite mitigation was considered nor was any new drainage areas introduced. However, it is anticipated that the project will slightly improve the current flooding condition in the downtown areas due to the added catch basins and additional storage in the upsized and proposed drainage facility systems. The City will need to continue construction of the Master Plan to improve the overall existing drainage conditions and avoid flooding in the study area. In addition, as the Project moves forward, the drainage system improvements will need to be consistent with the Transit Zoning Code and adhere to regulations such as NPDES, OCDAMP requirements, and City's Local Implementation Plan including mitigation measures specifically MM4.6.2 as stated in Chapter 4.6 of the "City of Santa Ana Transit Zoning Code EIR.

4.1 Quantity Estimate

Quantity take-offs were prepared, based on the improvements identified with each fixed guideway alignment alternative, for use in developing concept-level cost estimates for the project. Total quantities are summarized in Appendix H.

4.2 List of Issues

This study is part of the conceptual design phase for Santa Ana-Garden Grove Fixed Guideway Project, and therefore does not address all design issues or future proposed elements. The following additional analyses are required as the project moves through preliminary and final design:

- Water Quality Management – Runoff Treatment and Best Management Practices
- Survey information of all existing utilities
- Pothole information to accurately locate existing utilities
- Updated City of Santa Ana Drainage Master Plan
- Further hydrologic and hydraulic analyses

5.0 REFERENCES

5.1 Design Manuals

- Orange County Department of Public Works - Hydrology Manual
- City of Santa Ana Drainage Master Plan. (May, 1994)

5.2 Design Software

- Haestad Methods FlowMaster® Hydraulic Analysis
- Bentley StormCad v5.6

4.0 SUMMARY

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- Bentley StormCad v5.6

Appendix A:

Fixed Guideway Alternatives

Alternative A-1: Santa Ana-Garden Grove Fixed Guideway Alternatives

- Transportation Systems management (TSM) Alternative (Bus Elements)
- Streetcar 1 and Streetcar 2

Transportation Systems Management (TSM) Alternative (Bus Elements)



 **LEGEND**

-  TSM 1st Street Alignment (OCTA Route 64)
-  Skip Stop Overlay to/from SARTC
-  TSM Civic Center Alignment
-  TSM Station Link Enhancement (OCTA BRT Route 462)
-  Proposed Stop
-  Study Area

Streetcar 1 - Santa Ana Boulevard/4th Street Couplet



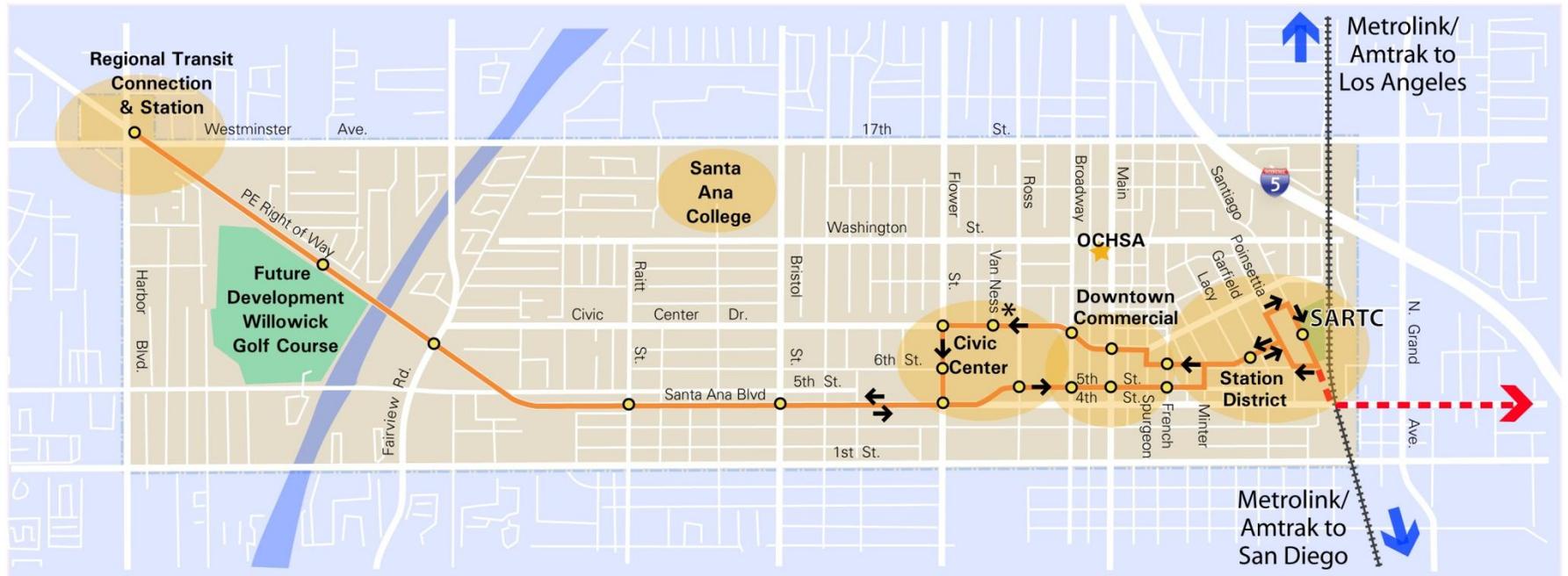
LEGEND

- Streetcar 1
- Proposed Stop
- - - Future Extension to Metro East Mixed-Use Development
- Study Area



Alternative 1 Design Option 1
Sasscer Park mitigation

Streetcar 2 - Santa Ana Boulevard/5th Street & Civic Center Drive Couplet



LEGEND

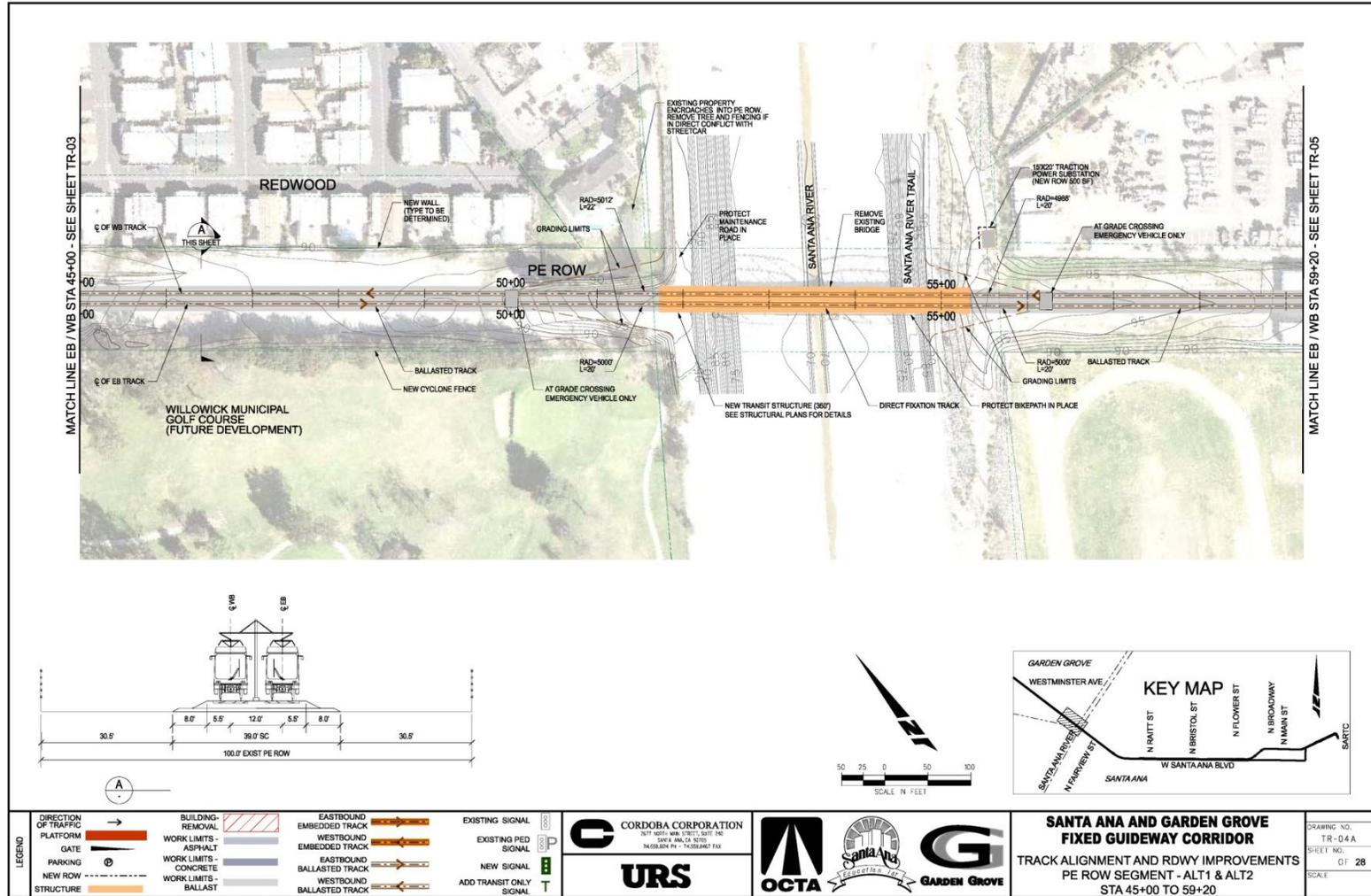
- Streetcar 2
- Proposed Stop
- - - Future Extension to Metro East Mixed-Use Development
- Study Area
- * Civic Center station/stop on Civic Center Drive is located at Van Ness in Design Option 1 and at Ross Street in Design Option 2

Alternative A-2: Historical Santa Ana River Bridge Design Options

- Option 1: Bridge Replacement
- Option 2: Bridge Avoidance A
- Option 3: Bridge Relocation
- Option 4: Bridge Avoidance B

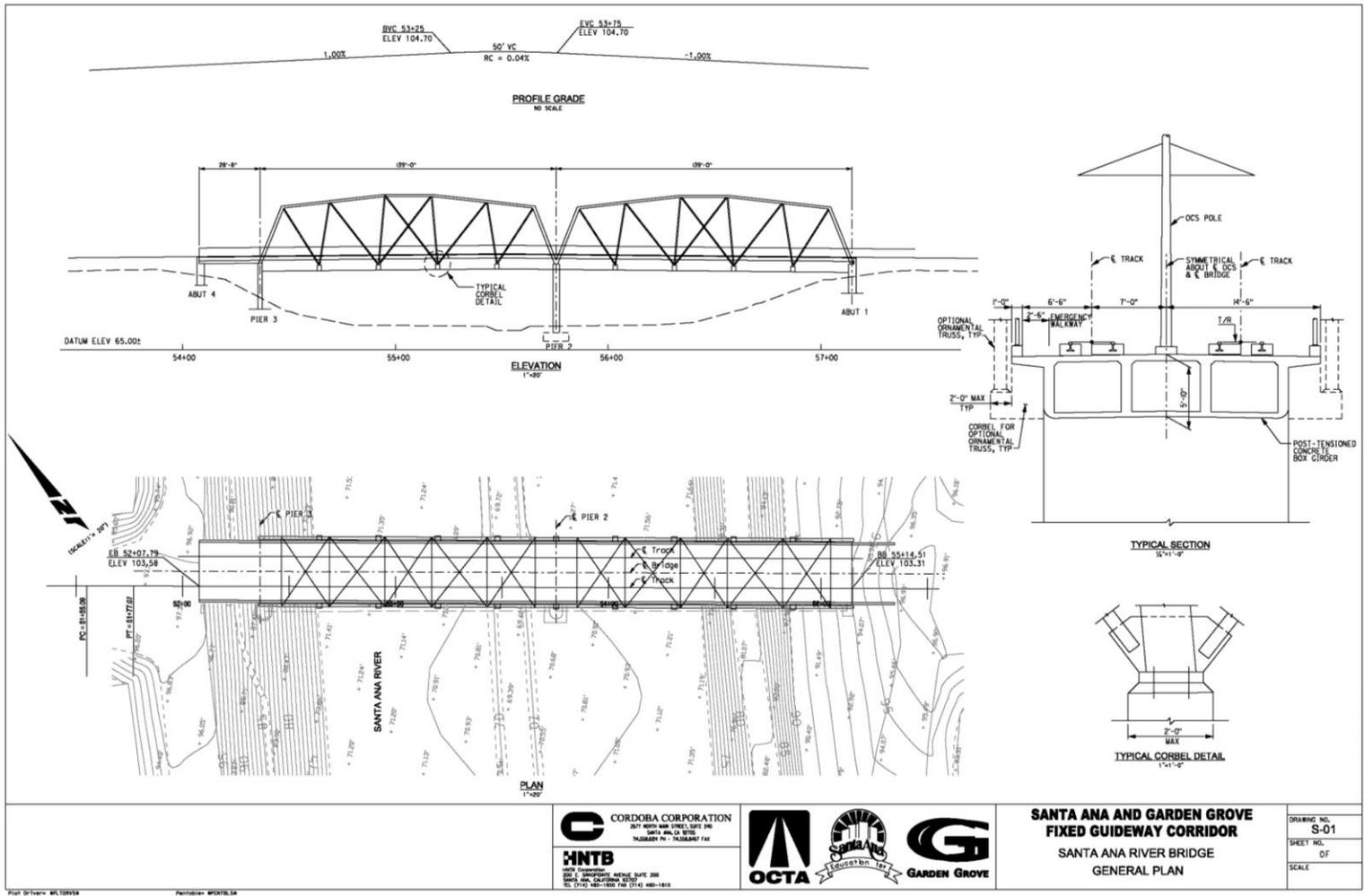
Option 1: Bridge Replacement – Demolish the existing bridge and replace with a new bridge that includes decorative treatment to provide a similar look to the existing bridge

Alignment



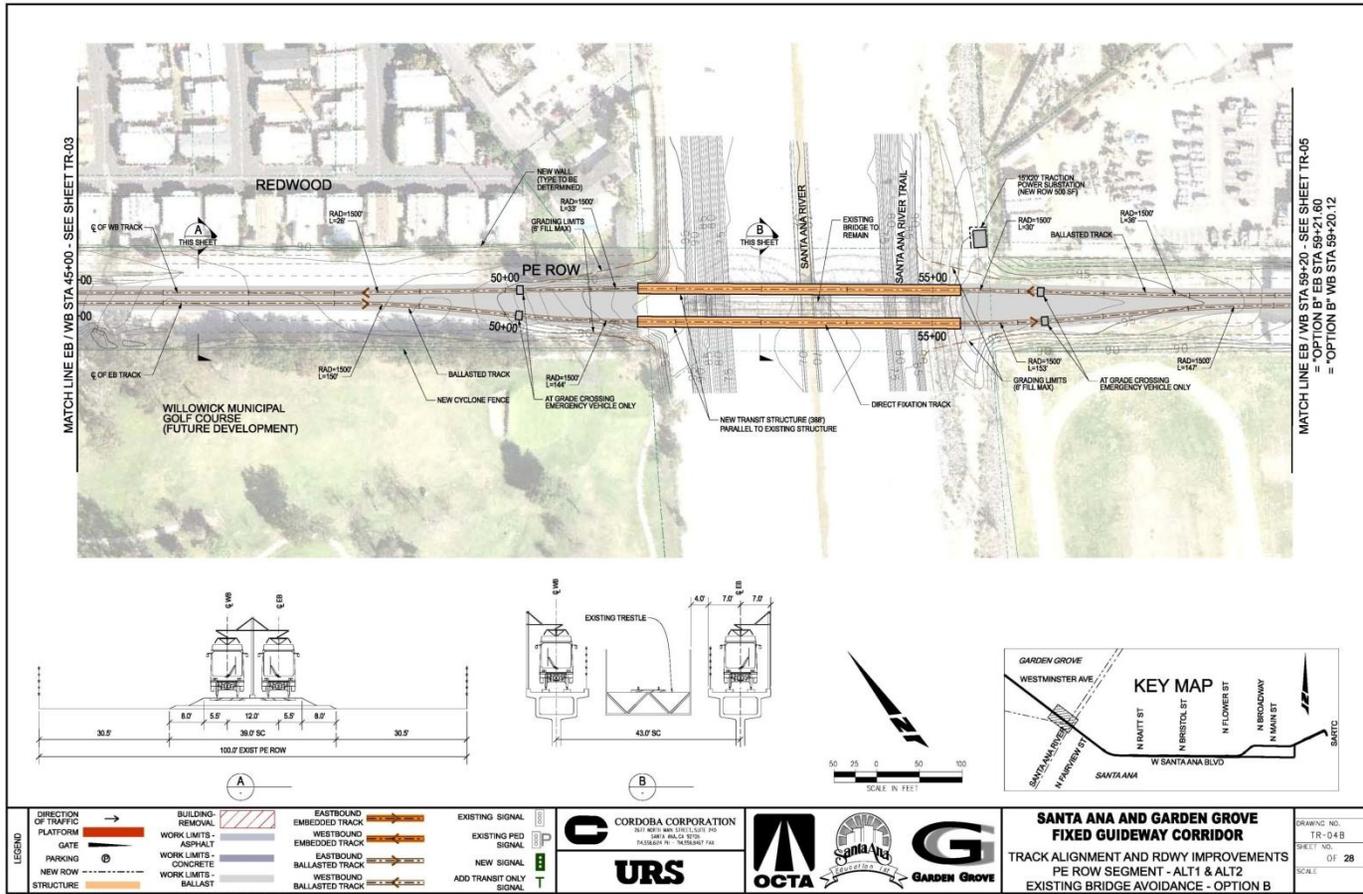
Option 1: Bridge Replacement – Demolish the existing bridge and replace with a new double-track bridge that includes decorative treatment to provide a similar look to the existing bridge

Plan, Profile and Typical Section



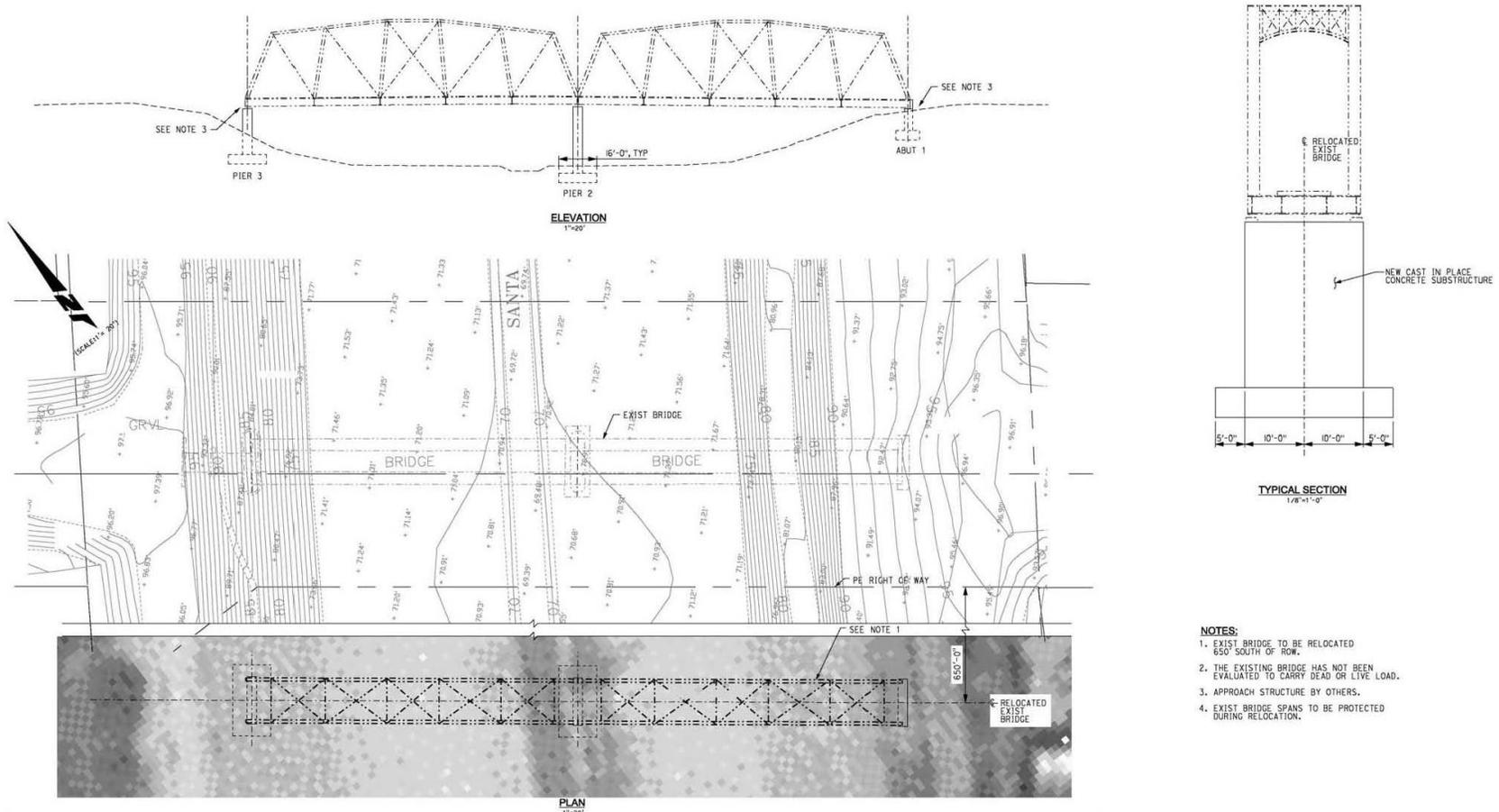
Option 2: Bridge Avoidance A: Leave the existing historic bridge in place and construct two new single-track bridges on each side of the existing bridge

Alignment, Typical Section



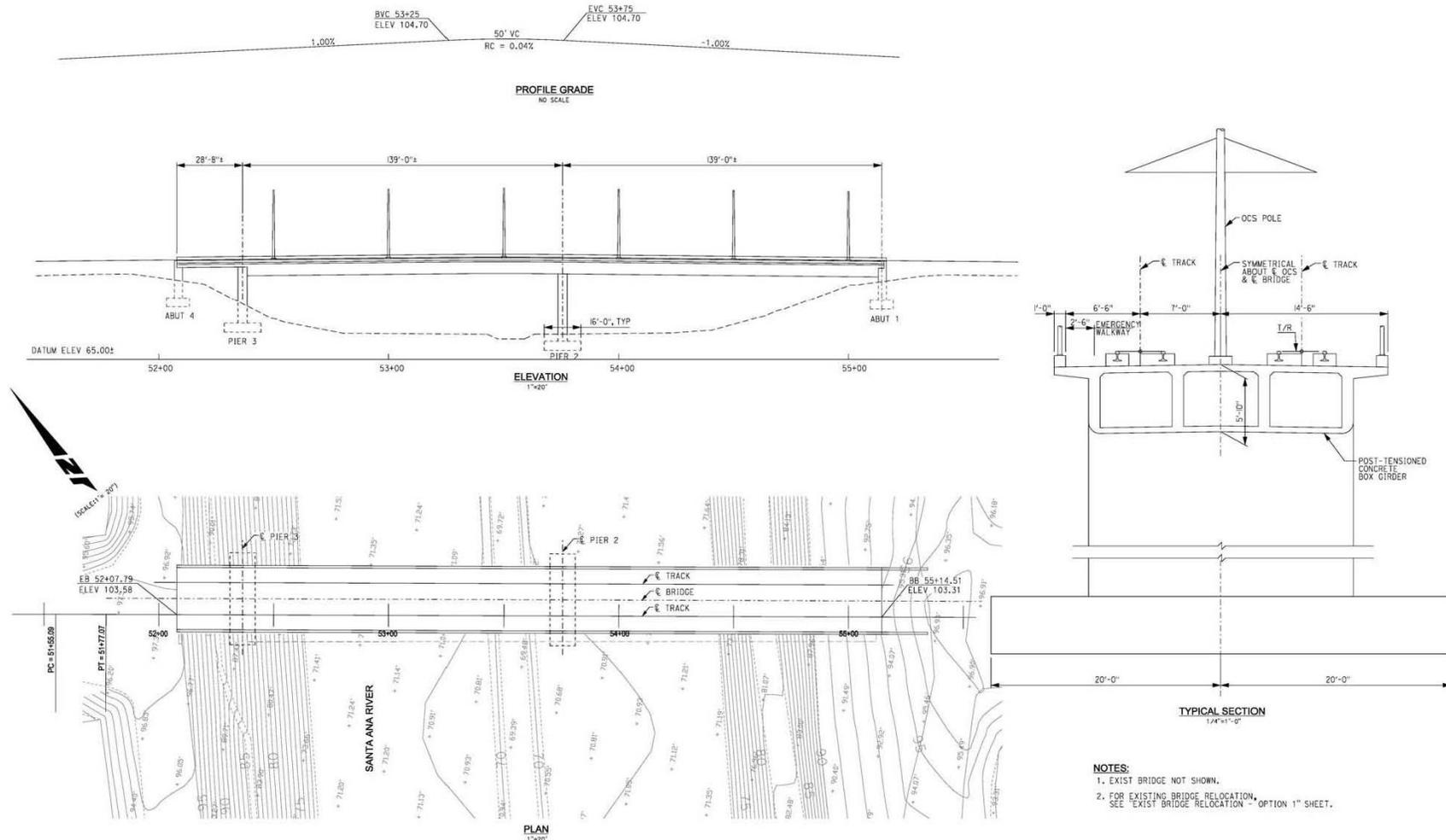
Option 3: Bridge Relocation – Relocate the existing historical bridge approximately 650 feet south of its current location and reposition on new foundation; construct new double-track bridge within the PE ROW

Relocated Historic Bridge: Plan, profile and typical section



Option 3: Bridge Relocation – Relocate the existing historical bridge approximately 650 feet south of its current location and reposition on new foundation; construct new double-track bridge within the PE ROW

New Double-Track Bridge: Plan, profile and typical section



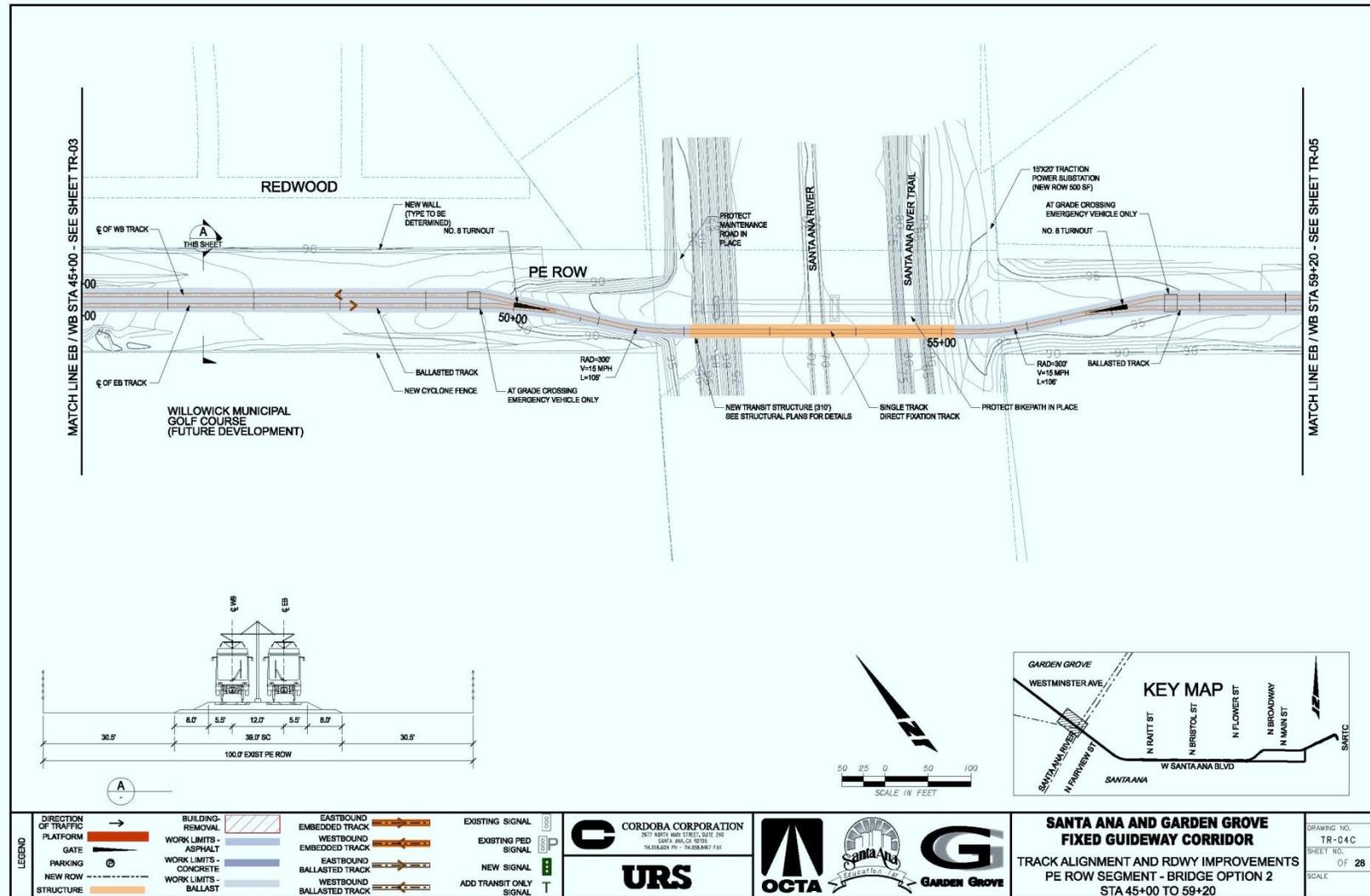
Option 3: Bridge Relocation – Relocate the existing historical bridge approximately 650 feet south of its current location and reposition on new foundation; construct new double-track bridge within the PE ROW - continue

Photo Simulation – From the south, looking north



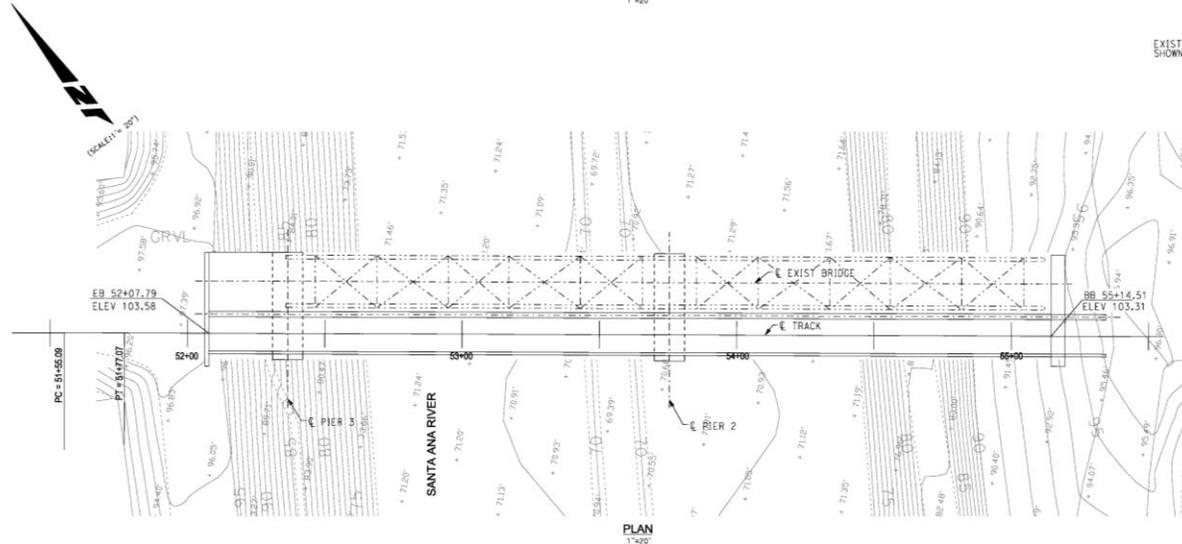
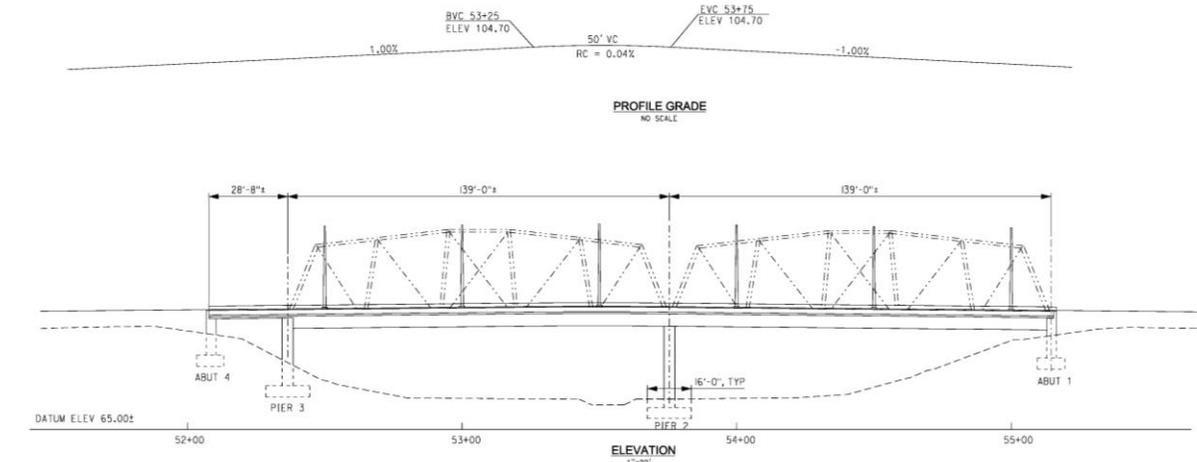
Option 4: Bridge Avoidance B - Leave the existing historic bridge in place and construct one new single-track bridge on the south side of the existing bridge

Alignment, Typical Section



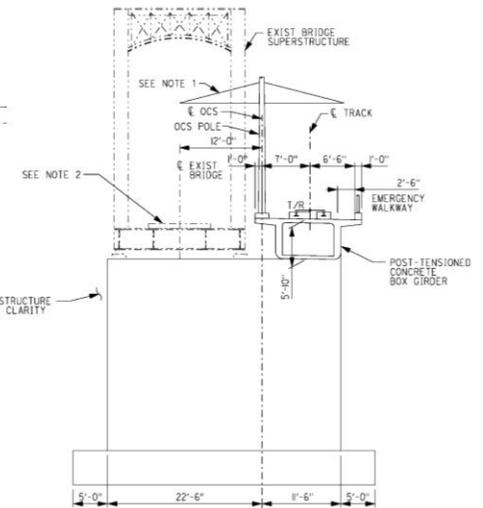
Option 4: Bridge Avoidance B - Leave the existing historic bridge in place and construct one new single-track bridge on the south side of the existing bridge

Plan, profile and typical section



STAGE CONSTRUCTION NOTES:

1. EXIST BRIDGE SUPERSTRUCTURE TO BE TEMPORARILY MOVED DURING CONSTRUCTION OF NEW BRIDGE. EXIST BRIDGE SPANS TO BE PROTECTED DURING TEMPORARY MOVE AND PLACEMENT ON NEW CONCRETE SUPERSTRUCTURE.
2. TEMPORARY LOCATION OF EXIST BRIDGE SUPERSTRUCTURE TO BE WITHIN PE ROW AND LOCATION TO BE APPROVED BY OWNER.
3. EXIST SUBSTRUCTURE TO BE REMOVED.
4. BUILD NEW CONCRETE SUBSTRUCTURE AND SUPERSTRUCTURE.
5. PLACE EXISTING SUPERSTRUCTURE ON NEW SUBSTRUCTURE.



NOTES:

1. OCS POLE BY OTHERS
2. THE EXISTING BRIDGE HAS NOT BEEN EVALUATED TO CARRY DEAD OR LIVE LOAD

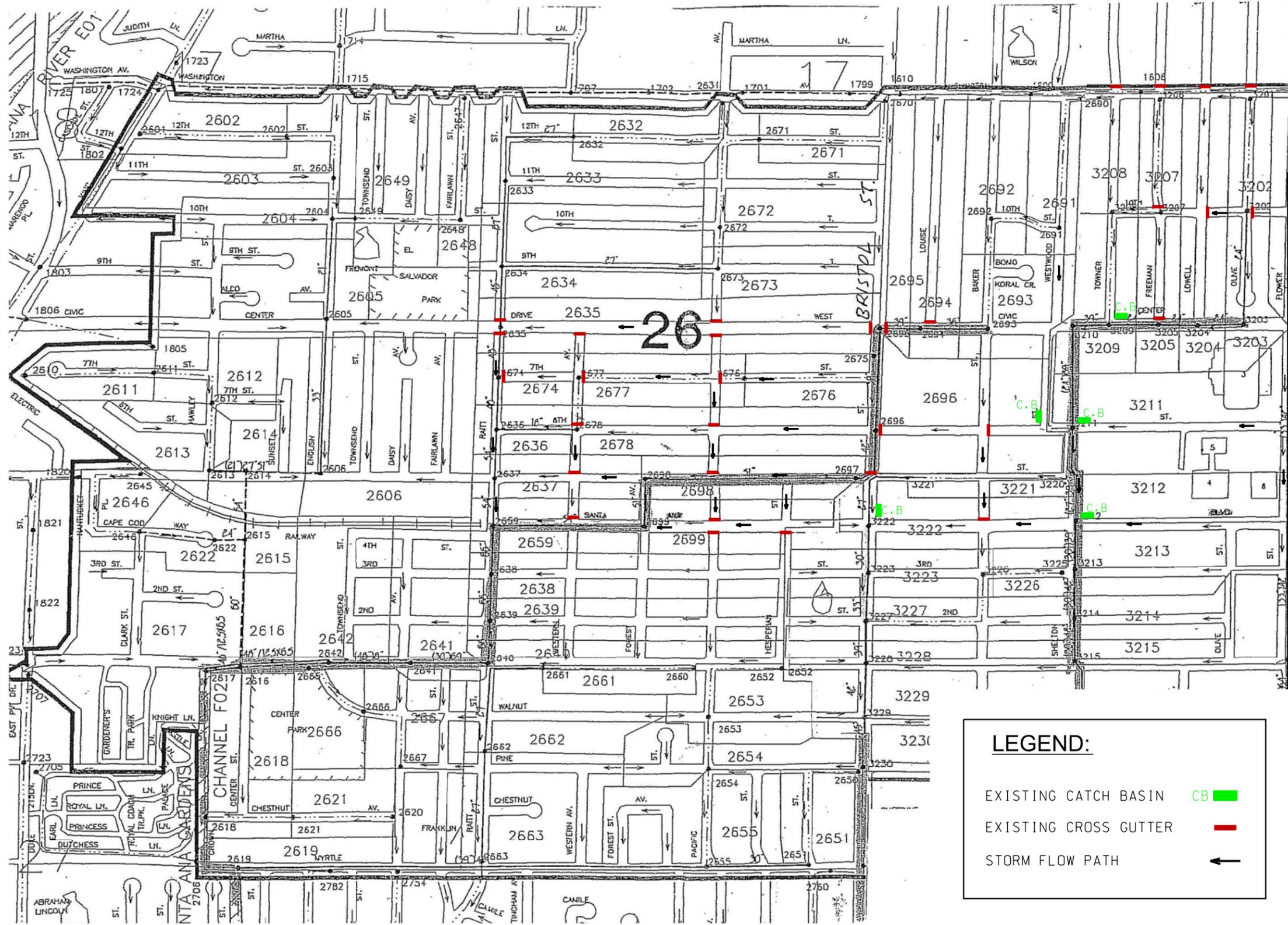
Option 4: Bridge Avoidance B - Leave the existing historic bridge in place and construct one new single-track bridge on the south side of the existing bridge

Photo Simulation – From the south, looking north



Appendix B:

Existing Drainage Systems Map



MATCH LINE SEE SHEET D-002



LEGEND:

- EXISTING CATCH BASIN CB ■
- EXISTING CROSS GUTTER —
- STORM FLOW PATH ←

REVISIONS		
NUMBER	DATE	DESCRIPTIONS

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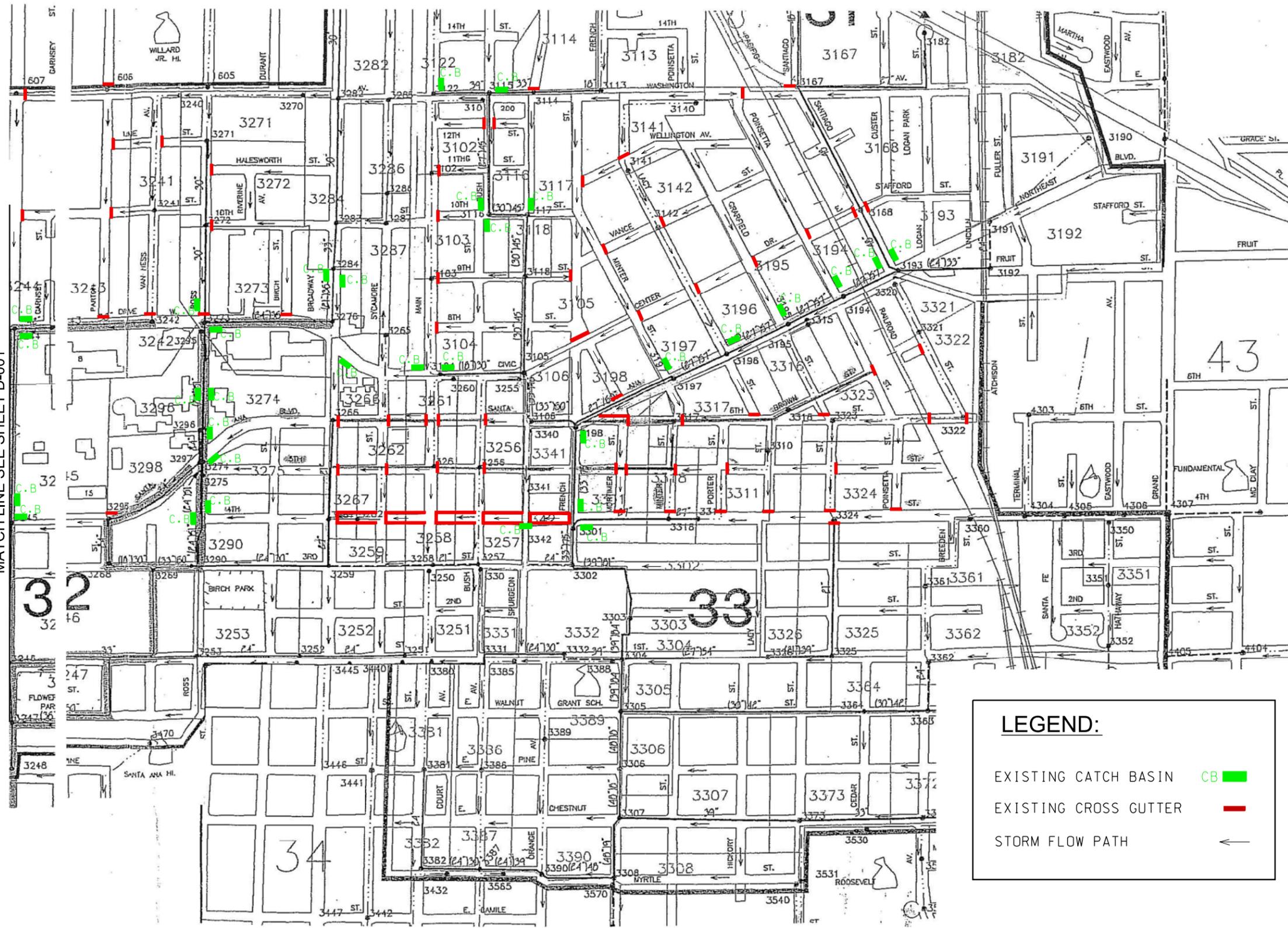


**CITY OF SANTA ANA AND GARDEN GROVE
FIXED GUIDEWAY CORRIDOR**

EXISTING DRAINAGE
SYSTEM MAP

CONTRACT NO.		
DRAWING NO.		D-001
REVISION	SHEET NO.	1 OF 2
SCALE	NTS	

MATCH LINE SEE SHEET D-001



LEGEND:

- EXISTING CATCH BASIN CB ■
- EXISTING CROSS GUTTER —
- STORM FLOW PATH ←



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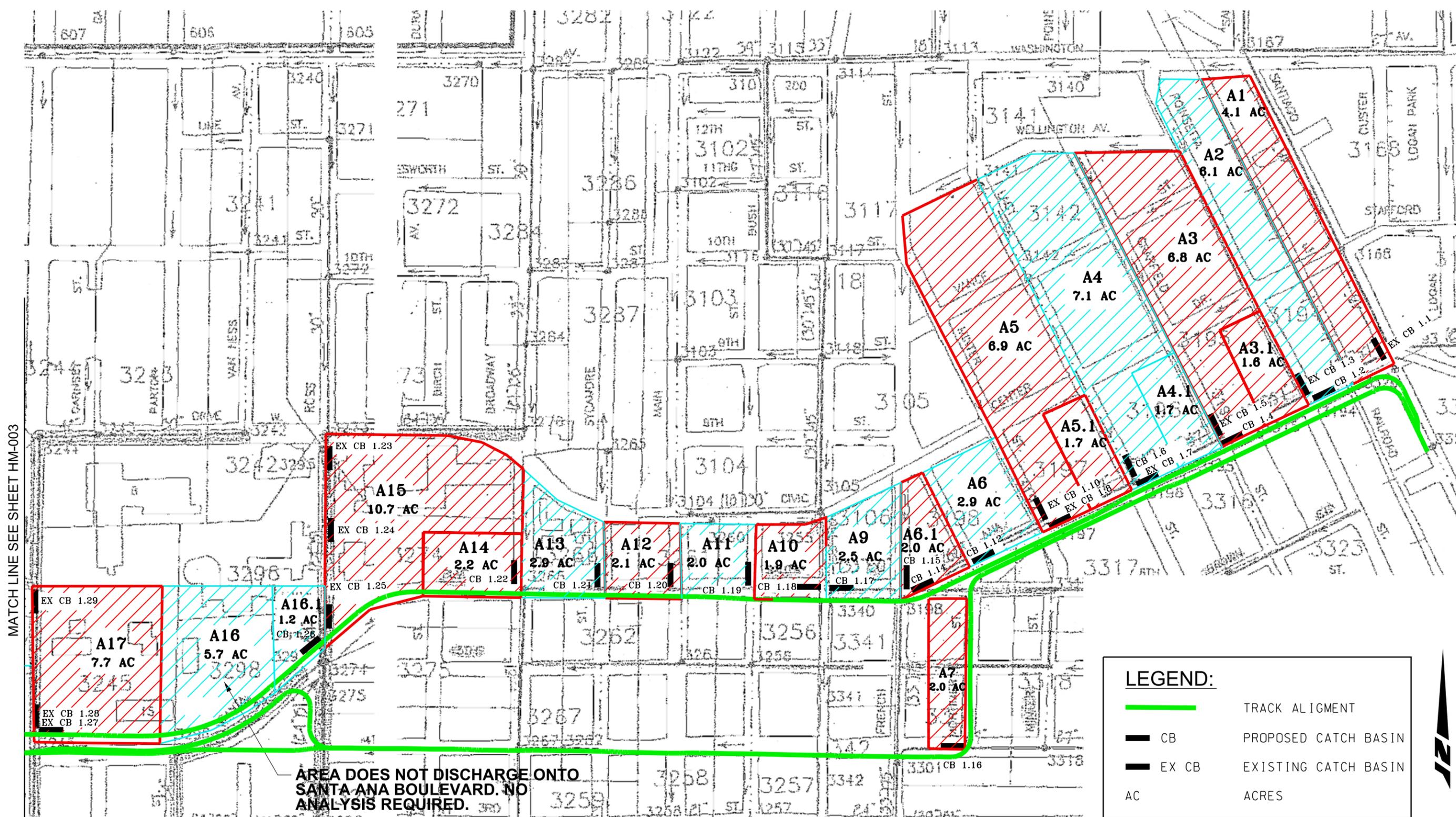
OCTA **Santa Ana Education 1st** **GARDEN GROVE**

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FIXED GUIDEWAY CORRIDOR**

EXISTING DRAINAGE SYSTEM MAP

CONTRACT NO.	
DRAWING NO. D-002	
REVISION	SHEET NO. 2 OF 2
SCALE NTS	

Appendix C:
Hydrology Maps



MATCH LINE SEE SHEET HM-003

LEGEND:

- TRACK ALIGNMENT
- CB PROPOSED CATCH BASIN
- EX CB EXISTING CATCH BASIN
- AC ACRES

AREA DOES NOT DISCHARGE ONTO SANTA ANA BOULEVARD. NO ANALYSIS REQUIRED.

REVISIONS			
NUMBER	DATE	DESCRIPTIONS	APPROVED

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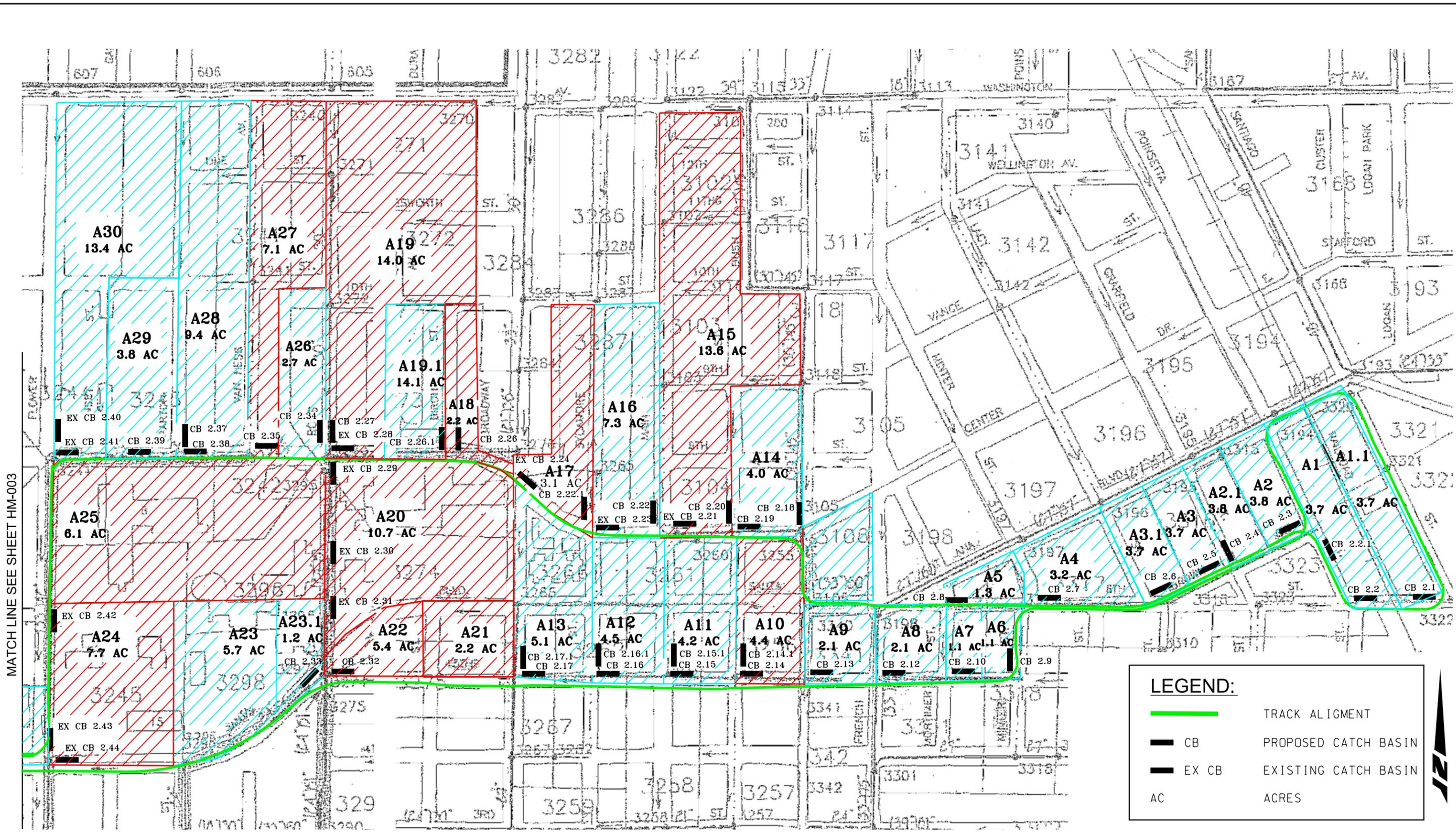
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OCTA **G** **GARDEN GROVE**

**CITY OF SANTA ANA AND GARDEN GROVE
FIXED GUIDEWAY CORRIDOR**

HYDROLOGY MAP
DOWNTOWN SEGMENT
STREET CAR ALTERNATIVE 1

CONTRACT NO.	
DRAWING NO. HM-001	
REVISION	SHEET NO.
	1 OF 3
SCALE NTS	



MATCH LINE SEE SHEET HM-003

LEGEND:

- TRACK ALIGNMENT
- CB PROPOSED CATCH BASIN
- EX CB EXISTING CATCH BASIN
- AC ACRES

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NUMBER	DATE	DESCRIPTIONS

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OCTA

Santa Ana
Education 1st

G
GARDEN GROVE

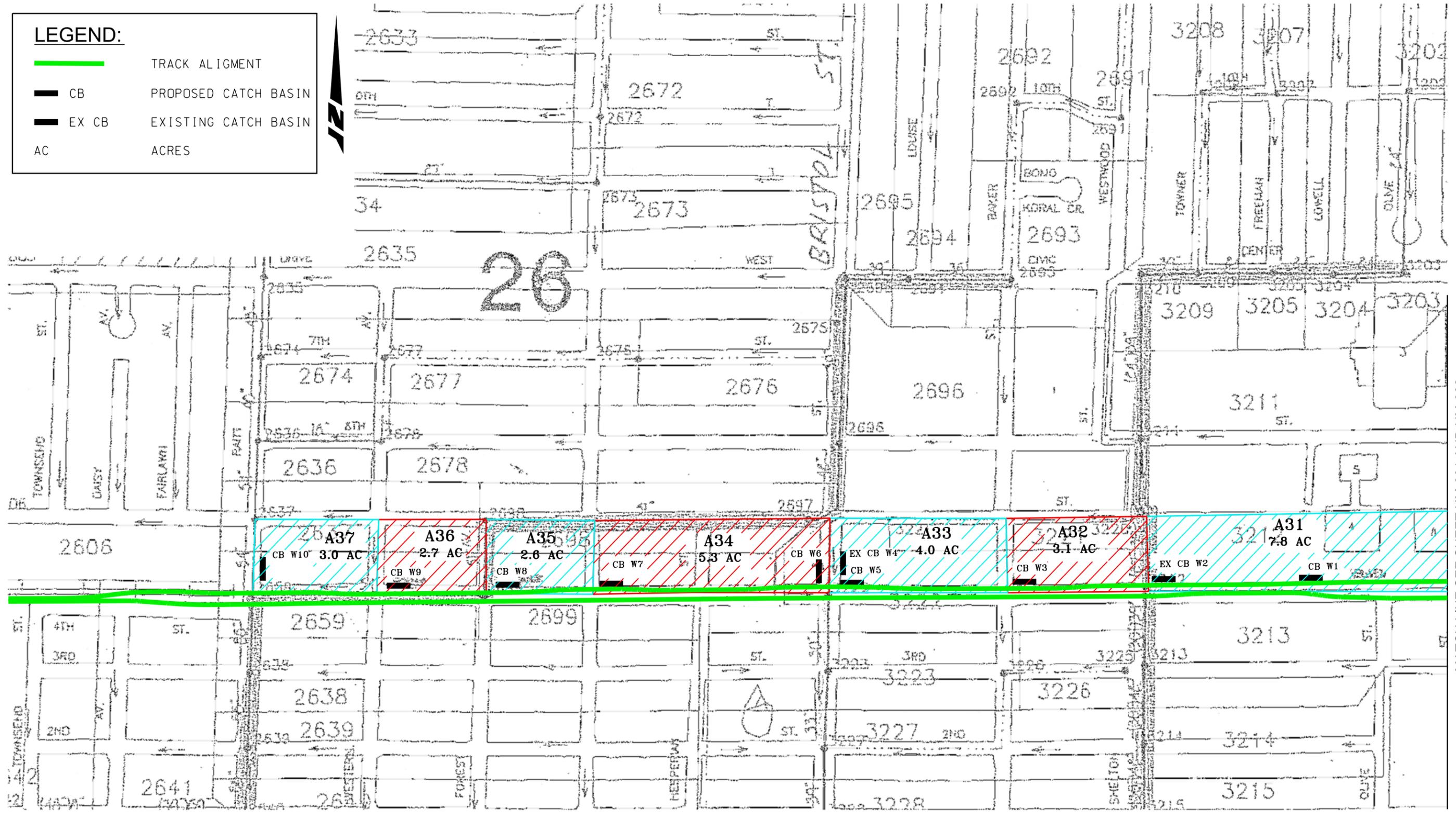
**CITY OF SANTA ANA AND GARDEN GROVE
FIXED GUIDEWAY CORRIDOR**

HYDROLOGY MAP
DOWNTOWN SEGMENT
STREET CAR ALTERNATIVE 2

CONTRACT NO.	
DRAWING NO. HM-002	
REVISION	SHEET NO.
	2 OF 3
SCALE NTS	

LEGEND:

-  TRACK ALIGNMENT
-  CB PROPOSED CATCH BASIN
-  EX CB EXISTING CATCH BASIN
- AC ACRES



MATCH LINE SEE SHEET HM-001 AND HM-002

REVISIONS		
NUMBER	DATE	DESCRIPTIONS

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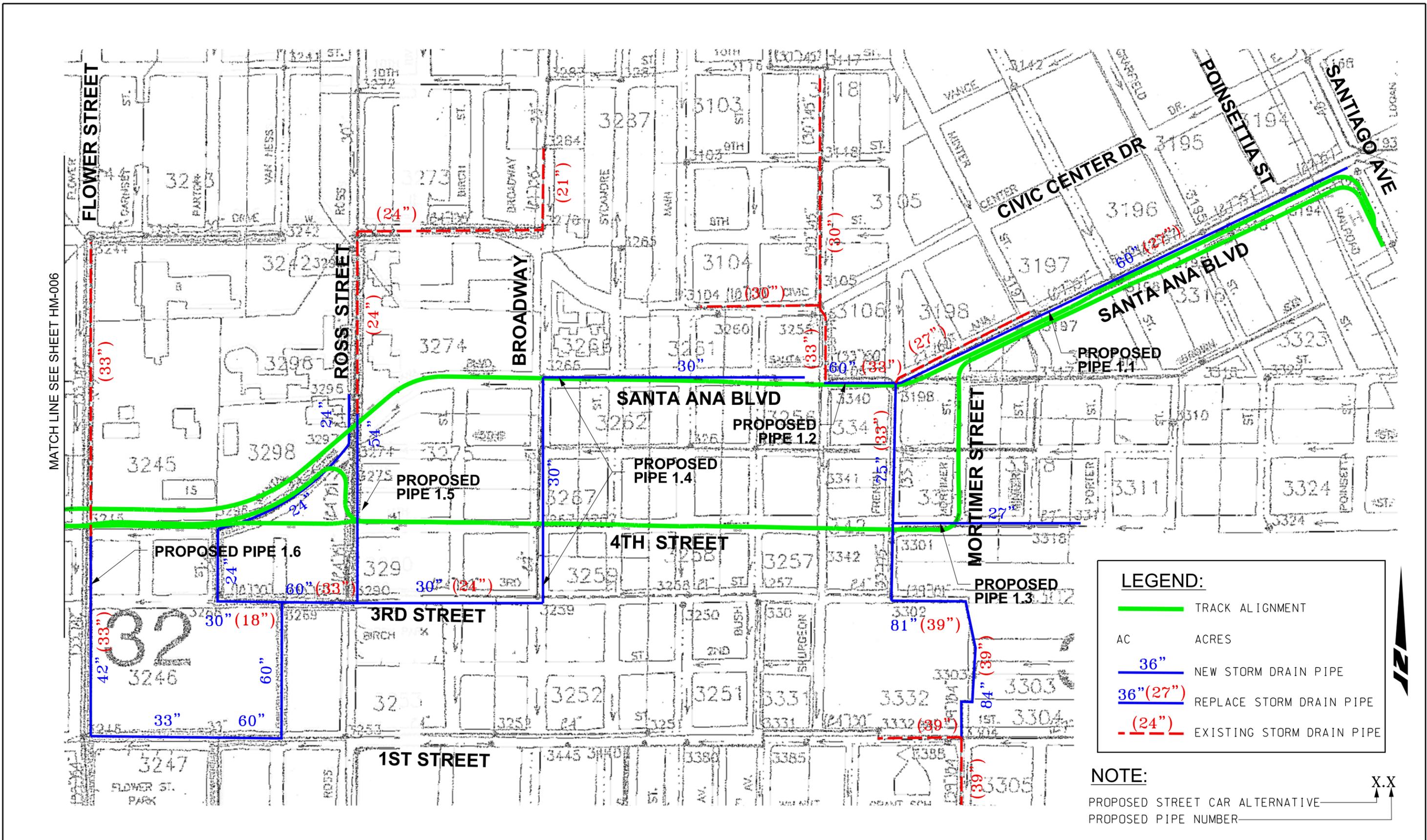
**CITY OF SANTA ANA AND GARDEN GROVE
FIXED GUIDEWAY CORRIDOR**

HYDROLOGY MAP
RAITT TO FLOWER SEGMENT
STREET CAR ALTERNATIVES 1 & 2

CONTRACT NO.		HM-003
DRAWING NO.		3 OF 3
REVISION	SHEET NO.	3 OF 3
SCALE		NTS

Appendix D:

Proposed Storm Drain Systems



LEGEND:

- TRACK ALIGNMENT
- AC ACRES
- 36" NEW STORM DRAIN PIPE
- - 36" (27") REPLACE STORM DRAIN PIPE
- - (24") EXISTING STORM DRAIN PIPE

NOTE:

PROPOSED STREET CAR ALTERNATIVE ———— X.X

PROPOSED PIPE NUMBER - - - - -

REVISIONS		
NUMBER	DATE	DESCRIPTIONS

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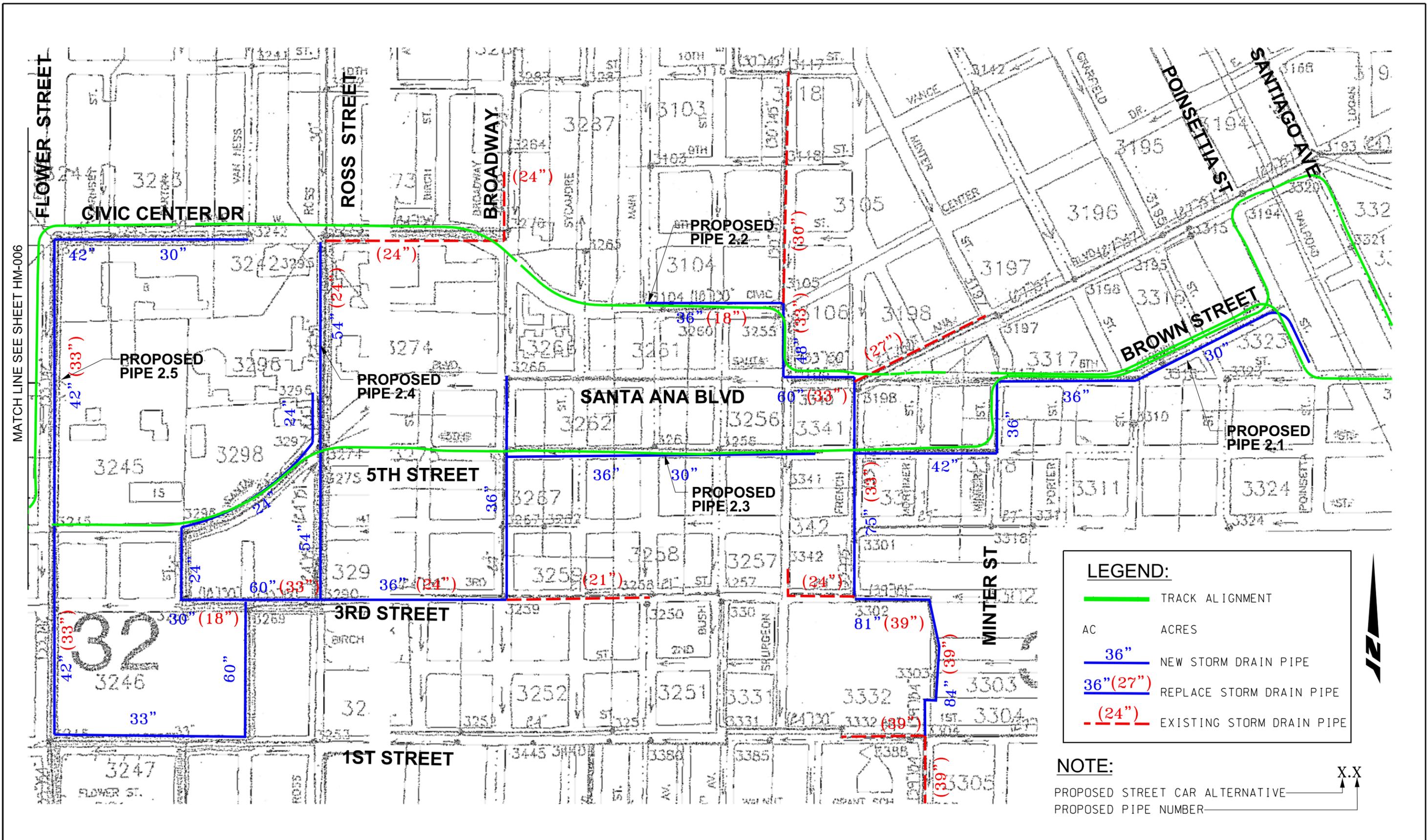
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OCTA **Santa Ana Education 1st** **G** GARDEN GROVE

**CITY OF SANTA ANA AND GARDEN GROVE
 FIXED GUIDEWAY CORRIDOR**

PROPOSED STORM DRAIN
 DOWNTOWN SEGMENT
 STREET CAR ALTERNATIVE 1

CONTRACT NO.	
DRAWING NO. HM-004	
REVISION	SHEET NO. 1 OF 3
SCALE NTS	



LEGEND:

- TRACK ALIGNMENT
- AC ACRES
- 36" NEW STORM DRAIN PIPE
- 36" (27") REPLACE STORM DRAIN PIPE
- - (24") EXISTING STORM DRAIN PIPE

NOTE:

PROPOSED STREET CAR ALTERNATIVE X.X

PROPOSED PIPE NUMBER X.X

REVISIONS		
NUMBER	DATE	DESCRIPTIONS

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OCTA **G** GARDEN GROVE

**CITY OF SANTA ANA AND GARDEN GROVE
 FIXED GUIDEWAY CORRIDOR**

PROPOSED STORM DRAIN
 DOWNTOWN SEGMENT
 STREET CAR ALTERNATIVE 2

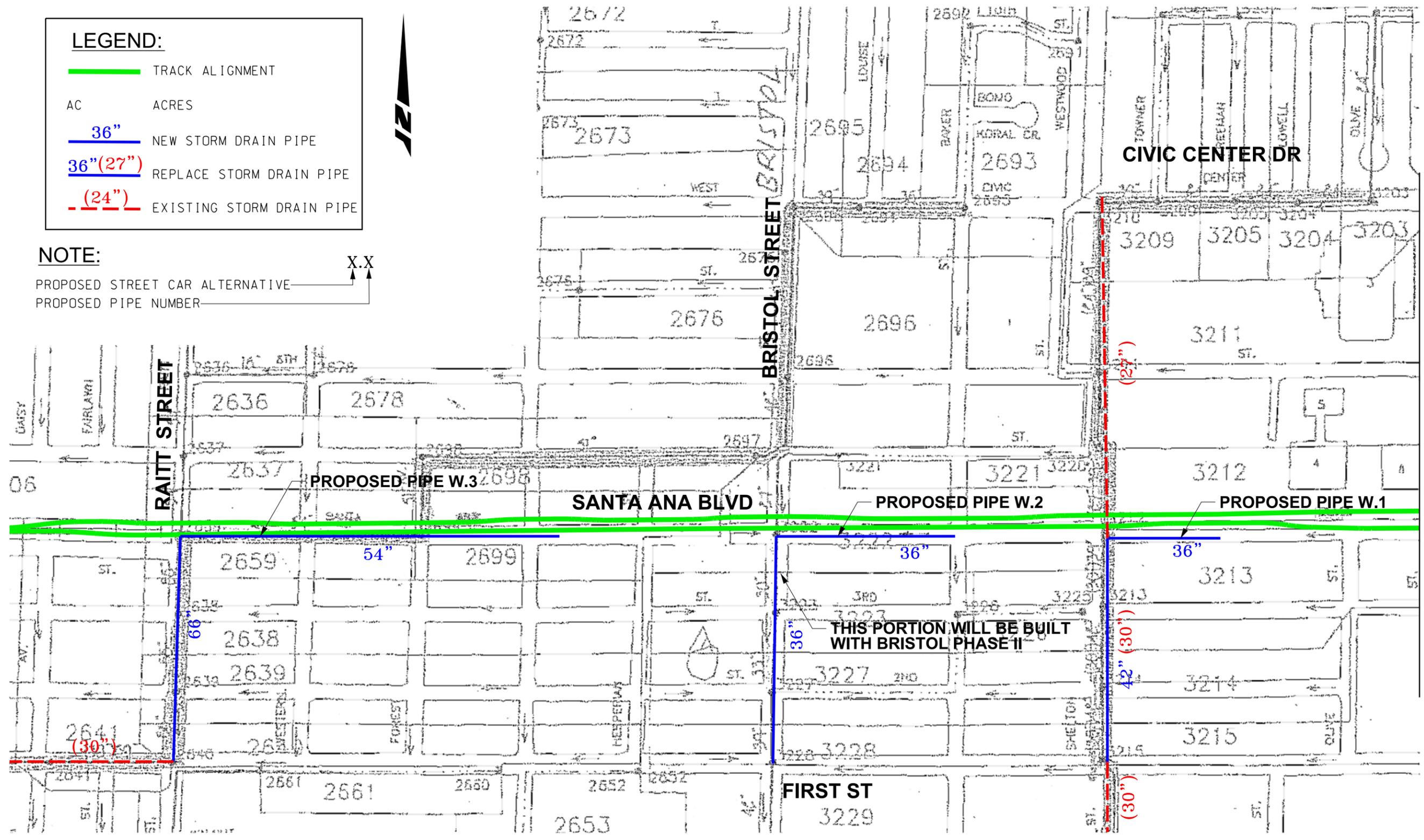
CONTRACT NO.	
DRAWING NO. HM-005	
REVISION	SHEET NO. 2 OF 3
SCALE NTS	

LEGEND:

- TRACK ALIGNMENT
- AC ACRES
- 36" NEW STORM DRAIN PIPE
- 36"(27") REPLACE STORM DRAIN PIPE
- - - (24") EXISTING STORM DRAIN PIPE

NOTE:

PROPOSED STREET CAR ALTERNATIVE X.X
 PROPOSED PIPE NUMBER X.X



MATCH LINE SEE SHEET HM-004 AND HM-005

REVISIONS		
NUMBER	DATE	DESCRIPTIONS

INFORMATION CONFIDENTIAL:
 All plans, drawings, specifications, and/or information furnished herewith shall remain the property of City of Santa Ana and shall be held confidential and shall not be used for any purpose not provided for in agreements with City of Santa Ana.

DESIGNED BY
J.GARCIA
 DRAWN BY
D.SO
 CHECKED BY
R.RAMIREZ
 APPROVED BY
R.RAMIREZ
 DATE
7/6/2011

C CORDOBA CORPORATION
 2677 NORTH MAIN STREET, SUITE 240
 SANTA ANA, CA 92705
 714.558.6124 PH - 714.558.8467 FAX

OCTA **G** GARDEN GROVE

**CITY OF SANTA ANA AND GARDEN GROVE
 FIXED GUIDEWAY CORRIDOR**
 PROPOSED STORM DRAIN SYSTEM
 RAITT TO FLOWER SEGMENT
 FOR STREET CAR ALTERNATIVES 1 & 2

CONTRACT NO.	
DRAWING NO. HM-006	
REVISION	SHEET NO.
	3 OF 3
SCALE	

Appendix E:

Hydrology Calculations

SANTA ANA FIXED GUIDEWAY

HYDROLOGY CALCULATIONS

$Q = CIA$ where,

Q = Discharge in cubic feet per second (cfs)

C = Developed runoff coefficient (dimensionless)

I = Average rainfall intensity in inches per hour (in/hr)

A = Drainage Area (acres)

STREET CAR ALTERNATIVE 1 - DOWNTOWN SEGMENT

Subarea	Area (acres)	C	Length (ft)	Tc (min)	I- Rainfall Intensity (in/hour)		Flow Rate (cfs)	
					Storm Frequency (years)		Q ₁₀	Q ₂₅
					10	25		
1	4.1	0.90	1000	13.0	2.35	2.67	8.64	9.82
2	6.1	0.90	1000	13.0	2.35	2.67	12.89	14.65
3	6.8	0.90	1000	13.0	2.35	2.67	14.37	16.33
3.1	1.6	0.90	490	10.0	2.73	3.11	3.93	4.48
4	7.1	0.90	1000	13.0	2.35	2.67	15.00	17.05
4.1	1.7	0.90	480	10.0	2.73	3.11	4.18	4.76
5	6.9	0.90	1000	13.0	2.35	2.67	14.58	16.57
5.1	1.7	0.90	485	10.0	2.73	3.11	4.18	4.76
6	2.9	0.90	600	11.5	2.52	2.87	6.57	7.48
6.1	2.0	0.90	505	10.5	2.65	3.02	4.78	5.44
7	2.0	0.90	605	11.5	2.52	2.87	4.53	5.16
9	2.5	0.90	565	11.0	2.58	2.94	5.81	6.62
10	1.9	0.90	445	10.0	2.73	3.11	4.67	5.32
11	2.0	0.90	435	10.0	2.73	3.11	4.91	5.60
12	2.1	0.90	435	10.0	2.73	3.11	5.16	5.88
13	2.9	0.90	450	10.0	2.73	3.11	7.12	8.12
14	2.2	0.90	460	10.0	2.73	3.11	5.40	6.16
15	10.7	0.90	985	13.5	2.30	2.61	22.13	25.13
16	5.7	0.90	765	12.5	2.40	2.73	12.32	14.01
16.1	1.2	0.90	425	10.0	2.73	3.11	2.95	3.36
17	7.7	0.90	855	12.5	2.40	2.73	16.64	18.92

SANTA ANA FIXED GUIDEWAY

HYDROLOGY CALCULATIONS

STREET CAR ALTERNATIVE 2 - DOWNTOWN SEGMENT

Subarea	Area (acres)	C	Length (ft)	Tc (min)	Rainfall Intensity (in/hour)		Flow Rate (cfs)	
					Storm Frequency (years)		Q₁₀	Q₂₅
					10	25		
1	3.7	0.90	915	13.5	2.30	2.61	7.65	8.69
1.1	3.7	0.90	1000	13.0	2.35	2.67	7.82	8.89
2	1.9	0.90	600	11.5	2.52	2.87	4.31	4.90
2.1	1.9	0.90	600	11.5	2.52	2.87	4.31	4.90
3	1.85	0.90	585	11.0	2.58	2.94	4.30	4.90
3.1	1.85	0.90	585	11.0	2.58	2.94	4.30	4.90
4	3.2	0.90	525	11.0	2.58	2.94	7.44	8.47
5	1.3	0.90	380	9.5	2.81	3.21	3.29	3.75
6	1.1	0.90	350	9.5	2.81	3.21	2.78	3.17
7	1.1	0.90	350	9.5	2.81	3.21	2.78	3.17
8	2.1	0.90	450	10.0	2.73	3.11	5.16	5.88
9	2.1	0.90	435	10.0	2.73	3.11	5.16	5.88
10	4.4	0.90	725	12.5	2.40	2.73	9.51	10.81
11	4.2	0.90	700	12.0	2.46	2.80	9.29	10.57
12	4.5	0.90	700	12.0	2.46	2.80	9.96	11.33
13	5.1	0.90	700	12.0	2.46	2.80	11.28	12.84
14	4.0	0.90	680	12.0	2.46	2.80	8.85	10.07
15	13.6	0.90	1000	13.0	2.35	2.67	28.74	32.66
16	7.3	0.90	1000	13.0	2.35	2.67	15.43	17.53
17	3.1	0.90	850	12.5	2.40	2.73	6.70	7.62
18	2.2	0.90	660	11.5	2.52	2.87	4.99	5.68
19	14.0	0.90	1000	13.0	2.35	2.67	29.54	33.57
19.1	4.1	0.90	1000	13.0	2.35	2.67	8.71	9.89
20	10.7	0.90	1000	13.0	2.35	2.67	22.61	25.70
21	2.2	0.90	465	10.0	2.73	3.11	5.40	6.16
22	5.4	0.90	915	13.5	2.30	2.61	11.17	12.68
23	5.7	0.90	900	13.0	2.35	2.67	12.05	13.69
23.1	1.2	0.90	900	13.0	2.35	2.67	2.54	2.88
24	7.7	0.90	825	12.5	2.40	2.73	16.64	18.92
25	6.1	0.90	1000	13.0	2.35	2.67	12.89	14.65
26	2.7	0.90	785	12.5	2.40	2.73	5.84	6.63
27	7.1	0.90	1000	13.0	2.35	2.67	15.00	17.05
28	9.4	0.90	1000	13.0	2.35	2.67	19.86	22.57
29	3.8	0.90	800	12.5	2.40	2.73	8.21	9.34
30	13.4	0.90	1000	13.0	2.35	2.67	28.32	32.18

SANTA ANA FIXED GUIDEWAY

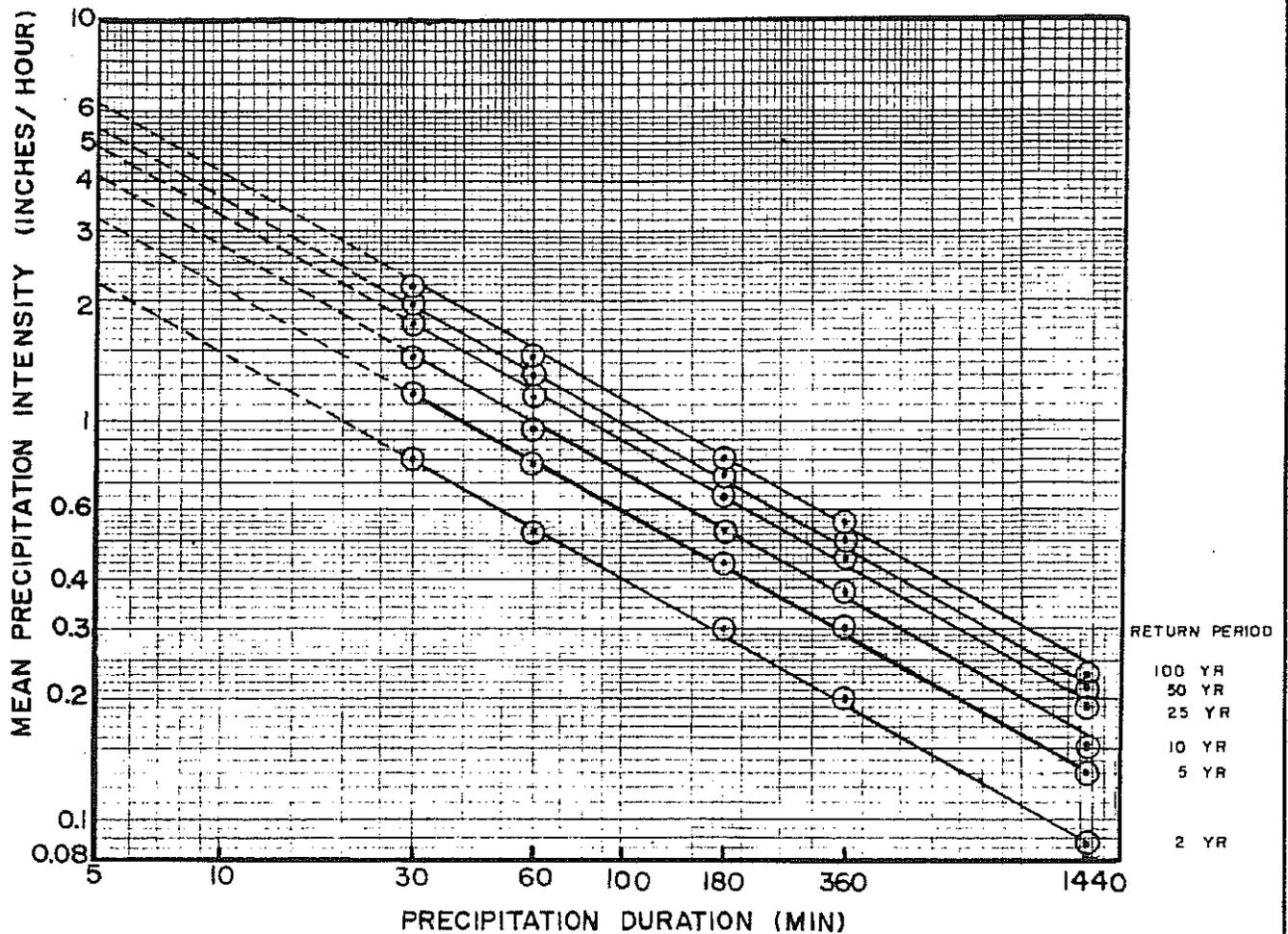
HYDROLOGY CALCULATIONS

STREET CAR ALTERNATIVE 1 AND 2 - RAITT TO FLOWER SEGMENT

Subarea	Area (acres)	C	Length (ft)	Tc (min)	Rainfall Intensity (in/hour)		Flow Rate (cfs)	
					Storm Frequency (years)		Q 10	Q 25
					10	25		
31	7.8	0.90	1000	13.0	2.35	2.67	16.48	18.73
32	3.1	0.90	605	11.5	2.52	2.87	7.03	8.00
33	4.0	0.90	765	12.5	2.40	2.73	8.64	9.83
34	5.3	0.90	1000	13.0	2.35	2.67	11.20	12.73
35	2.6	0.90	550	10.5	2.65	3.02	6.21	7.08
36	2.7	0.90	535	10.5	2.65	3.02	6.45	7.35
37	3.0	0.90	585	11.0	2.58	2.94	6.98	7.95

Regression Equations: $I(t) = at^b$
 (I = Intensity in inches/hour, t = duration in minutes)

Return Frequency (years)	a	b	
2	5.702	-0.574	
5	7.870	-0.562	
10	10.209	-0.573	$I(10) = 10.209(10)^{-0.573} = 2.75$
25	11.995	-0.566	$I(25) = 11.995(10)^{-0.566} = 3.25$
50	13.521	-0.566	
100	15.560	-0.573	

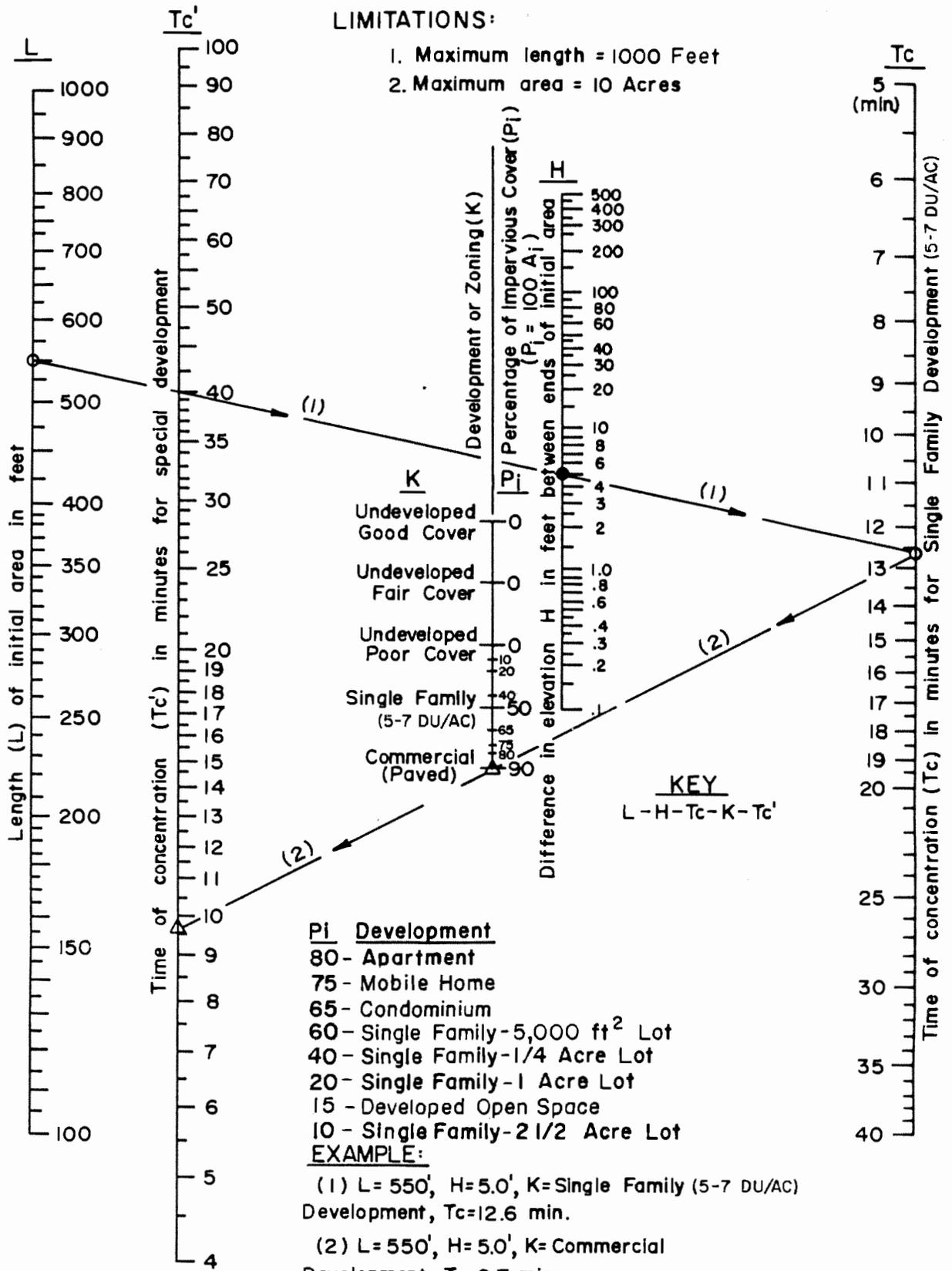


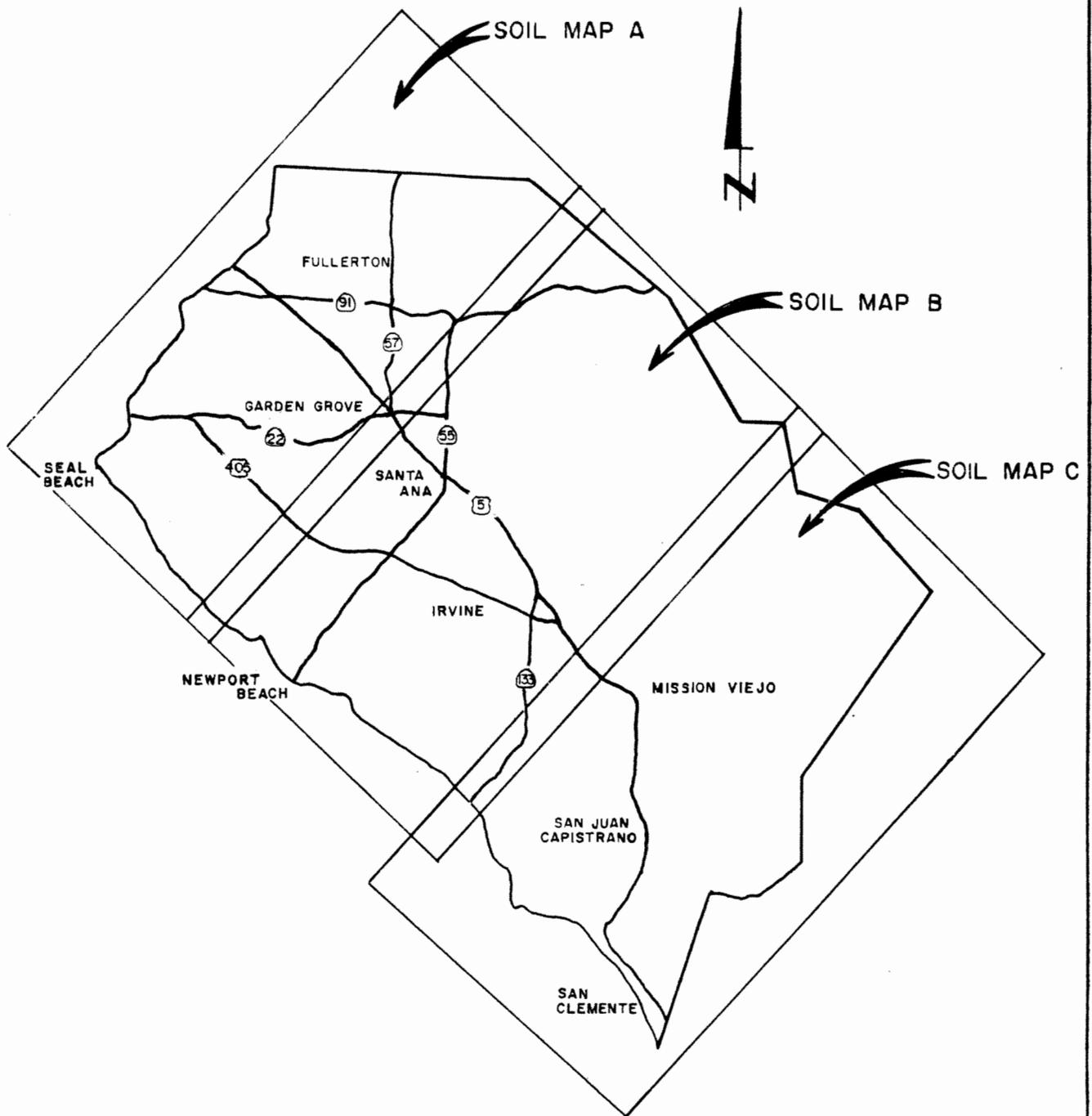
ORANGE COUNTY
 HYDROLOGY MANUAL

MEAN PRECIPITATION
 INTENSITIES FOR
 NONMOUNTAINOUS AREAS

LIMITATIONS:

1. Maximum length = 1000 Feet
2. Maximum area = 10 Acres





(SEE SOIL MAPS IN POCKET)

ORANGE COUNTY
HYDROLOGY MANUAL

ORANGE COUNTY
SOIL MAP INDEX

Appendix F:
Hydraulic Calculations

Worksheet for Ex. CB 1.1 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	8.64	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	82.09	%
Intercepted Flow	7.09	ft ³ /s
Bypass Flow	1.55	ft ³ /s
Spread	14.23	ft
Depth	0.41	ft
Flow Area	2.15	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.01	ft/s
Equivalent Cross Slope	0.08132	ft/ft
Length Factor	0.62	
Total Interception Length	22.75	ft

Worksheet for Proposed CB 1.2 - Curb Inlet On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	1.55	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	7.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	97.34	%
Intercepted Flow	1.51	ft ³ /s
Bypass Flow	0.04	ft ³ /s
Spread	6.31	ft
Depth	0.25	ft
Flow Area	0.52	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	2.95	ft/s
Equivalent Cross Slope	0.13727	ft/ft
Length Factor	0.87	
Total Interception Length	8.08	ft

Worksheet for Ex. CB 1.3 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	14.65	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	20.31	ft
Depth	0.53	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.4 - Curb Inlet On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	3.93	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.99	%
Intercepted Flow	3.93	ft ³ /s
Bypass Flow	0.00	ft ³ /s
Spread	10.11	ft
Depth	0.33	ft
Flow Area	1.15	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.42	ft/s
Equivalent Cross Slope	0.10395	ft/ft
Length Factor	0.99	
Total Interception Length	14.10	ft

Worksheet for Ex. CB 1.5 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	16.33	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	21.84	ft
Depth	0.56	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.6 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	17.05	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	22.47	ft
Depth	0.57	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.7 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	4.18	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	17.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	100.00	%
Intercepted Flow	4.18	ft ³ /s
Bypass Flow	0.00	ft ³ /s
Spread	10.40	ft
Depth	0.33	ft
Flow Area	1.21	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.46	ft/s
Equivalent Cross Slope	0.10196	ft/ft
Length Factor	1.16	
Total Interception Length	14.64	ft

Worksheet for Ex. CB 1.8 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	4.18	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.64	%
Intercepted Flow	4.16	ft ³ /s
Bypass Flow	0.02	ft ³ /s
Spread	10.40	ft
Depth	0.33	ft
Flow Area	1.21	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.46	ft/s
Equivalent Cross Slope	0.10196	ft/ft
Length Factor	0.96	
Total Interception Length	14.64	ft

Worksheet for Ex. CB 1.10 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	16.57	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	22.05	ft
Depth	0.57	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.12 - Curb Inlet On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	6.57	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	90.29	%
Intercepted Flow	5.93	ft ³ /s
Bypass Flow	0.64	ft ³ /s
Spread	12.68	ft
Depth	0.38	ft
Flow Area	1.74	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.79	ft/s
Equivalent Cross Slope	0.08850	ft/ft
Length Factor	0.73	
Total Interception Length	19.28	ft

Worksheet for Proposed CB 1.14 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge		0.90	ft ³ /s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		7.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		3.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	2.85	ft
Depth	0.22	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.15 - Curb Inlet On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	5.44	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	95.18	%
Intercepted Flow	5.18	ft ³ /s
Bypass Flow	0.26	ft ³ /s
Spread	11.69	ft
Depth	0.36	ft
Flow Area	1.49	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.64	ft/s
Equivalent Cross Slope	0.09387	ft/ft
Length Factor	0.81	
Total Interception Length	17.19	ft

Worksheet for Proposed CB 1.16 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.16	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	3.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.66	ft
Depth	0.31	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.17 Curb Inlet on Grade (Sag)

Project Description

Solve For Spread

Input Data

Discharge	6.62	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.50	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	4.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.92	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.18 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.46	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.52	ft
Depth	0.34	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.19 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.60	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.70	ft
Depth	0.33	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.20 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge		5.88	ft ³ /s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		21.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	11.05	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.21 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge		8.12	ft ³ /s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		21.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		3.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	13.08	ft
Depth	0.38	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.22 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	6.16	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	3.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.88	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.23 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	25.13	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	17.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	59.68	%
Intercepted Flow	15.00	ft ³ /s
Bypass Flow	10.13	ft ³ /s
Spread	21.87	ft
Depth	0.56	ft
Flow Area	4.91	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.12	ft/s
Equivalent Cross Slope	0.05966	ft/ft
Length Factor	0.40	
Total Interception Length	42.90	ft

Worksheet for Ex. CB 1.24 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	10.13	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	77.10	%
Intercepted Flow	7.81	ft ³ /s
Bypass Flow	2.32	ft ³ /s
Spread	15.20	ft
Depth	0.43	ft
Flow Area	2.44	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.16	ft/s
Equivalent Cross Slope	0.07748	ft/ft
Length Factor	0.56	
Total Interception Length	25.04	ft

Worksheet for Ex. CB 1.25 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	2.32	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	17.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	6.69	ft
Depth	0.26	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.26 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	3.36	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.51	ft
Depth	0.31	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.27 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	1.19	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	17.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	4.29	ft
Depth	0.21	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.28 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	7.88	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	84.93	%
Intercepted Flow	6.69	ft ³ /s
Bypass Flow	1.19	ft ³ /s
Spread	13.70	ft
Depth	0.40	ft
Flow Area	2.00	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.93	ft/s
Equivalent Cross Slope	0.08366	ft/ft
Length Factor	0.65	
Total Interception Length	21.52	ft

Worksheet for Ex. CB 1.29 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	18.92	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	58.36	%
Intercepted Flow	11.04	ft ³ /s
Bypass Flow	7.88	ft ³ /s
Spread	19.55	ft
Depth	0.52	ft
Flow Area	3.95	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.79	ft/s
Equivalent Cross Slope	0.06454	ft/ft
Length Factor	0.39	
Total Interception Length	36.33	ft

Worksheet for Proposed CB 2.1 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	8.89	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	14.56	ft
Depth	0.41	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.2 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	1.57	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	5.73	ft
Depth	0.23	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.2.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	8.69	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	81.91	%
Intercepted Flow	7.12	ft ³ /s
Bypass Flow	1.57	ft ³ /s
Spread	14.27	ft
Depth	0.41	ft
Flow Area	2.16	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.02	ft/s
Equivalent Cross Slope	0.08118	ft/ft
Length Factor	0.61	
Total Interception Length	22.83	ft

Worksheet for Proposed CB 2.3 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	4.90	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	97.39	%
Intercepted Flow	4.77	ft ³ /s
Bypass Flow	0.13	ft ³ /s
Spread	11.17	ft
Depth	0.35	ft
Flow Area	1.37	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.57	ft/s
Equivalent Cross Slope	0.09700	ft/ft
Length Factor	0.87	
Total Interception Length	16.13	ft

Worksheet for Proposed CB 2.4 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.03	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.96	ft
Depth	0.32	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.5 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	4.90	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	97.39	%
Intercepted Flow	4.77	ft ³ /s
Bypass Flow	0.13	ft ³ /s
Spread	11.17	ft
Depth	0.35	ft
Flow Area	1.37	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.57	ft/s
Equivalent Cross Slope	0.09700	ft/ft
Length Factor	0.87	
Total Interception Length	16.13	ft

Worksheet for Proposed CB 2.6 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.03	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	12.45	ft
Depth	0.37	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.7 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	8.47	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	14.10	ft
Depth	0.40	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.8 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge		3.75	ft ³ /s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		14.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	10.24	ft
Depth	0.32	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.9 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge		2.78	ft ³ /s
Slope		0.01000	ft/ft
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Roughness Coefficient		0.013	
Curb Opening Length		7.00	ft
Local Depression		2.00	in
Local Depression Width		2.00	ft

Results

Efficiency	81.83	%
Intercepted Flow	2.27	ft ³ /s
Bypass Flow	0.51	ft ³ /s
Spread	8.59	ft
Depth	0.30	ft
Flow Area	0.86	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.22	ft/s
Equivalent Cross Slope	0.11574	ft/ft
Length Factor	0.61	
Total Interception Length	11.43	ft

Worksheet for Proposed CB 2.10 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	3.68	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.11	ft
Depth	0.32	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.12 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.88	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.05	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.13 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	5.88	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.05	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.14 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	2.70	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	8.22	ft
Depth	0.28	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.14.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	10.81	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	75.06	%
Intercepted Flow	8.11	ft ³ /s
Bypass Flow	2.70	ft ³ /s
Spread	15.61	ft
Depth	0.44	ft
Flow Area	2.56	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.22	ft/s
Equivalent Cross Slope	0.07598	ft/ft
Length Factor	0.54	
Total Interception Length	26.04	ft

Worksheet for Proposed CB 2.15 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	2.56	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	7.94	ft
Depth	0.28	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.15.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	10.57	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	75.77	%
Intercepted Flow	8.01	ft ³ /s
Bypass Flow	2.56	ft ³ /s
Spread	15.47	ft
Depth	0.44	ft
Flow Area	2.52	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.19	ft/s
Equivalent Cross Slope	0.07650	ft/ft
Length Factor	0.55	
Total Interception Length	25.69	ft

Worksheet for Proposed CB 2.16 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	2.99	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	8.80	ft
Depth	0.30	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.16.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	11.33	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	73.60	%
Intercepted Flow	8.34	ft ³ /s
Bypass Flow	2.99	ft ³ /s
Spread	15.92	ft
Depth	0.44	ft
Flow Area	2.66	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.26	ft/s
Equivalent Cross Slope	0.07492	ft/ft
Length Factor	0.52	
Total Interception Length	26.78	ft

Worksheet for Proposed CB 2.17 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	3.89	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.49	ft
Depth	0.33	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.17.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	12.84	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	69.72	%
Intercepted Flow	8.95	ft ³ /s
Bypass Flow	3.89	ft ³ /s
Spread	16.74	ft
Depth	0.46	ft
Flow Area	2.93	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.38	ft/s
Equivalent Cross Slope	0.07219	ft/ft
Length Factor	0.49	
Total Interception Length	28.86	ft

Worksheet for Proposed CB 2.18 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	10.07	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	77.29	%
Intercepted Flow	7.78	ft ³ /s
Bypass Flow	2.29	ft ³ /s
Spread	15.17	ft
Depth	0.43	ft
Flow Area	2.43	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.15	ft/s
Equivalent Cross Slope	0.07762	ft/ft
Length Factor	0.56	
Total Interception Length	24.95	ft

Worksheet for Proposed CB 2.19 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	2.29	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	7.37	ft
Depth	0.27	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.20 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	32.66	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	28.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	65.32	%
Intercepted Flow	21.33	ft ³ /s
Bypass Flow	11.33	ft ³ /s
Spread	24.22	ft
Depth	0.61	ft
Flow Area	5.99	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.45	ft/s
Equivalent Cross Slope	0.03782	ft/ft
Length Factor	0.44	
Total Interception Length	62.96	ft

Worksheet for Ex. CB 2.21 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	11.33	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	17.11	ft
Depth	0.46	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.22 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	17.53	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	81.19	%
Intercepted Flow	14.23	ft ³ /s
Bypass Flow	3.30	ft ³ /s
Spread	18.97	ft
Depth	0.51	ft
Flow Area	3.73	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.71	ft/s
Equivalent Cross Slope	0.06595	ft/ft
Length Factor	0.60	
Total Interception Length	34.73	ft

Worksheet for Proposed CB 2.22.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	7.62	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	85.95	%
Intercepted Flow	6.55	ft ³ /s
Bypass Flow	1.07	ft ³ /s
Spread	13.51	ft
Depth	0.40	ft
Flow Area	1.95	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.91	ft/s
Equivalent Cross Slope	0.08453	ft/ft
Length Factor	0.66	
Total Interception Length	21.09	ft

Worksheet for Ex. CB 2.23 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	3.30	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.40	ft
Depth	0.31	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 2.24 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	1.07	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	7.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	92.40	%
Intercepted Flow	0.99	ft ³ /s
Bypass Flow	0.08	ft ³ /s
Spread	5.00	ft
Depth	0.23	ft
Flow Area	0.38	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	2.84	ft/s
Equivalent Cross Slope	0.08525	ft/ft
Length Factor	0.76	
Total Interception Length	9.20	ft

Worksheet for Proposed CB 2.26 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	5.76	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	93.80	%
Intercepted Flow	5.40	ft ³ /s
Bypass Flow	0.36	ft ³ /s
Spread	11.99	ft
Depth	0.37	ft
Flow Area	1.56	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.68	ft/s
Equivalent Cross Slope	0.09221	ft/ft
Length Factor	0.79	
Total Interception Length	17.80	ft

Worksheet for Proposed CB 2.26.1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	9.89	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	96.75	%
Intercepted Flow	9.57	ft ³ /s
Bypass Flow	0.32	ft ³ /s
Spread	15.05	ft
Depth	0.43	ft
Flow Area	2.39	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.13	ft/s
Equivalent Cross Slope	0.07805	ft/ft
Length Factor	0.85	
Total Interception Length	24.68	ft

Worksheet for Proposed CB 2.27 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	33.57	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	61.77	%
Intercepted Flow	20.74	ft ³ /s
Bypass Flow	12.83	ft ³ /s
Spread	24.48	ft
Depth	0.62	ft
Flow Area	6.12	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.48	ft/s
Equivalent Cross Slope	0.05524	ft/ft
Length Factor	0.41	
Total Interception Length	50.74	ft

Worksheet for Ex. CB 2.28 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	13.18	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	68.92	%
Intercepted Flow	9.08	ft ³ /s
Bypass Flow	4.10	ft ³ /s
Spread	16.92	ft
Depth	0.47	ft
Flow Area	2.99	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.41	ft/s
Equivalent Cross Slope	0.07163	ft/ft
Length Factor	0.48	
Total Interception Length	29.31	ft

Worksheet for Ex. CB 2.29 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	25.70	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	57.64	%
Intercepted Flow	14.81	ft ³ /s
Bypass Flow	10.89	ft ³ /s
Spread	22.06	ft
Depth	0.57	ft
Flow Area	4.99	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.15	ft/s
Equivalent Cross Slope	0.03965	ft/ft
Length Factor	0.38	
Total Interception Length	55.34	ft

Worksheet for Ex. CB 2.30 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	10.89	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	60.90	%
Intercepted Flow	6.63	ft ³ /s
Bypass Flow	4.26	ft ³ /s
Spread	15.66	ft
Depth	0.44	ft
Flow Area	2.58	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.22	ft/s
Equivalent Cross Slope	0.04791	ft/ft
Length Factor	0.41	
Total Interception Length	34.44	ft

Worksheet for Ex. CB 2.31 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	4.26	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.15	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.32 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	18.84	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	24.02	ft
Depth	0.60	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.33 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	2.88	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	6.87	ft
Depth	0.26	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.34 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge		6.63	ft ³ /s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		14.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	14.97	ft
Depth	0.42	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.35 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge		15.00	ft ³ /s
Slope		0.01000	ft/ft
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Roughness Coefficient		0.013	
Curb Opening Length		14.00	ft
Local Depression		2.00	in
Local Depression Width		4.00	ft

Results

Efficiency	52.65	%
Intercepted Flow	7.90	ft ³ /s
Bypass Flow	7.10	ft ³ /s
Spread	17.83	ft
Depth	0.48	ft
Flow Area	3.30	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.54	ft/s
Equivalent Cross Slope	0.04449	ft/ft
Length Factor	0.34	
Total Interception Length	41.19	ft

Worksheet for Proposed CB 2.37 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	22.57	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	73.44	%
Intercepted Flow	16.57	ft ³ /s
Bypass Flow	6.00	ft ³ /s
Spread	20.96	ft
Depth	0.55	ft
Flow Area	4.52	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.99	ft/s
Equivalent Cross Slope	0.06144	ft/ft
Length Factor	0.52	
Total Interception Length	40.29	ft

Worksheet for Proposed CB 2.38 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	13.10	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	69.11	%
Intercepted Flow	9.05	ft ³ /s
Bypass Flow	4.05	ft ³ /s
Spread	16.88	ft
Depth	0.46	ft
Flow Area	2.98	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.40	ft/s
Equivalent Cross Slope	0.07176	ft/ft
Length Factor	0.48	
Total Interception Length	29.21	ft

Worksheet for Proposed CB 2.39 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	13.39	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	19.13	ft
Depth	0.50	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 2.40 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	32.18	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	52.17	%
Intercepted Flow	16.79	ft ³ /s
Bypass Flow	15.39	ft ³ /s
Spread	24.08	ft
Depth	0.61	ft
Flow Area	5.93	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.43	ft/s
Equivalent Cross Slope	0.03793	ft/ft
Length Factor	0.34	
Total Interception Length	62.46	ft

Worksheet for Ex. CB 2.41 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge		15.39	ft ³ /s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		21.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	20.99	ft
Depth	0.54	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 2.42 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge		14.65	ft ³ /s
Slope		0.01000	ft/ft
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Roughness Coefficient		0.013	
Curb Opening Length		14.00	ft
Local Depression		2.00	in
Local Depression Width		2.00	ft

Results

Efficiency	65.73	%
Intercepted Flow	9.63	ft ³ /s
Bypass Flow	5.02	ft ³ /s
Spread	17.66	ft
Depth	0.48	ft
Flow Area	3.24	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.52	ft/s
Equivalent Cross Slope	0.06945	ft/ft
Length Factor	0.45	
Total Interception Length	31.22	ft

Worksheet for Ex. CB 2.43 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	23.94	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	52.11	%
Intercepted Flow	12.47	ft ³ /s
Bypass Flow	11.47	ft ³ /s
Spread	21.46	ft
Depth	0.56	ft
Flow Area	4.73	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.06	ft/s
Equivalent Cross Slope	0.06045	ft/ft
Length Factor	0.34	
Total Interception Length	41.70	ft

Worksheet for Ex. CB 2.44 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	11.47	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	21.57	ft
Depth	0.55	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W1 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	18.73	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	66.02	%
Intercepted Flow	12.36	ft ³ /s
Bypass Flow	6.37	ft ³ /s
Spread	19.48	ft
Depth	0.52	ft
Flow Area	3.92	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.78	ft/s
Equivalent Cross Slope	0.04236	ft/ft
Length Factor	0.45	
Total Interception Length	46.57	ft

Worksheet for Ex. CB W2 On Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	6.37	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	14.57	ft
Depth	0.41	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W3 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	8.00	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.78	%
Intercepted Flow	7.98	ft ³ /s
Bypass Flow	0.02	ft ³ /s
Spread	13.78	ft
Depth	0.40	ft
Flow Area	2.03	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.95	ft/s
Equivalent Cross Slope	0.08327	ft/ft
Length Factor	0.97	
Total Interception Length	21.72	ft

Worksheet for Ex. CB W4 On Grade

Project Description

Solve For Efficiency

Input Data

Discharge	9.83	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	96.87	%
Intercepted Flow	9.52	ft ³ /s
Bypass Flow	0.31	ft ³ /s
Spread	15.02	ft
Depth	0.43	ft
Flow Area	2.38	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.13	ft/s
Equivalent Cross Slope	0.07819	ft/ft
Length Factor	0.85	
Total Interception Length	24.59	ft

Worksheet for Proposed CB W5- Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	0.31	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	7.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	2.72	ft
Depth	0.17	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W6 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	12.73	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	90.61	%
Intercepted Flow	11.54	ft ³ /s
Bypass Flow	1.19	ft ³ /s
Spread	16.69	ft
Depth	0.46	ft
Flow Area	2.91	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.37	ft/s
Equivalent Cross Slope	0.07237	ft/ft
Length Factor	0.73	
Total Interception Length	28.71	ft

Worksheet for Proposed CB W7 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	1.19	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	4.76	ft
Depth	0.22	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W8 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	7.08	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	12.51	ft
Depth	0.37	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W9 - Curb Inlet on Grade (sag)

Project Description

Solve For Spread

Input Data

Discharge	7.35	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	12.62	ft
Depth	0.38	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W10 - Curb Inlet on Grade

Project Description

Solve For Efficiency

Input Data

Discharge	7.95	ft ³ /s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.83	%
Intercepted Flow	7.94	ft ³ /s
Bypass Flow	0.01	ft ³ /s
Spread	13.75	ft
Depth	0.40	ft
Flow Area	2.02	ft ²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.94	ft/s
Equivalent Cross Slope	0.08343	ft/ft
Length Factor	0.97	
Total Interception Length	21.63	ft

Cross Section for Proposed Pipe 1.1 (60" RCP)

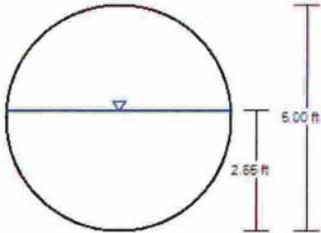
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	2.65 ft
Diameter	5.00 ft
Discharge	101.35 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 1.1 (75" RCP)

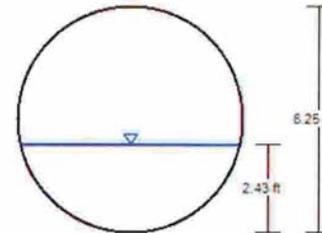
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	2.43 ft
Diameter	6.25 ft
Discharge	106.51 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 1.2 (60" RCP)

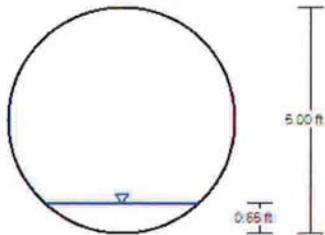
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	0.65 ft
Diameter	5.00 ft
Discharge	6.62 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 1.3 (27" RCP)

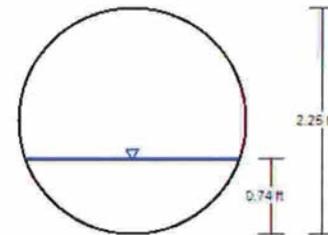
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	0.74 ft
Diameter	2.25 ft
Discharge	5.16 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 1.5 (54" RCP)

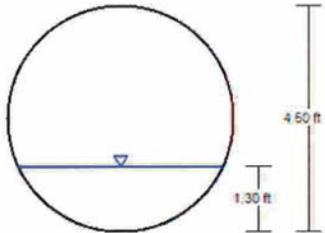
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.30 ft
Diameter	4.50 ft
Discharge	25.13 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 1.6 (42" RCP)

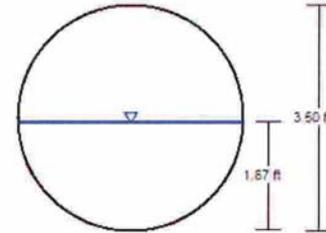
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.67 ft
Diameter	3.50 ft
Discharge	32.93 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 2.1 (30" RCP)

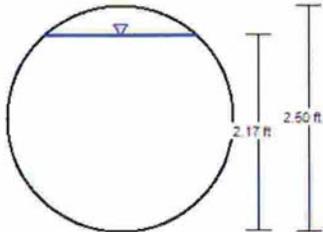
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00750 ft/ft
Normal Depth	2.17 ft
Diameter	2.50 ft
Discharge	37.18 ft ³ /s

Cross Section Image



V:1
H:1

Cross Section for Proposed Pipe 2.1 (36" RCP)

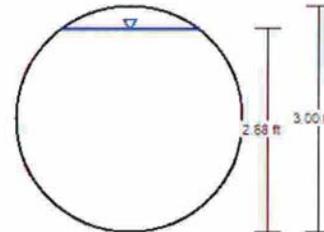
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00550 ft/ft
Normal Depth	2.68 ft
Diameter	3.00 ft
Discharge	52.58 ft ³ /s

Cross Section Image



V:1
H:1

Cross Section for Proposed Pipe 2.1 (42" RCP)

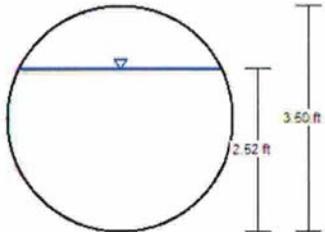
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	2.52 ft
Diameter	3.50 ft
Discharge	61.64 ft ³ /s

Cross Section Image



V. 1
H. 1

Cross Section for Proposed Pipe 2.2 (36" RCP)

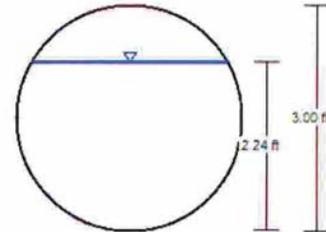
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	2.24 ft
Diameter	3.00 ft
Discharge	42.73 ft ³ /s

Cross Section Image



V. 1
H. 1

Cross Section for Proposed Pipe 2.3 (30" RCP)

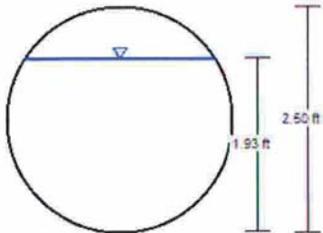
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.93 ft
Diameter	2.50 ft
Discharge	27.26 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 2.3 (36" RCP)

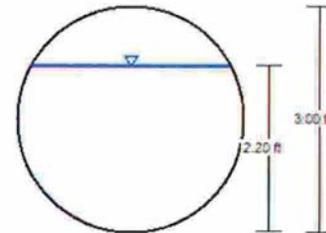
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00750 ft/ft
Normal Depth	2.20 ft
Diameter	3.00 ft
Discharge	51.42 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 2.4 (54" RCP)

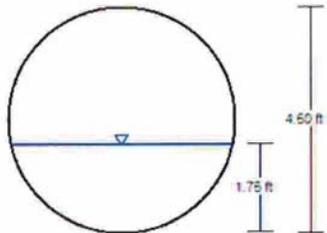
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.75 ft
Diameter	4.50 ft
Discharge	44.54 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 2.5 (30" RCP)

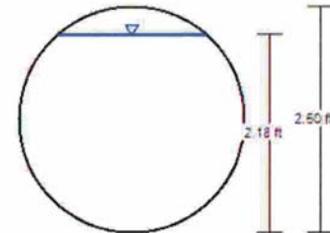
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00550 ft/ft
Normal Depth	2.18 ft
Diameter	2.50 ft
Discharge	31.91 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe 2.5 (42" RCP)

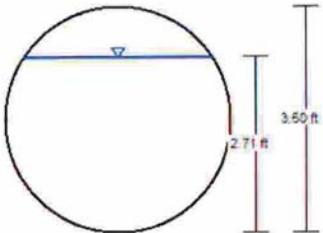
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00750 ft/ft
Normal Depth	2.71 ft
Diameter	3.50 ft
Discharge	82.31 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe W.1 (36" RCP)

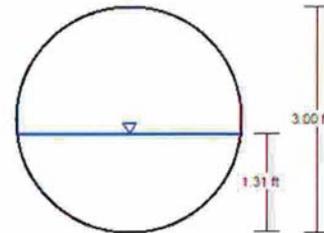
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.31 ft
Diameter	3.00 ft
Discharge	18.73 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe W.1 (42" RCP)

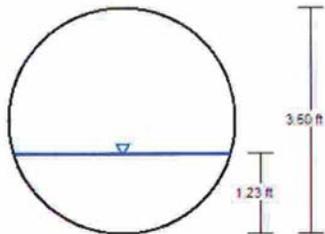
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.23 ft
Diameter	3.50 ft
Discharge	18.73 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe W.2 (36" RCP)

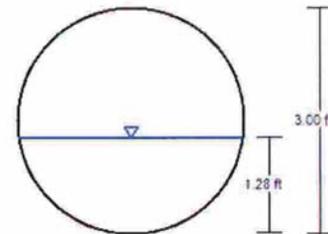
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.28 ft
Diameter	3.00 ft
Discharge	17.83 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe W.3 (54" RCP)

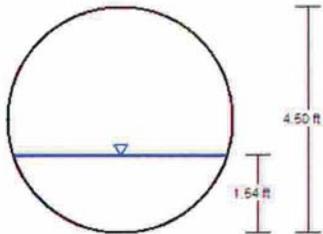
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.54 ft
Diameter	4.50 ft
Discharge	35.10 ft ³ /s

Cross Section Image



V: 1
H: 1

Cross Section for Proposed Pipe W.3 (66" RCP)

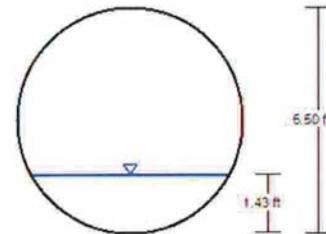
Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

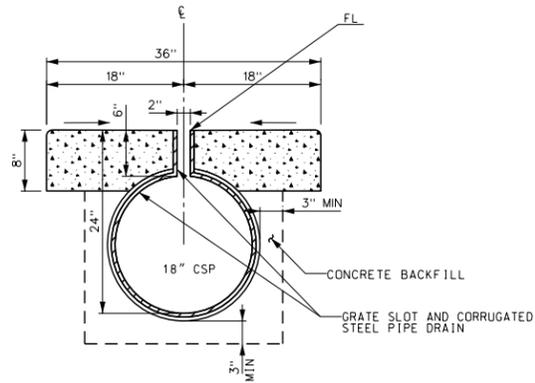
Roughness Coefficient	0.013
Channel Slope	0.00500 ft/ft
Normal Depth	1.43 ft
Diameter	5.50 ft
Discharge	35.10 ft ³ /s

Cross Section Image

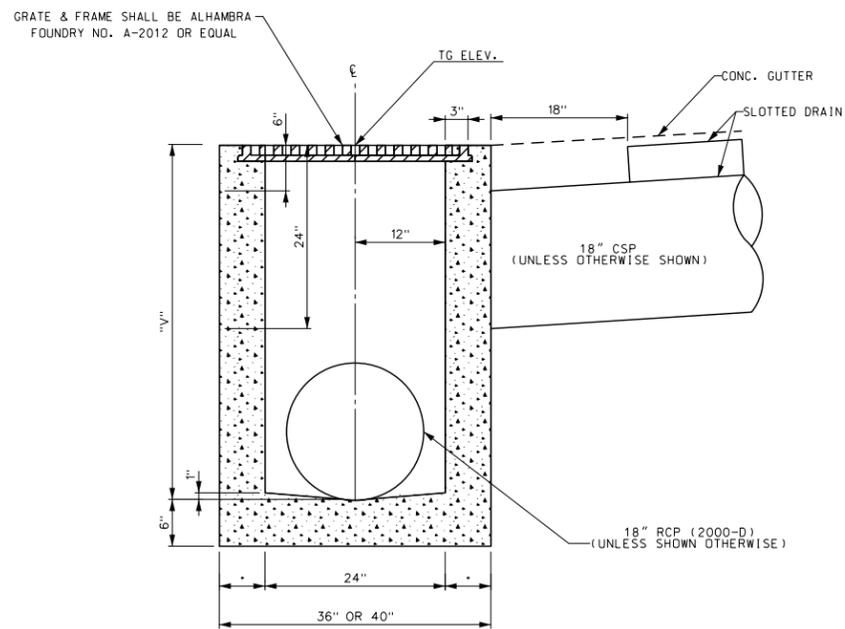


V: 1
H: 1

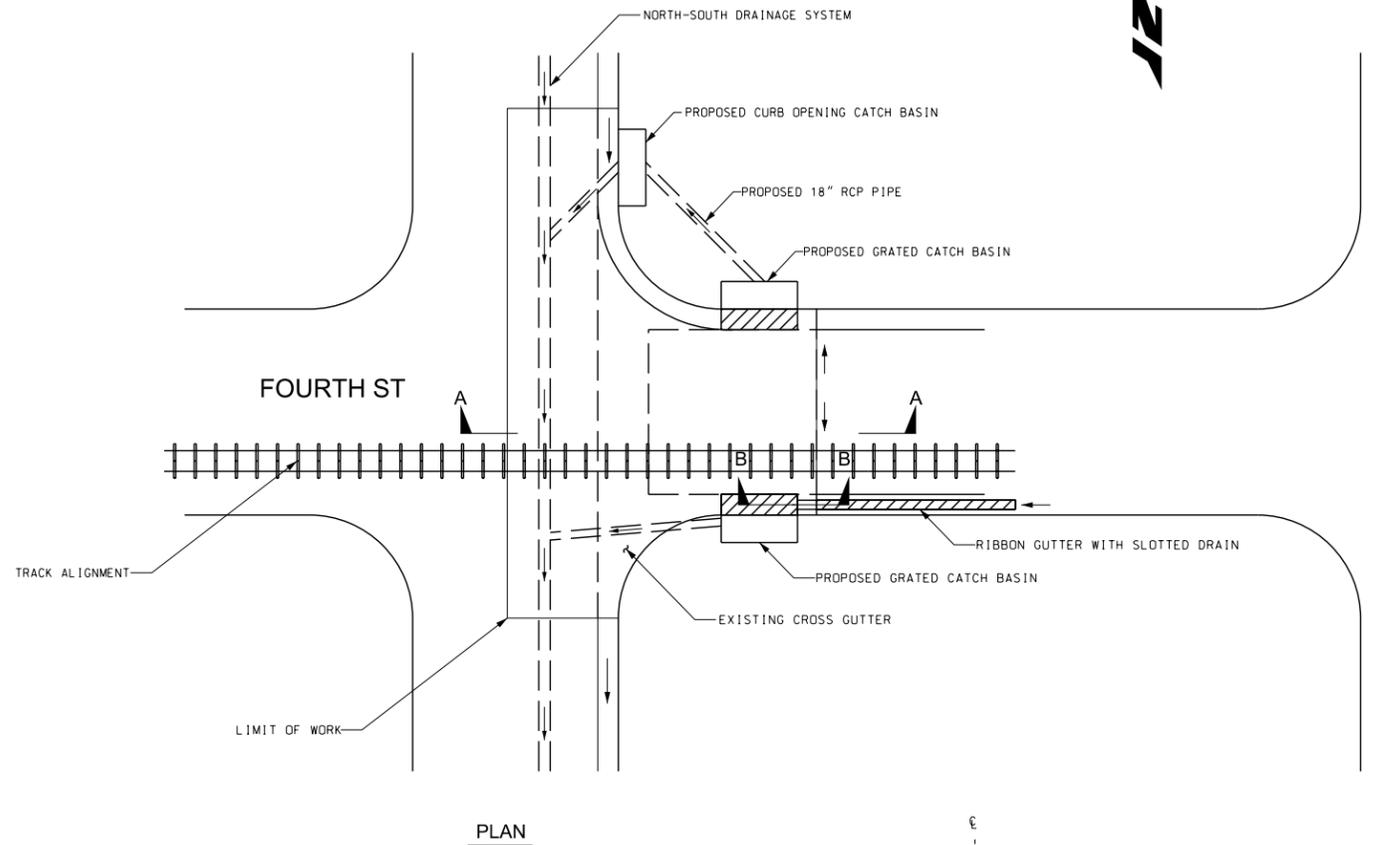
Appendix G:
Drainage Details



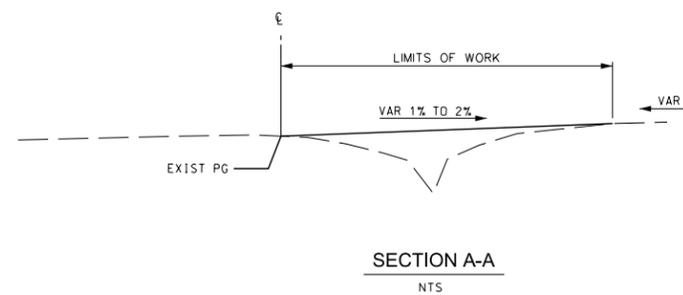
RIBBON GUTTER W/SLOTTED DRAIN
NTS



SECTION B-B
NTS



PLAN



TYPICAL INTERSECTION DETAIL
NTS

REVISIONS			
NUMBER	DATE	DESCRIPTIONS	APPRVD

INFORMATION CONFIDENTIAL:
All plans, drawings, specifications, and or information furnished herewith shall remain the property of City of Santa Ana and shall be held confidential and shall not be used for any purpose not provided for in agreements with City of Santa Ana.

DESIGNED BY
J.GARCIA
DRAWN BY
D.SO
CHECKED BY
R.RAMIREZ
APPROVED BY
R.RAMIREZ
DATE

C **CORDOBA CORPORATION**
2677 NORTH MAIN STREET, SUITE 240
SANTA ANA, CA 92705
714.558.6124 PH - 714.558.8467 FAX

OCTA **Santa Ana Education 1st** **GARDEN GROVE**

CITY OF SANTA ANA AND GARDEN GROVE
FIXED GUIDEWAY CORRIDOR
DRAINAGE DETAIL

CONTRACT NO.	
DRAWING NO. D-003	
REVISION	SHEET NO. 1 OF 1
SCALE	NTS

Appendix H:
Quantity Estimates

Santa Ana Fixed Guideway Project
Drainage Infrastructure Improvements

STREET CAR ALTERNATIVE 1 (Downtown Segment)

Segment SC1-1: Santiago Street to French Street

Item Description	Unit	Quantity
27" RCP	LF	300
60" RCP	LF	2,100
84" RCP	LF	950
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	15

Segment SC1-2: French Street to Broadway

Item Description	Unit	Quantity
36" RCP	LF	1,800
Catch Basin	EA	6
18" RCP (Laterals)	LF	200
Manholes/Junction Structures	EA	6

Segment SC1-3: Broadway to Ross Street

Item Description	Unit	Quantity
36" RCP	LF	1,200
54" RCP	LF	400
Catch Basin	EA	4
18" RCP (Laterals)	LF	120
Manholes/Junction Structures	EA	5

Santa Ana Fixed Guideway Project
Drainage Infrastructure Improvements

STREET CAR ALTERNATIVE 2 (Downtown Segment)

Segment SC2-1: Santiago Street to French Street		
Item Description	Unit	Quantity
30" RCP	LF	1,200
36" RCP	LF	600
84" RCP	LF	1,000
Catch Basin	EA	15
18" RCP (Laterals)	LF	375
Manholes/Junction Structures	EA	18

Segment SC2-2: French Street to Broadway		
Item Description	Unit	Quantity
36" RCP	LF	2,000
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	15

Segment SC2-3: Broadway to Ross Street		
Item Description	Unit	Quantity
54" RCP	LF	1,200
Catch Basin	EA	2
18" RCP (Laterals)	LF	60
Manholes/Junction Structures	EA	4

Segment SC2-4: Ross Street to Flower Street		
Item Description	Unit	Quantity
36" RCP	LF	900
42" RCP	LF	1,900
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	12

Santa Ana Fixed Guideway Project
Drainage Infrastructure Improvements

STREET CAR ALTERNATIVES 1 & 2 (Raitt to Flower Segment)

Segment W-1: Flower Street to Shelton		
Item Description	Unit	Quantity
36" RCP	LF	700
42" RCP	LF	400
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	13

Segment W-2: Shelton to Bristol Street		
Item Description	Unit	Quantity
36" RCP	LF	1,000
Catch Basin	EA	3
18" RCP (Laterals)	LF	100
Manholes/Junction Structures	EA	6

Segment W-3: Bristol Street to Raitt Street		
Item Description	Unit	Quantity
42" RCP	LF	2,200
66" RCP	LF	900
Catch Basin	EA	6
18" RCP (Laterals)	LF	200
Manholes/Junction Structures	EA	14

Segment W-4: Raitt Street to Santa Ana River		
Item Description	Unit	Quantity
36" RCP	LF	2,250
42" RCP	LF	2,250
Catch Basin	EA	25
18" RCP (Laterals)	LF	800
Manholes/Junction Structures	EA	35

Segment W-5: Santa Ana River to Harbor Boulevard		
Item Description	Unit	Quantity
36" RCP	LF	2,100
42" RCP	LF	2,100
Catch Basin	EA	25
18" RCP (Laterals)	LF	800
Manholes/Junction Structures	EA	35

Appendix C:
Storm Water Data Report

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STORM WATER DATA REPORT

in support of the

SANTA ANA AND GARDEN GROVE FIXED GUIDEWAY CORRIDOR STUDY

Santa Ana Regional Transportation Center (SARTC) to Harbor Boulevard

Prepared for

City of Santa Ana

in cooperation with

City of Garden Grove

Orange County Transportation Authority



Prepared by
Cordoba Corporation
2677 North Main Street, Suite 240
Santa Ana, CA 92705

July 12, 2011

STORM WATER DATA INFORMATION

1. Project Description

The cities of Santa Ana and Garden Grove are considering a fixed guideway project that would provide high frequency transit service between the Santa Ana Regional Transportation Center (SARTC) and a new multi-modal transportation center in the city of Garden Grove. A “fixed guideway” refers to any transit service that uses exclusive or controlled rights-of-way or rails. The proposed project alignments travel along a major east-west corridor through central Orange County, providing access to Santa Ana’s downtown area and the Santa Ana Civic Center where city, county, state and federal government offices and courthouses are located. It will connect the historic and densely populated neighborhoods east and west of the Downtown and Civic Center with employment and educational opportunities, and goods and services, and will also provide access to several redeveloping, transit-oriented areas within both cities. The major engineering features for the Project include:

- Trackwork
- Infrastructure Improvements
 - Utilities (Water, Sewer)
 - Roadway
 - Drainage
- Structural
- Urban Design (Stations)
- Maintenance Facilities
- Systems

The streetcar alignment runs east/west along Santa Ana Boulevard to Raitt Street and then continues onto the PE ROW across the Santa Ana River to Harbor Blvd/Westminster Ave into the City of Garden Grove. Streetcars would operate in mixed flow traffic on tracks embedded within existing city streets, except for the Pacific Electric Right-of-Way (PE ROW) segment where streetcars would operate on tracks dedicated exclusively for streetcar use.

The total disturbed area is approximately 5.56 acres. This area was calculated by tabulating areas of the streets where the street car alignment will run and the areas maintenance facilities. An acquisition of approximately 2.2 acres of right-of-way will be necessary to construct the maintenance facilities for the proposed street cars.

The project’s impervious area, before and after the proposed improvements, will not change because the project limits are within the existing roadway envelope and no street widening will be required.

2. Site Data and Storm Water Quality Design Issues (refer to Checklists SW-1, SW-2, and SW-3)

The proposed fixed guideway project is located in Santa Ana River watershed and Water Quality Control Board Region 8. Stormwater runoff from the development area will be conveyed through a series of existing and proposed drainage main lines pipes which will drain to the Orange County storm flow facilities Santa Ana Delhi Channel (F01) and Santa Ana Gardens Channel (F02) to finally drain to Upper Newport Bay which is located in the San Diego Creek Watershed. The outfall to the Orange county channels (F01 and F02) is located outside the project limit.

Total Maximum daily Loads (TMDL's) have been established for 303 (d) listed Santa Ana Region 8 at Upper Newport Bay presents the following pollutant of concerns:

<i>Pollutant</i>	<i>Potential Source</i>
Chlordane	Unknown
Copper	Unknown
DDT	Unknown
Metals	Urban Runoff / Storm Sewers
PCBs (Polychlorinated biphenyls)	Unknown
Sediment Toxicity	Unknown

The Santa Ana fixed guideway project will require Section 401 Certification because of the proposed re-construction of a bridge crossing over the Santa Ana River.

Santa Ana River watershed is completely developed. Land uses consist of industrial, residential, and commercial. Since the project does not encompass any City of Santa Ana or Orange County domestic water supply reservoirs, including domestic groundwater percolation facilities, direct discharge of runoff into high risk facilities is not possible in the event of spill.

Soil stabilization and sediment control shall be provided by the contractor as defined in the Storm Water Pollution Prevention Plan and the Water Pollution Control throughout construction and especially during the rainy season of October 1 to May 1.

RWQCB Special Requirements / Concerns (SW-2, Question 4)

Total maximum daily Loads (TMDL's) for toxic Pollutants at San Diego Creek and Newport Bay were established by U.S Environmental Protection Agency (EPA). Please see attached report where you can obtain data such as numeric targets, loading capacity and TMDL's.

Project Design Considerations:

Climate

Santa Ana experiences a Mediterranean climate, with mild, wet winters and the dry, warm sunny weather in summer. Precipitation ranges varies from 0.04 to 3.19 in. A major portion of the precipitation occurs between December (1.77 in.) and March (2.80 in.). December and August are respectively the coldest and the warmest months of the year. Rainfall Intensity curves for frequencies of 10 and 25 years were used to calculate the project's Q25. The average annual rainfall in the project area is approximately 13.9 in., most of which occurs during the winter period between December and March.

Soil

No geotechnical report has been prepared at this phase of the project. However, as per describe in the Orange County Hydrology Manual we can state that soils have a moderate infiltration rate when thoroughly wet. These consist mainly moderate deep or deep, moderate well-drained or well-drained soils that have moderate fine texture to moderate coarse texture. These soils have a moderate rate of water transmission and typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures In summary, per Natural Resources Conservation Service (NCRS) the project soil's is classified in the Hydrologic Soil Group (HSG) of "B"

Topography

The topography within the project limits is generally flat, sloping from northeast to southwest at approximately a 0.5 percent grade.

Ground Water

The occurrence of groundwater in the Santa Ana River watershed is highly controlled by the geology of the area, both the configuration of bedrock and by the extensive geologic faults. Most groundwater basins are unconfined, much like a bowl full of sand that has water poured in. However, the variable depth to bedrock, variations in geologic layers, and the presence of faults cause pressure zones where water flows toward (or to) the ground surface. In general, groundwater flows the same direction as surface water: from the mountains in the east/north to the Pacific Ocean in the west.

The project soil's erodibility has yet to be determined. The soils information and depth of groundwater within the project area will be provided when a comprehensive geotechnical report with borings and hydrological report are completed during initial phase of PS&E.

Risk Level

The risk level determination is based on the methodology as provided in Appendix 1 of the NPDES California General Permit Order No. 2009-0009-DWQ. The project combined

risk level was determined as Level 1 based on “Low” sediment risk level and “Low” receiving water risk level.

3. Regional Water Quality Control Board Agreements

The District/Regional NPDES coordinator shall furnish further information on any agreements. However, this project shall conform to NPDES California General Permit Order No. 2009-0009-DWQ. A Notice of Intent (NOI) shall be required for submittal 30 days prior to start of construction.

4. Proposed Design Pollution Prevention BMPs to be used on the Project.

Downstream Effects Related to Potentially Increased Flow, Checklist DPP-1, Parts 1 and 2

- The proposed fixed guideway project will not create a major increase in the velocity of downstream flow. However, the construction of catch basins and new RCP pipes will increase the amount of runoff in the existing storm water system and may cause other hydraulic changes that are not likely to affect the downstream channels Santa Ana Delhi Channel and Santa Ana Gardens Channel stability. The existing outfalls are located outside the project limits.

Slope/Surface Protection Systems, Checklist DPP-1, Parts 1 and 3

- The project will not create significant changes to the existing slopes and will try to maintain the existing slope conditions. Proposed hard surfaces include roadway resurfacing, ramps, and sidewalk.

Concentrated Flow Conveyance Systems, Checklist DPP-1, Parts 1 and 4

- Catch basins are proposed at street intersections to eliminate cross gutters and/or parkway culverts over the streetcar tracks. Some intersections will require reconstruction to eliminate cross gutters and provide for a smoother streetcar profile.
- On-site and minimal off-site runoff is being conveyed with proposed catch basins and new or upgraded underground drainage system.
- Drainage facilities shall be designed with appropriate approved materials to maintain the highest water quality

Preservation of Existing Vegetation, Checklist DPP-1, Parts 1 and 5

- The project limits are mostly within existing roadway limits. Existing vegetation which includes trees and grass areas will be preserved.
- Environmentally Sensitive Areas (ESA) have not been identified for this Project.

5. Proposed Permanent Treatment BMPs to be used on the Project

Treatment BMP Strategy, Checklist T-1

- As noted in Section 2, No TMDL's have been established for the Santa Ana River watershed. However, the selection of BMPs capable of remove the project's identified pollutant of concern (pathogens) will be necessary at the next phase of the project.

Biofiltration Swales/Strips, Checklist T-1, Parts 1 and 2

- Biofiltration swales and strips areas will be constructed in the PEROW segment to remove pollutants from stormwater runoff as it flows through the vegetation. Runoff will be captured in drain inlets and routed to the swales, while strips receive sheet flow directly from the pavement. Swales are conveyance channels where stormwater flow passes through the grass. Strips are broad surfaces with a grass cover that allows stormwater to flow in relatively thin sheets

Dry Weather Diversion, Checklist T-1, Parts 1 and 3

- Dry weather diversion BMPs are not incorporated into the project because flows are not anticipated to be persistent.

Infiltration Devices – Checklist T-1, Parts 1 and 4

- At this phase of the project there is no sufficient data to determine if the construction of an infiltration device is feasible. A comprehensive geotechnical report will be necessary to obtain information such a water table depth and soil infiltration rate.

Detention Devices, Checklist T-1, Parts 1 and 5

- At this phase of the project there is no sufficient data to determine if the construction of a detention device is feasible. A comprehensive geotechnical report will be necessary to obtain information such a water table depth and soil infiltration rate

Gross Solids Removal Devices (GSRDs), Checklist T-1, Parts 1 and 6

- GSRDs will not be incorporated into project. Gross solids will not be created at this project. Santa Ana watershed in not on a 303(d) list for trash and Total Maximum Daily Loads (TMDLs) for trash has not been established

Traction Sand Traps, Checklist T-1, Parts 1 and 7

- Traction Sand Traps will not be incorporated into project. Traction Sand or an abrasive will not be applied to paved roadway.

Media Filters, Checklist T-1, Parts 1 and 8

- Austin San Filter will be installed within the PEROW segment to removed pollutants from storm water runoff. The sand filter has a removal efficiency of 70 to 90 percent, which is similar to the removal efficiency for wet and dry detention basins. The sand filter is ideal for Southern California because it does not require vegetation and requires less space than other BMPs with similar removal efficiencies when a partial treatment sedimentation basin is used

Multi-Chambered Treatment Trains (MCTTs), Checklist T-1, Parts 1 and 9

- MCTTs are not recommended as a treatment BMP because in this specific case a “critical source area” as define by Project Planning and Design Guide (PPDG) is not being served. Therefore these devices will not be placed on this project

Wet Basins, Checklist T-1, Parts 1 and 10

- Wet basins are not feasible because a natural permanent water source does not exist. Therefore these devices will not be placed on this project

6. Proposed Temporary Construction Site BMPs to be used on Project

During construction the contractor will be required to implement several temporary site BMPs to limit soil erosion, control dust, and maintain the highest water quality runoff. The following is general list of required temporary BMPs:

- At all construction entrances the contractor will provide construction stabilized entrances / exit (TC-1).
- Regular Street and vacuuming (SC-7) will be required on paved surfaces.
- Management of all stock piles (WM-3)
- Wind and water erosion (WE-1)
- Concrete wastes (WM-8) with concrete washout.
- All catch basins and drainage inlets will include gravel bag berms or storm drain inlet protection (SC-10).
- For all construction equipment, fuels, and toxic chemicals spill prevention and spill control measures will be implemented before construction begins (WM-4).

BMPs shall be as defined in the approved Storm Water Pollution Prevention Plan (SWPPP). Additional items will be identified at the final phase of the project; dewatering is not expected for this Project.

Costs for construction site BMPs shall be determined at the preliminary phase of the Project.

7. Maintenance BMPs (Drain Inlet Stenciling)

Drain Inlet stencil will be required within the city limits of Santa Ana and Garden Grove. In such cases, the contractor will use the city's standards stenciling types unless otherwise informed by the proper city agent.

Required Attachments

- Vicinity Map
- Evaluation Documentation Form (EDF)

Supplemental Attachments

- Storm Water Checklist SW-1, Site Data Sources
- Storm Water Checklist SW-2, Storm Water Quality Issues Summary
- Storm Water Checklist SW-3, Measures for Avoiding or Reducing Potential Storm Water BMPs
- Checklist DPP-1, Parts 1-5 (Design Pollution Prevention BMPs)
- Checklist T-1, Parts 1-10 (Treatment BMPs)
- Checklist CS-1, Parts 1-6 (Construction Site BMPs)

DATE: 07/12/11

Project: Santa Ana Fixed Guideway

NO.	CRITERIA	YES ✓	NO ✓	SUPPLEMENTAL INFORMATION FOR EVALUATION
1.	Begin Project Evaluation regarding requirement for consideration of Treatment BMPs	✓		See Figure 4-1, Project Evaluation Process for Consideration of Permanent Treatment BMPs. Go to 2
2.	Is this an emergency project?		✓	If Yes , go to 10. If No , continue to 3.
3.	Have TMDLs or other Pollution Control Requirements been established for surface waters within the project limits? Information provided in the water quality assessment or equivalent document.		✓	If Yes , contact the District/Regional NPDES Coordinator to discuss the Department's obligations under the TMDL (if Applicable) or Pollution Control Requirements, go to 9 or 4. _____ (Dist./Reg. SW Coordinator initials) If No , continue to 4.
4.	Is the project located within an area of a local MS4 Permittee?	✓		If Yes . <i>City of santa Ana</i> , go to 5. If No , document in SWDR go to 5.
5.	Is the project directly or indirectly discharging to surface waters?	✓		If Yes , continue to 6. If No , go to 10.
6.	Is it a new facility or major reconstruction?	✓		If Yes , continue to 8. If No , go to 7.
7.	Will there be a change in line/grade or hydraulic capacity?	✓		If Yes , continue to 8. If No , go to 10.
8.	Does the project result in a <u>net increase of one acre or more of new impervious surface</u> ?	✓		If Yes , continue to 9. If No , go to 10. _5.56 Ac
9.	Project is required to consider approved Treatment BMPs.	✓		See Sections 2.4 and either Section 5.5 or 6.5 for BMP Evaluation and Selection Process. Complete Checklist T-1 in this Appendix E.
10.	Project is not required to consider Treatment BMPs. _____(Dist./Reg. Design SW Coord. Initials) _____(Project Engineer Initials) _____(Date)			Document for Project Files by completing this form, and attaching it to the SWDR.

See Figure 4-1, Project Evaluation Process for Consideration of Permanent Treatment BMPs

DATE: 07/12/11

Project: Santa Ana Fixed Guideway

Project Evaluation Process for the Consideration of Construction Site BMPs

NO.	CRITERIA	YES ✓	NO ✓	SUPPLEMENTAL INFORMATION
1.	Will construction of the project result in areas of disturbed soil as defined by the Project Planning and Design Guide (PPDG)?		✓	If Yes, Construction Site BMPs for Soil Stabilization (SS) will be required. Complete CS-1, Part 1. Continue to 2. If No, Continue to 3.
2.	Is there a potential for disturbed soil areas within the project to discharge to storm drain inlets, drainage ditches, areas outside the right-of-way, etc?	✓		If Yes, Construction Site BMPs for Sediment Control (SC) will be required. Complete CS-1, Part 2. Continue to 3.
3.	Is there a potential for sediment or construction related materials and wastes to be tracked offsite and deposited on private or public paved roads by construction vehicles and equipment?	✓		If Yes, Construction Site BMPs for Tracking Control (TC) will be required. Complete CS-1, Part 3. Continue to 4.
4.	Is there a potential for wind to transport soil and dust offsite during the period of construction?	✓		If Yes, Construction Site BMPs for Wind Erosion Control (WE) will be required. Complete CS-1, Part 4. Continue to 5.
5.	Is dewatering anticipated or will construction activities occur within or adjacent to a live channel or stream?		✓	If Yes, Construction Site BMPs for Non-Storm Water Management (NS) will be required. Complete CS-1, Part 5. Continue to 6.
6.	Will construction include saw-cutting, grinding, drilling, concrete or mortar mixing, hydro-demolition, blasting, sandblasting, painting, paving, or other activities that produce residues?	✓		If Yes, Construction Site BMPs for Non-Storm Water Management (NS) will be required. Complete CS-1, Parts 5 & 6. Continue to 7.
7.	Are stockpiles of soil, construction related materials, and/or wastes anticipated?	✓		If Yes, Construction Site BMPs for Waste Management and Materials Pollution Control (WM) will be required. Complete CS-1, Part 6. Continue to 8.
8.	Is there a potential for construction related materials and wastes to have direct contact with precipitation; stormwater run-on, or stormwater runoff; be dispersed by wind; be dumped and/or spilled into storm drain systems?	✓		If Yes, Construction Site BMPs for Waste Management and Materials Pollution Control (WM) will be required. Complete CS-1, Part 6. Continue to 9.
9.	End of checklist.			Document for Project Files by completing this form, and attaching it to the SWDR.

PE to initialize after concurrence with Construction (PS&E only) Date

Checklist SW-1, Site Data Sources

Prepared by: Roberto Ramirez PE Date: July 12, 2011 County: Orange

PM : _____ Project SAFG RWQCB: Santa Ana (Region 8)

Information for the following data categories should be obtained, reviewed and referenced as necessary throughout the project planning phase. Collect any available documents pertaining to the category and list them and reference your data source. For specific examples of documents within these categories, refer to Section 5.5 of this document. Example categories have been listed below; add additional categories, as needed. Summarize pertinent information in Section 2 of the SWDR.

DATA CATEGORY/SOURCES	Date
Topographic	
<ul style="list-style-type: none"> City of Santa Ana Master Plan of Drainage 	May, 1994
<ul style="list-style-type: none"> City of Santa Ana Transit Zoning Code (SD 84A and SD 84B) EIR 	February 2010
<ul style="list-style-type: none"> 	
Hydraulic	
<ul style="list-style-type: none"> City of Santa Ana Master Plan of Drainage 	May, 1994
<ul style="list-style-type: none"> City of Santa Ana Transit Zoning Code (SD 84A and SD 84B) EIR 	February 2010
<ul style="list-style-type: none"> 	
Soils	
<ul style="list-style-type: none"> Orange County Hydrology Manual 	October, 1986
<ul style="list-style-type: none"> 	
<ul style="list-style-type: none"> 	
Climatic	
<ul style="list-style-type: none"> City of Santa Ana Master Plan of Drainage 	May, 1994
<ul style="list-style-type: none"> US climate data (www.usclimatedata.com) 	
<ul style="list-style-type: none"> 	
Water Quality	
<ul style="list-style-type: none"> California Environmental Protection Agency www.swrcb.ca.gov (Region 8), Santa Ana River 	
<ul style="list-style-type: none"> City of Santa Ana Transit Zoning Code (SD 84A and SD 84B) EIR 	February 2010
<ul style="list-style-type: none"> 	
Other Data Categories	
<ul style="list-style-type: none"> Ground water: http://www.ocwd.com/Santa-Ana-Watershed/ca-29.aspx 	
<ul style="list-style-type: none"> 	
<ul style="list-style-type: none"> 	

Checklist SW-2, Storm Water Quality Issues Summary

Prepared by: Roberto Ramirez PE Date: July 12, 2011 County: Orange

PM : _____ Project SAFG RWQCB: Santa Ana (Region 8)

The following questions provide a guide to collecting critical information relevant to project stormwater quality issues. Complete responses to applicable questions, consulting other Caltrans functional units (Environmental, Landscape Architecture, Maintenance, etc.) and the District/Regional Storm Water Coordinator as necessary. Summarize pertinent responses in Section 2 of the SWDR.

- | | | |
|--|--|--|
| 1. Determine the receiving waters that may be affected by the project throughout the project life cycle (i.e., construction, maintenance and operation). | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 2. For the project limits, list the 303(d) impaired receiving water bodies and their constituents of concern. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 3. Determine if there are any municipal or domestic water supply reservoirs or groundwater percolation facilities within the project limits. Consider appropriate spill contamination and spill prevention control measures for these new areas. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 4. Determine the RWQCB special requirements, including TMDLs, effluent limits, etc. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 5. Determine regulatory agencies seasonal construction and construction exclusion dates or restrictions required by federal, state, or local agencies. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 6. Determine if a 401 certification will be required. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 7. List rainy season dates. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 8. Determine the general climate of the project area. Identify annual rainfall and rainfall intensity curves. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 9. If considering Treatment BMPs, determine the soil classification, permeability, erodibility, and depth to groundwater. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 10. Determine contaminated soils within the project area. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 11. Determine the total disturbed soil area of the project. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 12. Describe the topography of the project site. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 13. List any areas outside of the Caltrans right-of-way that will be included in the project (e.g. contractor's staging yard, work from barges, easements for staging, etc.). | <input type="checkbox"/> Complete | <input checked="" type="checkbox"/> NA |
| 14. Determine if additional right-of-way acquisition or easements and right-of-entry will be required for design, construction and maintenance of BMPs. If so, how much? | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 15. Determine if a right-of-way certification is required. | <input type="checkbox"/> Complete | <input checked="" type="checkbox"/> NA |
| 16. Determine the estimated unit costs for right-of-way should it be needed for Treatment BMPs, stabilized conveyance systems, lay-back slopes, or interception ditches. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 17. Determine if project area has any slope stabilization concerns. | <input type="checkbox"/> Complete | <input checked="" type="checkbox"/> NA |
| 18. Describe the local land use within the project area and adjacent areas. | <input checked="" type="checkbox"/> Complete | <input type="checkbox"/> NA |
| 19. Evaluate the presence of dry weather flow. | <input type="checkbox"/> Complete | <input checked="" type="checkbox"/> NA |

Checklist SW-3, Measures for Avoiding or Reducing Potential Storm Water Impacts

Prepared by: Roberto Ramirez PE Date: July 12, 2011 County: Orange

PM : _____ Project ID (or EA): SAFG RWQCB: Santa Ana (Region 8)

The PE must confer with other functional units, such as Landscape Architecture, Hydraulics, Environmental, Materials, Construction and Maintenance, as needed to assess these issues. Summarize pertinent responses in Section 2 of the SWDR.

Options for avoiding or reducing potential impacts during project planning include the following:

1. Can the project be relocated or realigned to avoid/reduce impacts to receiving waters or to increase the preservation of critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soil conditions? Yes No NA

2. Can structures and bridges be designed or located to reduce work in live streams and minimize construction impacts? Yes No NA

3. Can any of the following methods be utilized to minimize erosion from slopes:
 - a. Disturbing existing slopes only when necessary? Yes No NA
 - b. Minimizing cut and fill areas to reduce slope lengths? Yes No NA
 - c. Incorporating retaining walls to reduce steepness of slopes or to shorten slopes? Yes No NA
 - d. Acquiring right-of-way easements (such as grading easements) to reduce steepness of slopes? Yes No NA
 - e. Avoiding soils or formations that will be particularly difficult to re-stabilize? Yes No NA
 - f. Providing cut and fill slopes flat enough to allow re-vegetation and limit erosion to pre-construction rates? Yes No NA
 - g. Providing benches or terraces on high cut and fill slopes to reduce concentration of flows? Yes No NA
 - h. Rounding and shaping slopes to reduce concentrated flow? Yes No NA
 - i. Collecting concentrated flows in stabilized drains and channels? Yes No NA

4. Does the project design allow for the ease of maintaining all BMPs? Yes No

5. Can the project be scheduled or phased to minimize soil-disturbing work during the rainy season? Yes No

6. Can permanent storm water pollution controls such as paved slopes, vegetated slopes, basins, and conveyance systems be installed early in the construction process to provide additional protection and to possibly utilize them in addressing construction storm water impacts? Yes No NA

Design Pollution Prevention BMPs		
Checklist DPP-1, Part 1		
Prepared by: <u>Roberto Ramirez PE</u>	Date: <u>July 12, 2011</u>	County: <u>Orange</u>
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: <u>Santa Ana (Region 8)</u>

Consideration of Design Pollution Prevention BMPs

Consideration of Downstream Effects Related to Potentially Increased Flow [to streams or channels]

- Will project increase velocity or volume of downstream flow? Yes No NA
- Will the project discharge to unlined channels? Yes No NA
- Will project increase potential sediment load of downstream flow? Yes No NA
- Will project encroach, cross, realign, or cause other hydraulic changes to a stream that may affect downstream channel stability? Yes No NA

If Yes was answered to any of the above questions, consider **Downstream Effects Related to Potentially Increased Flow**, complete the DPP-1, Part 2 checklist.

Slope/Surface Protection Systems

- Will project create new slopes or modify existing slopes? Yes No NA

If Yes was answered to the above question, consider **Slope/Surface Protection Systems**, complete the DPP-1, Part 3 checklist.

Concentrated Flow Conveyance Systems

- Will the project create or modify ditches, dikes, berms, or swales? Yes No NA
- Will project create new slopes or modify existing slopes? Yes No NA
- Will it be necessary to direct or intercept surface runoff? Yes No NA
- Will cross drains be modified? Yes No NA

If Yes was answered to any of the above questions, consider **Concentrated Flow Conveyance Systems**; complete the DPP-1, Part 4 checklist.

Preservation of Existing Vegetation

It is the goal of the Storm Water Program to maximize the protection of desirable existing vegetation to provide erosion and sediment control benefits on all projects. Complete

Consider **Preservation of Existing Vegetation**, complete the DPP-1, Part 5 checklist.

Design Pollution Prevention BMPs

Checklist DPP-1, Part 2

Prepared by: Roberto Ramirez PE Date: July 12, 2011 District-Co-Route: Orange

PM : _____ Project ID (or EA): SAFG RWQCB: Santa Ana (Region 8)

Downstream Effects Related to Potentially Increased Flow

- 1. Review total paved area and reduce to the maximum extent practicable. Complete
- 2. Review channel lining materials and design for stream bank erosion control. Complete
 - (a) See Chapters 860 and 870 of the HDM. Complete
 - (b) Consider channel erosion control measures within the project limits as well as downstream. Consider scour velocity. Complete
- 3. Include, where appropriate, energy dissipation devices at culvert outlets. Complete
- 4. Ensure all transitions between culvert outlets/headwalls/wingwalls and channels are smooth to reduce turbulence and scour. Complete
- 5. Include, if appropriate, peak flow attenuation basins or devices to reduce peak discharges. Complete

Design Pollution Prevention BMPs	
Checklist DPP-1, Part 3 (NOT APPLICABLE)	
Prepared by: <u>Roberto Ramirez PE</u> Date: <u>July 12, 2011</u> District-Co-Route: <u>Orange</u>	
PM : _____ Project ID (or EA): <u>SAFG</u> RWQCB: <u>Santa Ana (Region 8)</u>	

Slope / Surface Protection Systems

1. What are the proposed areas of cut and fill? (attach plan or map) Complete
2. Were benches or terraces provided on high cut and fill slopes to reduce concentration of flows? Yes No
3. Were slopes rounded and/or shaped to reduce concentrated flow? Yes No
4. Were concentrated flows collected in stabilized drains or channels? Yes No
5. Are new or disturbed slopes > 4:1 horizontal:vertical (h:v)? Yes No
 If Yes, District Landscape Architect must prepare or approve an erosion control plan, at the District's discretion.
6. Are new or disturbed slopes > 2:1 (h:v)? Yes No
 If Yes, Geotechnical Services must prepare a Geotechnical Design Report, and the District Landscape Architect should prepare or approve an erosion control plan. Concurrence must be obtained from the District Maintenance Storm Water Coordinator for slopes steeper than 2:1 (h:v).
7. Estimate the net new impervious area that will result from this project. _____ acres Complete

VEGETATED SURFACES

1. Identify existing vegetation. Complete
2. Evaluate site to determine soil types, appropriate vegetation and planting strategies. Complete
3. How long will it take for permanent vegetation to establish? Complete
4. Minimize overland and concentrated flow depths and velocities. Complete

HARD SURFACES

1. Are hard surfaces required? Yes No
 If Yes, document purpose (safety, maintenance, soil stabilization, etc.), types, and general locations of the installations. Complete
- Review appropriate SSPs for Vegetated Surface and Hard Surface Protection Systems. Complete

Design Pollution Prevention BMPs			
Checklist DPP-1, Part 4			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Concentrated Flow Conveyance Systems

Ditches, Berms, Dikes and Swales

- 1. Consider Ditches, Berms, Dikes, and Swales as per Topics 813, 834.3, and 835, and Chapter 860 of the HDM. Complete
- 2. Evaluate risks due to erosion, overtopping, flow backups or washout. Complete
- 3. Consider outlet protection where localized scour is anticipated. Complete
- 4. Examine the site for run-on from off-site sources. Complete
- 5. Consider channel lining when velocities exceed scour velocity for soil. Complete

Overside Drains

- 1. Consider downdrains, as per Index 834.4 of the HDM. Complete
- 2. Consider paved spillways for side slopes flatter than 4:1 h:v. Complete

Flared Culvert End Sections

- 1. Consider flared end sections on culvert inlets and outlets as per Chapter 827 of the HDM. Complete

Outlet Protection/Velocity Dissipation Devices

- 1. Consider outlet protection/velocity dissipation devices at outlets, including cross drains, as per Chapters 827 and 870 of the HDM. Complete

Review appropriate SSPs for Concentrated Flow Conveyance Systems. Complete

Design Pollution Prevention BMPs	
Checklist DPP-1, Part 5	
Prepared by: <u>Roberto Ramirez PE</u>	Date: <u>July 12, 2011</u> District-Co-Route: <u>Orange</u>
PM : _____	Project ID (or EA): <u>SAFG</u> RWQCB: <u>Santa Ana (Region 8)</u>

Preservation of Existing Vegetation

1. Review Preservation of Property, Standard Specifications 16.1.01 and 16-1.02 (Clearing and Grubbing) to reduce clearing and grubbing and maximize preservation of existing vegetation. Complete

2. Has all vegetation to be retained been coordinated with Environmental, and identified and defined in the contract plans? Yes No

3. Have steps been taken to minimize disturbed areas, such as locating temporary roadways to avoid stands of trees and shrubs and to follow existing contours to reduce cutting and filling? Complete

4. Have impacts to preserved vegetation been considered while work is occurring in disturbed areas? Yes No

5. Are all areas to be preserved delineated on the plans? Yes No

Treatment BMPs			
Checklist T-1, Part 1			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Consideration of Treatment BMPs

This checklist is used for projects that require the consideration of Approved Treatment BMPs, as determined from the process described in Section 4 (Project Treatment Consideration) and the Evaluation Documentation Form (EDF). This checklist will be used to determine which Treatment BMPs should be considered for each watershed and sub-watershed within the project. Supplemental data will be needed to verify siting and design applicability for final incorporation into a project.

Complete this checklist for each phase of the project, when considering Treatment BMPs. Use the responses to the questions as the basis when developing the narrative in Section 5 of the Storm Water Data Report to document that Treatment BMPs have been appropriately considered.

Answer all questions, unless otherwise directed. Questions 14 through 16 should be answered after all subwatershed (drainages) are considered using this checklist.

1. Is the project in a watershed with prescriptive TMDL treatment BMP requirements in an adopted TMDL implementation plan? Yes No

If Yes, consult the District/Regional Storm Water Coordinator to determine whether the T-1 checklist should be used to propose alternative BMPs because the prescribed BMPs may not be feasible or other BMPs may be more cost-effective. Special documentation and regulatory response may be necessary.

2. Dry Weather Flow Diversion

- (a) Are dry weather flows generated by Caltrans anticipated to be persistent? Yes No

- (b) Is a sanitary sewer located on or near the site? Yes No

If Yes to both 2 (a) and (b), continue to (c). If No to either, skip to question 3.

- (c) Is connection to the sanitary sewer possible without extraordinary plumbing, features or construction practices? Yes No

- (d) Is the domestic wastewater treatment authority willing to accept flow? Yes No

If Yes was answered to all of these questions consider **Dry Weather Flow Diversion**, complete and attach **Part 3** of this checklist

3. Is the receiving water on the 303(d) list for litter/trash or has a TMDL been issued for litter/trash? Yes No

If Yes, consider **Gross Solids Removal Devices (GSRDs)**, complete and attach **Part 6** of this checklist. Note: Infiltration Devices, Detention Devices, Media Filters, MCTTs, and Wet Basins also can capture litter. Before considering GSRDs for stand-alone installation or in sequence with other BMPs, consult with District/Regional NPDES Storm Water Coordinator to determine whether Infiltration Devices, Detention Devices, Media Filters, MCTTs, and Wet Basins should be considered instead of GSRDs to meet litter/trash TMDL.

4. Is project located in an area (e.g., mountain regions) where traction sand is applied more than twice a year? Yes No

If Yes, consider **Traction Sand Traps**, complete and attach **Part 7** of this checklist.

5. Maximizing Biofiltration Strips and Swales

Objectives:

- 1) Quantify infiltration from biofiltration alone
- 2) Identify highly infiltrating biofiltration (i.e. > 90%) and skip further BMP consideration.
- 3) Identify whether amendments can substantially improve infiltration.

- (a) Have biofiltration strips and swales been designed for runoff from all project areas, including sheet flow and concentrated flow conveyance? If no, document justification in Section 5 of the SWDR. Yes No

(b) Based on site conditions, estimate what percentage of the WQV¹ can be infiltrated. When calculating the WQV, use a 12-hour drawdown for Type A and B soils, a 24-hour drawdown for Type C soils, and a 48-hour drawdown for Type D soils.

- X < 20% Complete
- 20 % - 50%
- 50% - 90%
- > 90%

- (c) Is infiltration greater than 90 percent? If Yes, skip to question 13. Yes No

¹ A complete methodology for determining WQV infiltration is available at: <http://www.dot.ca.gov/hq/oppd/stormwtr/index.htm>

(d) Can the infiltration ranking in question 5(b) above be increased by using soil amendments? Use the 'drain time' associated with the amended soil (the 12-hour WQV for Type A and B soils, the 24-hour WQV for Type C soils²). Yes No

If Yes, consider including soil amendments; increasing the infiltration ranking allows more flexibility in the selection of BMPs (strips and swales will show performance comparable to other BMPs). Record the new infiltration estimate below:

- < 20% (skip to 6)
- 20 % - 50% (skip to 6) Complete
- 50% - 90% (skip to 6)
- >90%

(e) Is infiltration greater than 90 percent? If Yes, skip to question 13. Yes No

6. Biofiltration in Rural Areas

Is the project in a rural area (outside of urban areas that is covered under an NDPES Municipal Stormwater Permit³). If Yes proceed to question 13. Yes No

7. Estimating Infiltration for BMP Combinations

Objectives:

- 1) Identify high-infiltration biofiltration or biofiltration and infiltration BMP combinations and skip further BMP consideration.
- 2) If high infiltration is infeasible, then identify the infiltration level of all feasible BMP combinations for use in the subsequent BMP selection matrices

(a) Has concentrated infiltration (i.e., via earthen basins or earthen filters) been prohibited? Consult your District/Regional Storm Water Coordinator and/or environmental documents. Yes No

If No proceed to 7 (b); if Yes skip to question 8 and do not consider earthen basin-type BMPs

² Type D soils are not expected where amendments are incorporated

³ See pages 39 and 40 of the Fact Sheets for the CGP.
http://www.waterboards.ca.gov/water_issues/programs/stormwater/docs/constpermits/wqo_2009_0009_factsheet.pdf

- (b) Assess infiltration of an infiltration BMP that is used in conjunction with biofiltration. Include infiltration losses from biofiltration, if biofiltration is feasible. Complete

(use 24 hr WQV)

- < 20% (do not consider this BMP combination)
 20% - 50%
 50% - 90%
 >90%

Is at least 90 percent infiltration estimated? If Yes proceed to 13. If No proceed to 7(c). Yes No

- (c) Assess infiltration of biofiltration with combinations with remaining approved earthen BMPs using water quality volumes based on the drain time of those BMPs. This assessment will be used in subsequent BMP selection matrices.

Earthen Detention Basin
(use 48 hr WQV)

- < 20%
 20% - 50%
 > 50%

Earthen Austin SF
(use 48 hr WQV)

- < 20%
 20% - 50%
 > 50%

Complete

Continue to Question 8

8. Identifying BMPs based on the Target Design Constituents

- (a) Does the project discharge to a water body that has been placed on the 303-d list or has had a TMDL adopted? If "No," use Matrix A to select BMPs, consider designing to treat 100% of the WQV, then skip to question 12. Yes No

If Yes, is the identified pollutant(s) considered a Targeted Design Constituent (TDC) (check all that apply below)?

- | | |
|---|--|
| <input checked="" type="checkbox"/> sediments | <input checked="" type="checkbox"/> copper (dissolved or total) |
| <input type="checkbox"/> phosphorus | <input type="checkbox"/> lead (dissolved or total) |
| <input type="checkbox"/> nitrogen | <input type="checkbox"/> zinc (dissolved or total) |
| | <input checked="" type="checkbox"/> general metals (dissolved or total) ¹ |

- (b) Treating Sediment. Is sediment a TDC? If Yes, use Matrix A to select BMPs, then skip to question 12. Otherwise, proceed to question 9. Yes No

¹ General metals include cadmium, nickel, chromium, and other trace metals. Note that selenium and arsenic are not metals. Mercury is a metal, but is considered later during BMP selection, under Question 12 below.

BMP Selection Matrix A: General Purpose Pollutant Removal			
Consider approaches to treat the remaining WQV with combinations of the BMPs in this table. The PE should select at least one BMP for the project; preference is for Tier 1 BMPs, followed by Tier 2 BMPs when Tier 1 BMPs are not feasible. Within each Tier, BMP selection will be determined by the site-specific determination of feasibility (Section 2.4.2.1). BMPs are chosen based on the infiltration category determined in question 7. BMPs in other categories should be ignored.			
	BMP ranking for infiltration category:		
	Infiltration < 20%	Infiltration 20% - 50%	Infiltration > 50%
Tier 1	Strip: HRT > 5 Austin filter (concrete) Austin filter (earthen) Delaware filter MCTT Wet basin	Austin filter (earthen) Detention (unlined) Infiltration basins* Infiltration trenches* Biofiltration Strip	Austin filter (earthen) Detention (unlined) Infiltration basins* Infiltration trenches* Biofiltration Strip Biofiltration Swale
Tier 2	Strip: HRT < 5 Biofiltration Swale Detention (unlined)	Austin filter (concrete) Delaware filter Biofiltration Swale MCTT Wet basin	Austin filter (concrete) Delaware filter MCTT Wet basin
HRT = hydraulic residence time (min) *Infiltration BMPs that infiltrate the water quality volume were considered previously, so only undersized infiltration BMPs or hybrid designs are considered where infiltration is less than 90% of the water quality volume.			

9. Treating both Metals and Nutrients.

Is copper, lead, zinc, or general metals AND nitrogen or phosphorous a TDC? If Yes use Matrix D to select BMPs, then skip to question 12. Otherwise, proceed to question 10. Yes No

10. Treating Only Metals.

Are copper, lead, zinc, or general metals listed TDCs? If Yes use Matrix B below to select BMPs, and skip to question 12. Otherwise, proceed to question 11. Yes No

BMP Selection Matrix B: Any metal is the TDC, but not nitrogen or phosphorous			
Consider approaches to treat the remaining WQV with combinations of the BMPs in this table. The PE should select at least one BMP for the project; preference is for Tier 1 BMPs, followed by Tier 2 BMPs when Tier 1 BMPs are not feasible. Within each Tier, BMP selection will be determined by the site-specific determination of feasibility (Section 2.4.2.1). BMPs are chosen based on the infiltration category determined in question 7. BMPs in other categories should be ignored.			
	BMP ranking for infiltration category:		
	Infiltration < 20%	Infiltration 20% - 50%	Infiltration > 50%
Tier 1	MCTT Wet basin Austin filter (earthen) Austin filter (concrete) Delaware filter	Austin filter (earthen) Detention (unlined) Infiltration basins* Infiltration trenches* MCTT Wet basin	Austin filter (earthen) Detention (unlined) Infiltration basins* Infiltration trenches* MCTT Biofiltration Strip Biofiltration Swale Wet basin
Tier 2	Strip: HRT > 5 Strip: HRT < 5 Biofiltration Swale Detention (unlined)	Austin filter (concrete) Delaware filter Biofiltration Strip Biofiltration Swale	Austin filter (concrete) Delaware filter
HRT = hydraulic residence time (min) *Infiltration BMPs that infiltrate the water quality volume were considered previously, so only undersized infiltration BMPs or hybrid designs are considered where infiltration is less than 90% of the water quality volume.			

11. Treating Only Nutrients.

Are nitrogen and/or phosphorus listed TDCs? If “Yes,” use Matrix C to select BMPs. If “No”, please check your answer to 8(a). At this point one of the matrices should have been used for BMP selection for the TDC in question, unless no BMPs are feasible. Yes No

BMP Selection Matrix C: Phosphorous and / or nitrogen is the TDC, but no metals are the TDC			
<p>Consider approaches to treat the remaining WQV with combinations of the BMPs in this table. The PE should select at least one BMP for the project; preference is for Tier 1 BMPs, followed by Tier 2 BMPs when Tier 1 BMPs are not feasible. Within each Tier, BMP selection will be determined by the site-specific determination of feasibility (Section 2.4.2.1). BMPs are chosen based on the infiltration category determined in question 7. BMPs in other categories should be ignored.</p>			
	BMP ranking for infiltration category:		
	Infiltration < 20%	Infiltration 20% - 50%	Infiltration > 50%
Tier 1	Austin filter (earthen) Austin filter (concrete) Delaware filter**	Austin filter (earthen) Detention (unlined) Infiltration basins* Infiltration trenches*	Austin filter (earthen) Detention (unlined) Infiltration basins* Infiltration trenches* Biofiltration Strip Biofiltration Swale
Tier 2	Wet basin Biofiltration Strip Biofiltration Swale Detention (unlined)	Austin filter (concrete) Delaware filter Biofiltration Strip Biofiltration Swale Wet basin	Austin filter (concrete) Delaware filter Wet basin
<p>* Infiltration BMPs that infiltrate the water quality volume were considered previously, so only undersized infiltration BMPs or hybrid designs are considered where infiltration is less than 90% of the water quality volume.</p>			
<p>** Delaware filters would be ranked in Tier 2 if the TDC is nitrogen only, as opposed to phosphorous only or both nitrogen and phosphorous.</p>			

BMP Selection Matrix D: Any metal, plus phosphorous and / or nitrogen are the TDCs			
<p>Consider approaches to treat the remaining WQV with combinations of the BMPs in this table. The PE should select at least one BMP for the project; preference is for Tier 1 BMPs, followed by Tier 2 BMPs when Tier 1 BMPs are not feasible. Within each Tier, BMP selection will be determined by the site-specific determination of feasibility (Section 2.4.2.1). BMPs are chosen based on the infiltration category determined in question 7. BMPs in other categories should be ignored.</p>			
	BMP ranking for infiltration category:		
	Infiltration < 20%	Infiltration 20% - 50%	Infiltration > 50%
Tier 1	Wet basin* Austin filter (earthen) Austin filter (concrete) Delaware filter**	Wet basin* Austin filter (earthen) Detention (unlined) Infiltration basins*** Infiltration trenches***	Wet basin* Austin filter (earthen) Detention (unlined) Infiltration basins*** Infiltration trenches*** Biofiltration Strip Biofiltration Swale
Tier 2	Biofiltration Strip Biofiltration Swale Detention (unlined)	Austin filter (concrete) Delaware filter Biofiltration Strip Biofiltration Swale	Austin filter (concrete) Delaware filter
* The wet basin should only be considered for phosphorus			
** In cases where earthen BMPs can infiltrate, Delaware filters are ranked in Tier 2 if the TDC is nitrogen only, but they are Tier 1 for phosphorous only or both nitrogen and phosphorous.			
*** Infiltration BMPs that infiltrate the water quality volume were considered previously, so only undersized infiltration BMPs or hybrid designs are considered where infiltration is less than 90% of the water quality volume.			

12. Does the project discharge to a waterbody that has been placed on the 303-d list or has had a TMDL adopted for mercury or low dissolved oxygen? Yes No
 If Yes contact the District/Regional NPDES Storm Water Coordinator to determine if standing water in a Delaware filter, wet basin, or MCTT would be a risk to downstream water quality.
13. After completing the above, identify and attach the checklists shown below for every Treatment BMP under consideration. (use one checklist every time the BMP is considered for a different drainage within the project) Complete
 X Biofiltration Strips and Biofiltration Swales: Checklist T-1, Part 2
 ___ Dry Weather Diversion: Checklist T-1, Part 3
 ___ Infiltration Devices: Checklist T-1, Part 4
 ___ Detention Devices: Checklist T-1, Part 5
 ___ GSRDs: Checklist T-1, Part 6
 ___ Traction Sand Traps: Checklist T-1, Part 7
 X Media Filter [Austin Sand Filter and Delaware Filter]: Checklist T-1, Part 8
 ___ Multi-Chambered Treatment Train: Checklist T-1, Part 9
 ___ Wet Basins: Checklist T-1, Part 10
14. Estimate what percentage of WQV (or WQF, depending upon the Treatment BMP selected) will be treated by the preferred Treatment BMP(s): _____% Complete
- (a) Have Treatment BMPs been considered for use in parallel or series to increase this percentage? Yes No
15. Estimate what percentage of the net WQV (for all new impervious surfaces within the project) that will be treated by the preferred treatment BMP(s): _____% Complete
16. Prepare cost estimate, including right-of-way, and site specific determination of feasibility (Section 2.4.2.1) for selected Treatment BMPs and include as supplemental information for SWDR approval. Complete

Treatment BMPs			
Checklist T-1, Part 2			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Biofiltration Swales / Biofiltration Strips

Feasibility

1. Do the climate and site conditions allow vegetation to be established? Yes No
2. Are flow velocities from a peak drainage facility design event < 4 fps (i.e. low enough to prevent scour of the vegetated biofiltration swale as per HDM Table 873.3E)? Yes No
 If "No" to either question above, Biofiltration Swales and Biofiltration Strips are not feasible.
3. Are Biofiltration Swales proposed at sites where known contaminated soils or groundwater plumes exist? Yes No
 If "Yes", consult with District/Regional NPDES Coordinator about how to proceed.
4. Does adequate area exist within the right-of-way to place Biofiltration device(s)? Yes No
 If "Yes", continue to Design Elements section. If "No", continue to Question 5.
5. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site Biofiltration devices and how much right-of-way would be needed to treat WQF? _____ acres Yes No
 If "Yes", continue to Design Elements section. If "No", continue to Question 6.
6. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of these Treatment BMPs into the project. Complete

Design Elements

* **Required** Design Element – A "Yes" response to these questions is required to further the consideration of this BMP into the project design. Document a "No" response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A "Yes" response is preferred for these questions, but not required for incorporation into a project design.

1. Has the District Landscape Architect provided vegetation mixes appropriate for climate and location? * Yes No
2. Can the biofiltration swale be designed as a conveyance system under any expected flows > the WQF event, as per HDM Chapter 800? * (e.g. freeboard, minimum slope, etc.) Yes No

- 3. Can the biofiltration swale be designed as a water quality treatment device under the WQF while meeting the required HRT, depth, and velocity criteria? (Reference Appendix B, Section B.2.3.1)* Yes No
- 4. Is the maximum length of a biofiltration strip \leq 300 ft? * Yes No
- 5. Has the minimum width (in the direction of flow) of the invert of the biofiltration swale received the concurrence of Maintenance? * Yes No
- 6. Can biofiltration swales be located in natural or low cut sections to reduce maintenance problems caused by animals burrowing through the berm of the swale? ** Yes No
- 7. Is the biofiltration strip sized as long as possible in the direction of flow? ** Yes No
- 8. Have Biofiltration Systems been considered for locations upstream of other Treatment BMPs, as part of a treatment train? ** Yes No

Treatment BMPs			
Checklist T-1, Part 3 (NOT APPLICABLE)			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Dry Weather Flow Diversion

Feasibility

1. Is a Dry-Weather Flow Diversion acceptable to a Publicly Owned Treatment Works (POTW)? Yes No
2. Would a connection require ordinary (i.e., not extraordinary) plumbing, features or construction methods to implement? Yes No
 If "No" to either question above, Dry Weather Flow Diversion is not feasible.
3. Does adequate area exist within the right-of-way to place Dry Weather Flow Diversion devices? Yes No
 If "Yes", continue to Design Elements sections. If "No", continue to Question 4.
4. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site Dry Weather Flow Diversion devices and how much right-of-way would be needed? _____ (acres) Yes No
 If "Yes", continue to the Design Elements section.
 If "No", continue to Question 5.
5. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

Design Elements

* **Required** Design Element – A "Yes" response to these questions is required to further the consideration of this BMP into the project design. Document a "No" response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A "Yes" response is preferred for these questions, but not required for incorporation into a project design.

1. Does the existing sanitary sewer pipeline have adequate capacity to accept project dry weather flows, or can an upgrade be implemented to handle the anticipated dry weather flows within the project's budget and objectives? * Yes No
2. Can the connection be designed to allow for Maintenance vehicle access? * Yes No
3. Can gate, weir, or valve be designed to stop diversion during storm events? * Yes No
4. Can the inlet be designed to reduce chances of clogging the diversion pipe or channel? * Yes No
5. Can a back flow prevention device be designed to prevent sanitary sewage from entering storm drain? * Yes No

Treatment BMPs			
Checklist T-1, Part 4			
Prepared by: <u>Roberto Ramirez PE</u>		Date: <u>July 12, 2011</u>	
		District-Co-Route: <u>Orange</u>	
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: <u>Santa Ana (Region 8)</u>	

Infiltration Devices

Feasibility

1. Does local Basin Plan or other local ordinance provide influent limits on quality of water that can be infiltrated, and would infiltration pose a threat to groundwater quality? Yes No

2. Does infiltration at the site compromise the integrity of any slopes in the area? Yes No

3. Per survey data or U.S. Geological Survey (USGS) Quad Map, are existing slopes at the proposed device site >15%? Yes No

4. At the invert, does the soil type classify as NRCS Hydrologic Soil Group (HSG) D, or does the soil have an infiltration rate < 0.5 inches/hr? Yes No

5. Is site located over a previously identified contaminated groundwater plume? Yes No
 If "Yes" to any question above, Infiltration Devices are not feasible; stop here and consider other approved Treatment BMPs.

6. (a) Does site have groundwater within 10 ft of basin invert? Yes No
 (b) Does site investigation indicate that the infiltration rate is significantly greater than 2.5 inches/hr? Yes No

 If "Yes" to either part of Question 6, the RWQCB must be consulted, and the RWQCB must conclude that the groundwater quality will not be compromised, before approving the site for infiltration.

7. Does adequate area exist within the right-of-way to place Infiltration Device(s)? Yes No
 If "Yes", continue to Design Elements sections. If "No", continue to Question 8.

8. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site Infiltration Devices and how much right-of-way would be needed to treat WQV? _____ acres Yes No
 If Yes, continue to Design Elements section.
 If No, continue to Question 9.

9. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

Design Elements – Infiltration Basin

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

- 1. Has a detailed investigation been conducted, including subsurface soil investigation, in-hole conductivity testing and groundwater elevation determination? (This report must be completed for PS&E level design.) * Yes No
- 2. Has an overflow spillway with scour protection been provided? * Yes No
- 3. Is the Infiltration Basin size sufficient to capture the WQV while maintaining a 40-48 hour drawdown time? (Note: the WQV must be $\geq 4,356 \text{ ft}^3$ [0.1 acre-feet]) * Yes No
- 4. Can access be placed to the invert of the Infiltration Basin? * Yes No
- 5. Can the Infiltration Basin accommodate the freeboard above the overflow event elevation (reference Appendix B.1.3.1)? * Yes No
- 6. Can the Infiltration Basin be designed with interior side slopes no steeper than 4:1 (h:v) (may be 3:1 [h:v] with approval by District Maintenance)? * Yes No
- 7. Can vegetation be established in the Infiltration Basin? ** Yes No
- 8. Can diversion be designed, constructed, and maintained to bypass flows exceeding the WQV? ** Yes No
- 9. Can a gravity-fed Maintenance Drain be placed? ** Yes No

Design Elements – Infiltration Trench

* **Required** Design Element – (see definition above)

** **Recommended** Design Element – (see definition above)

- 1. Has a detailed investigation been conducted, including subsurface soil investigation, in-hole conductivity testing and groundwater elevation determination? (This report must be completed for PS&E level design.) * Yes No
- 2. Is the surrounding soil within Hydrologic Soil Groups (HSG) Types A or B? * Yes No
- 3. Is the volume of the Infiltration Trench equal to at least the 2.85x the WQV, while maintaining a drawdown time of ≤ 96 hours? It is recommended to use a drawdown time between 40 and 48 hours. (Note: the WQV must be $\geq 4,356 \text{ ft}^3$ [0.1 acre-feet], unless the District/Regional NPDES Storm Water Coordinator will allow a volume between $2,830 \text{ ft}^3$ and $4,356 \text{ ft}^3$ to be considered.) * Yes No
- 4. Is the depth of the Infiltration Trench ≤ 13 ft? * Yes No
- 5. Can an observation well be placed in the trench? * Yes No
- 6. Can access be provided to the Infiltration Trench? * Yes No
- 7. Can pretreatment be provided to capture sediment in the runoff (such as using vegetation)? * Yes No
- 8. Can flow diversion be designed, constructed, and maintained to bypass flows exceeding the Water Quality event? ** Yes No
- 9. Can a perimeter curb or similar device be provided (to limit wheel loads upon the trench)? ** Yes No

Treatment BMPs			
Checklist T-1, Part 5			
Prepared by: <u>Roberto Ramirez PE</u>		Date: <u>July 12, 2011</u>	
		District-Co-Route: <u>Orange</u>	
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: <u>Santa Ana (Region 8)</u>	

Detention Devices

Feasibility

1. Is there sufficient head to prevent objectionable backwater conditions in the upstream drainage systems? Yes No

2. 2a) Is the volume of the Detention Device equal to at least the WQV? (Note: the WQV must be $\geq 4,356 \text{ ft}^3$ [0.1 acre-feet]) Yes No
 Only answer (b) if the Detention Device is being used also to capture traction sand.

- 2b) Is the total volume of the Detention Device at least equal to the WQV plus the anticipated volume of traction sand, while maintaining a minimum 12 inch freeboard (1 ft)? Yes No

3. Is basin invert ≥ 10 ft above seasonally high groundwater or can it be designed with an impermeable liner? (Note: If an impermeable liner is used, the seasonally high groundwater elevation must not encroach within 12 inches of the invert.) Yes No

- If No to any question above, then Detention Devices are not feasible.

4. Does adequate area exist within the right-of-way to place Detention Device(s)? Yes No
 If Yes, continue to the Design Elements section. If No, continue to Question 5.

5. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site Detention Device(s) and how much right-of way would be needed to treat WQV? _____ acres Yes No
 If Yes, continue to the Design Elements section. If No, continue to Question 6.

6. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

Design Elements

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

1. Has the geotechnical integrity of the site been evaluated to determine potential impacts to surrounding slopes due to incidental infiltration? If incidental infiltration through the invert of an unlined Detention Device is a concern, consider using an impermeable liner. * Yes No
2. Has the location of the Detention Device been evaluated for any effects to the adjacent roadway and subgrade? * Yes No
3. Can a minimum freeboard of 12 inches be provided above the overflow event elevation? * Yes No
4. Is an overflow outlet provided? * Yes No
5. Is the drawdown time of the Detention Device within 24 to 72 hours with 40-hrs the preferred design drawdown time? * Yes No
6. Is the basin outlet designed to minimize clogging (minimum outlet orifice diameter of 0.5 inches)? * Yes No
7. Are the inlet and outlet structures designed to prevent scour and re-suspension of settled materials, and to enhance quiescent conditions? * Yes No
8. Can vegetation be established in an earthen basin at the invert and on the side slopes for erosion control and to minimize re-suspension? Note: Detention Basins may be lined, in which case no vegetation would be required for lined areas.* Yes No
9. Has sufficient access for Maintenance been provided? * Yes No
10. Is the side slope 4:1 (h:v) or flatter for interior slopes? **
(Note: Side slopes up to 3:1 (h:v) allowed with approval by District Maintenance.) Yes No
11. If significant sediment is expected from nearby slopes, can the Detention Device be designed with additional volume equal to the expected annual loading? ** Yes No
12. Is flow path as long as possible (\geq 2:1 length to width ratio at WQV elevation is recommended)? ** Yes No

Treatment BMPs			
Checklist T-1, Part 6 (NOT APPLICABLE)			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Gross Solids Removal Devices (GSRDs)

Feasibility

- 1. Is the receiving water body downstream of the tributary area to the proposed GSRD on a 303(d) list or has a TMDL for litter been established? Yes No
- 2. Are the devices sized for flows generated by the peak drainage facility design event or can peak flow be diverted? Yes No
- 3. Are the devices sized to contain gross solids (litter and vegetation) for a period of one year? Yes No
- 4. Is there sufficient access for maintenance and large equipment (vacuum truck)? Yes No

If “No” to any question above, then Gross Solids Removal Devices are not feasible. Note that Biofiltration Systems, Infiltration Devices, Detention Devices, Dry Weather Flow Diversion, MCTT, Media Filters, and Wet Basins may be considered for litter capture, but consult with District/Regional NPDES if proposed to meet a TMDL for litter.

- 5. Does adequate area exist within the right-of-way to place Gross Solids Removal Devices? Yes No
If “Yes”, continue to Design Elements section. If “No”, continue to Question 6.
- 6. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site Gross Solids Removal Devices and how much right-of-way would be needed? _____ acres Yes No
If “Yes”, continue to Design Elements section. If “No”, continue to Question 7.
- 7. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

Design Elements – Linear Radial Device

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

- 1. Does sufficient hydraulic head exist to place the Linear Radial GSRD? * Yes No
- 2. Was the litter accumulation rate of 10 ft³/ac/yr (or a different rate recommended by Maintenance) used to size the device? * Yes No
- 3. Were the standard detail sheets used for the layout of the devices? ** Yes No
If No, consult with Headquarters Office of Storm Water Management and District/Regional NPDES.
- 4. Is the maximum depth of the storage within 10 ft of the ground surface, or another depth as required by District Maintenance? * Yes No

Design Elements – Inclined Screen

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

- 1. Does sufficient hydraulic head exist to place the Inclined Screen GSRD? * Yes No
- 2. Was the litter accumulation rate of 10 ft³/ac/yr (or a different rate recommended by Maintenance) used to size the device? * Yes No
- 3. Were the standard details sheets used for the layout of the devices? ** Yes No
If No, consult with Headquarters Office of Storm Water Management and District NPDES.
- 4. Is the maximum depth of the storage within 10 ft of the ground surface, or another depth as required by District Maintenance? * Yes No

Treatment BMPs			
Checklist T-1, Part 7 (NOT APPLICABLE)			
Prepared by: <u>Roberto Ramirez PE</u>		Date: <u>July 12, 2011</u>	
		District-Co-Route: <u>Orange</u>	
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: _____	<u>Santa Ana (Region 8)</u>

Traction Sand Traps

Feasibility

1. Can a Detention Device be sized to capture the estimated traction sand and the WQV from the tributary area? Yes No
 If Yes, then a separate Traction Sand Trap may not be necessary. Coordinate with the District/Regional Design Storm Water Coordinator and also complete Checklist T-1, Part 5.

2. Is the Traction Sand Trap proposed for a site where sand or other traction enhancing substances are applied to the roadway at least twice per year? Yes No

3. Is adequate space provided for Maintenance staff and equipment access for annual cleanout? Yes No

 If the answer to any one of Questions 2 or 3 is No, then a Traction Sand Trap is not feasible.

4. Does adequate area exist within the right-of-way to place Traction Sand Traps? Yes No
 If Yes, continue to Design Elements section. If No, continue to Question 5.

5. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site Traction Sand Traps and how much right-of-way would be needed? _____ acres Yes No
 If Yes, continue to the Design Elements section. If No, continue to Question 7.

6. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

Design Elements

*** Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

**** Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

1. Was the local Caltrans Maintenance Station contracted to provide the amount of traction sand used annually at the location? * (Detention Device or CMP type)
List application rate reported. _____ yd³ Yes No
2. Does the Traction Sand Trap have enough volume to store settled sand over the winter using the formula presented in Appendix B, Section B.5? * (Detention Device or CMP type) Yes No
3. Is the invert of the Traction Sand Trap a minimum of 3 ft above seasonally high groundwater? * (CMP type) Yes No
4. Is the maximum depth of the storage within 10 ft of the ground surface, or another depth as required by District Maintenance? * (CMP type) Yes No
5. Can peak flow be diverted around the device? ** (CMP type) Yes No
6. Can peak flow be diverted around the device? ** (CMP type) Yes No
7. Is 6 inches separation provided between the top of the captured traction sand and the outlet from the device, in order to minimize re-suspension of the solids? ** (CMP type) Yes No

Treatment BMPs			
Checklist T-1, Part 8			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
		District-Co-Route:	Orange
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Media Filters

Caltrans has approved two types of Media Filter: Austin Sand Filters and Delaware Filters. Austin Sand filters are typically designed for larger drainage areas, while Delaware Filters are typically designed for smaller drainage areas. The Austin Sand Filter is constructed with an open top and may have a concrete or earthen invert, while the Delaware is always constructed as a vault. See Appendix B, Media Filters, for a further description of Media Filters.

Feasibility – Austin Sand Filter

1. Is the volume of the Austin Sand Filter equal to at least the WQV using a 24 hour drawdown? (Note: the WQV must be $\geq 4,356 \text{ ft}^3$ [0.1 acre-feet]) Yes No
2. Is there sufficient hydraulic head to operate the device (minimum 3 ft between the inflow and outflow chambers)? Yes No
3. If initial chamber has an earthen bottom, is initial chamber invert ≥ 3 ft above seasonally high groundwater? Yes No
4. If a vault is used for either chamber, is the level of the concrete base of the vault above seasonally high groundwater or is a special design provided?
If No to any question above, then an Austin Sand Filter is not feasible. Yes No
5. Does adequate area exist within the right-of-way to place an Austin Sand Filter(s)?
If Yes, continue to Design Elements sections. If No, continue to Question 6. Yes No
6. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site the device and how much right-of way would be needed to treat WQV? _____ acres
If Yes, continue to the Design Elements section.
If No, continue to Question 7. Yes No
7. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

If an Austin Sand Filter meets these feasibility requirements, continue to the Design Elements – Austin Sand Filter below.

Feasibility- Delaware Filter

- 1. Is the volume of the Delaware Filter equal to at least the WQV using a 40 to 48 hour drawdown? (Note: the WQV must be $\geq 4,356 \text{ ft}^3$ [0.1 acre-feet], consult with District/Regional Design Storm Water Coordinator if a lesser volume is under consideration.) Yes No
- 2. Is there sufficient hydraulic head to operate the device (minimum 3 ft between the inflow and outflow chambers)? Yes No
- 3. Would a permanent pool of water be allowed by the local vector control agency? Confirm that check valves and vector proof lid as shown on standard detail sheets will be allowed, is used. Yes No

If No to any question, then a Delaware Filter is not feasible

- 4. Does adequate area exist within the right-of-way to place a Delaware Filter(s)?
If Yes, continue to Design Elements sections. If No, continue to Question 5. Yes No
- 5. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site the device and how much right-of way would be needed to treat WQV? _____ acres
If Yes, continue to the Design Elements section. If No, continue to Question 6. Yes No
- 6. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete
- 7. Does the project discharge to a waterbody that has been placed on the 303-d list or has had a TMDL adopted for bacteria, mercury, sulfides, or low dissolved oxygen? Yes No

If yes, contact the Regional/District NPDES Storm Water Coordinator to determine if standing water in this treatment BMP would be a risk to downstream water quality. If standing water is a potential issue, consider use of another treatment BMP.

If a Delaware Filter is still under consideration, continue to the Design Elements – Delaware Filter section.

Design Elements – Austin Sand Filter

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

- 1. Is the drawdown time of the 2nd chamber 24 hours? * Yes No
- 2. Is access for Maintenance vehicles provided to the Austin Sand Filter? * Yes No
- 3. Is a bypass/overflow provided for storms > WQV? * Yes No
- 4. Is the flow path length to width ratio for the sedimentation chamber of the “full” Austin Sand Filter $\geq 2:1$? ** Yes No
- 5. Can pretreatment be provided to capture sediment and litter in the runoff (such as using vegetation)? ** Yes No
- 6. Can the Austin Sand Filter be placed using an earthen configuration? **
If No, go to Question 9. Yes No
- 7. Is the Austin Sand Filter invert separated from the seasonally high groundwater table by ≥ 10 ft)? *
If No, design with an impermeable liner. Yes No
- 8. Are side slopes of the earthen chamber 3:1 (h:v) or flatter? * Yes No
- 9. Is maximum depth ≤ 13 ft below ground surface? * Yes No
- 10. Can the Austin Sand Filter be placed in an offline configuration? ** Yes No

Design Elements – Delaware Filter

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

- | | |
|---|---|
| 1. Is the drawdown time of the 2 nd chamber between 40 and 48 hours, typically 40-48 hrs? * | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| 2. Is access for Maintenance vehicles provided to the Delaware Filter? * | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| 3. Is a bypass/overflow provided for storms > WQV? ** | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| 4. Can pretreatment be provided to capture sediment and litter in the runoff (such as using vegetation)? ** | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| 5. Is maximum depth ≤ 13 ft below ground surface? * | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |

Treatment BMPs			
Checklist T-1, Part 9			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

MCTT (Multi-chambered Treatment Train)

Feasibility

- 1. Is the proposed location for the MCTT located to serve a “critical source area” (i.e. vehicle service facility, parking area, paved storage area, or fueling station)? Yes No
- 2. Is the WQV $\geq 4,346 \text{ ft}^3$ [0.1 acre-foot]? Yes No
- 3. Is there sufficient hydraulic head (typically ≥ 6 feet) to operate the device? Yes No
- 4. Would a permanent pool of water be allowed by the local vector control agency? Confirm that check valves and vector proof lid as shown on standard detail sheets be allowed. Yes No

If No to any question above, then an MCTT is not feasible.

- 5. Does adequate area exist within the right-of-way to place an MCTT(s)? Yes No
If Yes, continue to Design Elements sections. If No, continue to Question 6.
- 6. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site the device and how much right-of way would be needed to treat WQV? _____ acres Yes No
If Yes, continue to Design Elements section. If No, continue to Question 7.
- 7. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete
- 8. Does the project discharge to a waterbody that has been placed on the 303-d list or has had a TMDL adopted for bacteria, mercury, sulfides, low dissolved oxygen, or odors? Yes No

If yes, contact the Regional/District NPDES Storm Water Coordinator to determine if standing water in this treatment BMP would be a risk to downstream water quality. If standing water is a potential issue, consider use of another treatment BMP.

Design Elements

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

1. Is the maximum depth of the 3rd chamber \leq 13 ft below ground surface and has Maintenance accepted this depth? * Yes No
2. Is the drawdown time in the 3rd chamber between 24 and 48 hours, typically designed for 24-hrs? * Yes No
3. Is access for Maintenance vehicles provided to all chambers of the MCTT? * Yes No
4. Is there sufficient hydraulic head to operate the device? * Yes No
5. Has a bypass/overflow been provided for storms > WQV? * Yes No
6. Can pretreatment be provided to capture sediment and litter in the runoff (such as using vegetation)? ** Yes No

Treatment BMPs			
Checklist T-1, Part 10			
Prepared by: <u>Roberto Ramirez PE</u>		Date: <u>July 12, 2011</u>	
		District-Co-Route: <u>Orange</u>	
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: <u>Santa Ana (Region 8)</u>	

Wet Basin

Feasibility

- 1. Is the volume of the Wet Basin above the permanent pool equal to at least the WQV using a 24 to 96 hour drawdown (40 to 48 hour drawdown preferred)? (Note: the WQV must be $\geq 4,356 \text{ ft}^3$ [0.1 acre-feet] and the permanent pool must be at least 3x the WQV.) Yes No
- 2. Is a permanent source of water available in sufficient quantities to maintain the permanent pool for the Wet Basin? Yes No
- 3. Is proposed site in a location where naturally occurring wetlands do not exist? Yes No

Answer either question 4 or question 5:

- 4. For Wet Basins with a proposed invert above the seasonally high groundwater, Are NRCS Hydrologic Soil Groups [HSG] C and D at the proposed invert elevation, or can an impermeable liner be used? (Note: If an impermeable liner is used, the seasonally high groundwater elevation must not encroach within 12 inches of the invert.) Yes No
- 5. For Wet Basins with a proposed invert below the groundwater table: Can written approval from the local Regional Water Quality Control Board be obtained to place the Wet Basin in direct hydraulic connectivity to the groundwater? Yes No
- 6. Is freeboard provided ≥ 1 foot? Yes No
- 7. Is the maximum impoundment volume < 14.75 acre-feet? Yes No
- 8. Would a permanent pool of water be allowed by the local vector control agency? Yes No
If No to any question above, then a Wet Basin is not feasible.
- 9. Is the maximum basin width ≤ 49 ft as suggested in Section B.10.2? Yes No
If No, consult with the local vector control agency and District Maintenance.
- 10. Does adequate area exist within the right-of-way to place a Wet Basin? Yes No
If Yes, continue to Design Elements sections.
If No, continue to Question 11.

- 11. If adequate area does not exist within right-of-way, can suitable, additional right-of-way be acquired to site the device and how much right-of way would be needed to treat WQV? _____ acres Yes No
If Yes, continue to Design Elements section.
If No, continue to Question 12.

- 12. Have the appropriate state and federal regulatory agencies been contacted to discuss location and potential to attract and harbor sensitive or endangered species? Yes No
If No, contact the Regional/District NPDES Coordinator

- 13. If adequate area cannot be obtained, document in Section 5 of the SWDR that the inability to obtain adequate area prevents the incorporation of this Treatment BMP into the project. Complete

- 14. Does the project discharge to a waterbody that has been placed on the 303-d list or has had a TMDL adopted for bacteria, mercury, sulfides, low dissolved oxygen, or odors? Yes No
If yes, contact the Regional/District NPDES Storm Water Coordinator to determine if standing water in this treatment BMP would be a risk to downstream water quality. If standing water is a potential issue, consider use of another treatment BMP.

Design Elements

* **Required** Design Element – A “Yes” response to these questions is required to further the consideration of this BMP into the project design. Document a “No” response in Section 5 of the SWDR to describe why this Treatment BMP cannot be included into the project design.

** **Recommended** Design Element – A “Yes” response is preferred for these questions, but not required for incorporation into a project design.

- | | | |
|---|------------------------------|-----------------------------|
| 1. Can a controlled outlet and an overflow structure be designed for storm events larger than the Water Quality event? * | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 2. Is access for Maintenance vehicles provided? * | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 3. Is the drawdown time for the WQV between 24 and 96 hours? * | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 4. Has appropriate vegetation been selected for each hydrologic zone? * | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 5. Can all design elements required by the local vector control agency be incorporated? * | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 6. Has a minimum flow path length-to-width ration of at least 2:1 been provided? ** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 7. Has an upstream bypass been provided for storms > WQV? ** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 8. Can pretreatment be provided to capture sediment and litter in the runoff (such as using vegetation, or a forebay)? ** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 9. Can public access be restricted using a fence if proposed at locations accessible on foot by the public? ** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 10. Is the maximum depth < 10 ft?" | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

Construction Site BMPs	
Checklist CS-1, Part 1	
Prepared by: <u>Roberto Ramirez PE</u> Date: <u>July 12, 2011</u> District-Co-Route: <u>Orange</u>	
PM : _____ Project ID (or EA): <u>SAFG</u> RWQCB: <u>Santa Ana (Region 8)</u>	

Soil Stabilization

General Parameters

1. How many rainy seasons are anticipated between begin and end of construction? 2
2. What is the total disturbed soil area for the project? (ac) 5.56
 - (a) How much of the project DSA consists of slopes 4:1 (h:v) or flatter? (ac) 5.56
 - (b) How much of the project DSA consists of 4:1 (h:v) < slopes < 2:1 (h:v)? (ac) 0
 - (c) How much of the project DSA consists of slopes 2:1 (h:v) and steeper? (ac) 0
 - (d) How much of the project DSA consists of slopes with slope lengths longer than 20 ft? (ac) 0.55
3. What rainfall area does the project lie within? (Refer to Table 2-1 of the Construction Site Best Management Practices Manual) Area 4
4. Review the required combination of temporary soil stabilization and temporary sediment controls and barriers for area, slope inclinations, rainy and non-rainy season, and active and non-active disturbed soil areas. (Refer to Tables 2-2, and 2-3 of the Construction Site Best Management Practices Manual for Rainfall Area requirements.) Complete

Scheduling (SS-1)

5. Does the project have a duration of more than one rainy season and have disturbed soil area in excess of 25 acres? Yes No
 - (a) Include multiple mobilizations (Move-in/Move-out) as a separate contract bid line item to implement permanent erosion control or revegetation work on slopes that are substantially complete. (Estimate at least 6 mobilizations for each additional rainy season. Designated Construction Representative may suggest an alternate number of mobilizations.) Complete
 - (b) Edit Order of Work specifications for permanent erosion control or revegetation work to be implemented on slopes that are substantially complete. Complete
 - (c) Edit permanent erosion control or revegetation specifications to require seeding and planting work to be performed when optimal. Complete

Preservation of Existing Vegetation (SS-2)

- 6. Do Environmentally Sensitive Areas (ESAs) exist within or adjacent to the project limits? (Verify the completion of DPP-1, Part 5) Yes No
 - (a) Verify the protection of ESAs through delineation on all project plans. Complete
 - (b) Protect from clearing and grubbing and other construction disturbance by enclosing the ESA perimeter with high visibility plastic fence or other BMP. Complete

- 7. Are there areas of existing vegetation (mature trees, native vegetation, landscape planting, etc.) that need not be disturbed by project construction? Will areas designated for proposed treatment BMPs need protection (infiltration characteristics, vegetative cover, etc.)? (Coordinate with District Environmental and Construction to determine limits of work necessary to preserve existing vegetation to the maximum extent practicable.) Yes No
 - (a) Designate as outside of limits of work (or designate as ESAs) and show on all project plans. Complete
 - (b) Protect with high visibility plastic fence or other BMP. Complete

- 8. If yes for 6, 7, or both, then designate ESA fencing as a separate contract bid line item, *if not already incorporated as part of design pollution prevention work (See DPP-1, Part 5).* Complete

Slope Protection

- 9. Provide a soil stabilization BMP(s) appropriate for the DSA, slope steepness, slope length, and soil erodibility. (Consult with District/Regional Landscape Architect.)
 - (a) Select SS-3 (Hydraulic Mulch), SS-4 (Hydroseeding), SS-5 (Soil Binders), SS-6 (Straw Mulch), SS-7 (Geotextiles, Mats, Plastic Covers, and Erosion Control Blankets), SS-8 (Wood Mulching), other BMPs or a combination to cover the DSA throughout the project's rainy season. Complete
 - (b) Increase the quantities by 25% for each additional rainy season. (Designated Construction Representative may suggest an alternate increase.) Complete
 - (c) Designate as a separate contract bid line item. Complete

Slope Interrupter Devices

- 10. Provide slope interrupter devices for all slopes with slope lengths equal to or greater than of 20 ft in length. (Consult with District/Regional Landscape Architect and Designated Construction Representative.)

- (a) Select SC-5 (Fiber Rolls) or other BMPs to protect slopes throughout the project's rainy season. Complete
- (b) For slope inclination of 4:1 (h:v) and flatter, SC-5 (Fiber Rolls) or other BMPs shall be placed along the contour and spaced 20 ft on center. Complete
- (c) For slope inclination between 4:1 (h:v) and 2:1 (h:v), SC-5 (Fiber Rolls) or other BMPs shall be placed along the contour and spaced 15 ft on center. Complete
- (d) For slope inclination of 2:1 (h:v) and greater, SC-5 (Fiber Rolls) or other BMPs shall be placed along the contour and spaced 10 ft on center. Complete
- (e) Increase the quantities by 25% for each additional rainy season. (Designated Construction Representative may suggest alternate increase.) Complete
- (f) Designate as a separate contract bid line item. Complete

Channelized Flow

- 11. Identify locations within the project site where concentrated flow from stormwater runoff can erode areas of soil disturbance. Identify locations of concentrated flow that enters the site from outside of the right-of-way (off-site run-on). Complete
- (a) Utilize SS-7 (Geotextiles, Mats, Plastic Covers, and Erosion Control Blankets), SS-9 (Earth Dikes/Swales, Ditches), SS-10 (Outlet Protection/Velocity Dissipation), SS-11 (Slope Drains), SC-4 (Check Dams), or other BMPs to convey concentrated flows in a non-erosive manner. Complete
- (b) Designate as a separate contract bid line item. Complete

Construction Site BMPs	
Checklist CS-1, Part 2	
Prepared by: <u>Roberto Ramirez PE</u>	Date: <u>July 12, 2011</u> District-Co-Route: <u>Orange</u>
PM : _____	Project ID (or EA): <u>SAFG</u> RWQCB: <u>Santa Ana (Region 8)</u>

Sediment Control

Perimeter Controls - Run-off Control

1. Is there a potential for sediment laden sheet and concentrated flows to discharge offsite from runoff cleared and grubbed areas, below cut slopes, embankment slopes, etc.? Yes No
 - (a) Select linear sediment barrier such as SC-1 (Silt Fence), SC-5 (Fiber Rolls), SC-6 (Gravel Bag Berm), SC-8 (Sand Bag Barrier), SC-9 (Straw Bale Barrier), or a combination to protect wetlands, water courses, roads (paved and unpaved), construction activities, and adjacent properties. (Coordinate with District Construction for selection and preference of linear sediment barrier BMPs.) Complete
 - (b) Increase the quantities by 25% for each additional rainy season. (Designated Construction Representative may suggest an alternate increase.) Complete
 - (c) Designate as a separate contract bid line item. Complete

Perimeter Controls - Run-on Control

2. Do locations exist where sheet flow upslope of the project site and where concentrated flow upstream of the project site may contact DSA and construction activities? Yes No
 - (a) Utilize linear sediment barriers such as SS-9 (Earth Dike/Drainage Swales and Lined Ditches), SC-5 (Fiber Rolls), SC-6 (Gravel Bag Berm), SC-8 (Sand Bag Barrier), SC-9 (Straw Bale Barrier), or other BMPs to convey flows through and/or around the project site. (Coordinate with District Construction for selection and preference of perimeter control BMPs.) Complete
 - (b) Designate as a separate contract bid line item. Complete

Storm Drain Inlets

3. Do existing or proposed drainage inlets exist within the project limits? Yes No

- (a) Select SC-10 (Storm Drain Inlet Protection) to protect municipal storm drain systems or receiving waters wetlands at each drainage inlet. (Coordinate with District Construction for selection and preference of inlet protection BMPs.) Complete
- (b) Designate as a separate contract bid line item. Complete
- 4. Can existing or proposed drainage inlets utilize an excavated sediment trap as described in SC-10 (Storm Drain Inlet Protection- Type 2)? Yes No
- (a) Include with other types of SC-10 (Storm Drain Inlet Protection). Complete

Sediment/Desilting Basin (SC-2)

- 5. Does the project lie within a Rainfall Area where the required combination of temporary soil stabilization and sediment control BMPs includes desilting basins? (Refer to Tables 2-1, 2-2, and 2-3 of the Construction Site Best Management Practices Manual for Rainfall Area requirements.) Yes No
- (a) Consider feasibility for desilting basin allowing for available right-of-way within the project limits, topography, soil type, disturbed soil area within the watershed, and climate conditions. Document if the inclusion of sediment/desilting basins is infeasible. Complete
- (b) If feasible, design desilting basin(s) per the guidance in SC-2 Sediment/ Desilting Basins of the Construction Site BMP Manual to maximize capture of sediment-laden runoff. Complete
- Designate as a separate contract bid item. Complete
- 6. Is ATS to be used for controlling sediment? Yes No
- (a) If "yes", then will desilting basin or other means of natural storage be used? Yes No
- (b) If "no", then plan for storage tanks sufficient to hold treatment volume. Complete
- 7. Will the project benefit from the early implementation of proposed permanent Treatment BMPs? (Coordinate with District Construction.) Yes No
- (a) Edit Order of Work specifications for permanent treatment BMP work to be implemented in a manner that will allow its use as a construction site BMP. Complete

Sediment Trap (SC-3)

- 8. Can sediment traps be located to collect channelized runoff from disturbed soil areas prior to discharge? Yes No
- (a) Design sediment traps in accordance with the Construction Site BMP Manual. Complete
- (b) Designate as a separate contract bid line item. Complete

Construction Site BMPs		
Checklist CS-1, Part 3		
Prepared by: <u>Roberto Ramirez PE</u>	Date: <u>July 12, 2011</u>	District-Co-Route: <u>Orange</u>
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: <u>Santa Ana (Region 8)</u>

Tracking Controls

Stabilized Construction Entrance/Exit (TC-1)

1. Are there points of entrance and exit from the project site to paved roads where mud and dirt could be transported offsite by construction equipment? (Coordinate with District Construction for selection and preference of tracking control BMPs.) Yes No
- (a) Identify and designate these entrance/exit points as stabilized construction entrances (TC-1). Complete
- (b) Designate as a separate contract bid line item. Complete

Tire/Wheel Wash (TC-3)

2. Are site conditions anticipated that would require additional or modified tracking controls such as entrance/outlet tire wash? (Coordinate with District Construction.) Yes No
- Designate as a separate contract bid line item. Complete

Stabilized Construction Roadway (TC-2)

3. Are temporary access roads necessary to access remote construction activity locations or to transport materials and equipment? (In addition to controlling dust and sediment tracking, access roads limit impact to sensitive areas by limiting ingress, and provide enhanced bearing capacity.) (Coordinate with District Construction.) Yes No
- (a) Designate these temporary access roads as stabilized construction roadways (TC-2). Complete
- (b) Designate as a separate contract bid line item. Complete

Street Sweeping and Vacuuming (SC-7)

4. Is there a potential for tracked sediment or construction related residues to be transported offsite and deposited on public or private roads? (Coordinate with District Construction for preference of including street sweeping and vacuuming with tracking control BMPs.) Yes No
- Designate as a separate contract bid line item. Complete

Construction Site BMPs		
Checklist CS-1, Part 4		
Prepared by: <u>Roberto Ramirez PE</u>	Date: <u>July 12, 2011</u>	District-Co-Route: <u>Orange</u>
PM : _____	Project ID (or EA): <u>SAFG</u>	RWQCB: <u>Santa Ana (Region 8)</u>

Wind Erosion Controls

Wind Erosion Control (WE-1)

1. Is the project located in an area where standard dust control practices in accordance with Standard Specifications, Section 10: Dust Control, are anticipated to be inadequate during construction to prevent the transport of dust offsite by wind? *(Note: Dust control by water truck application is paid for through the various items of work. Dust palliative, if it is included, is paid for as a separate item.)*

Yes No

- (a) Select SS-3 (Hydraulic Mulch), SS-4 (Hydroseeding), SS-5 (Soil Binders), SS-7 (Geotextiles, Mats, Plastic Covers, and Erosion Control Blankets), SS-8 (Wood Mulching) or a combination to cover the DSA subject to wind erosion year-round, especially when significant wind and dry conditions are anticipated during project construction. (Coordinate with District Construction for selection and preference of wind erosion control BMPs.)

Complete

- (b) Designate as a separate contract bid line item.

Complete

Construction Site BMPs	
Checklist CS-1, Part 5	
Prepared by: <u>Roberto Ramirez PE</u>	Date: <u>July 12, 2011</u> District-Co-Route: <u>Orange</u>
PM : _____	Project ID (or EA): <u>SAFG</u> RWQCB: <u>Santa Ana (Region 8)</u>

Non-Storm Water Management

Temporary Stream Crossing (NS-4) & Clear Water Diversion (NS-5)

- 1. Will construction activities occur within a waterbody or watercourse such as a lake, wetland, or stream? (Coordinate with District Construction for selection and preference for stream crossing and clear water diversion BMPs.) Yes No
 - (a) Select from types offered in NS-4 (Temporary Stream Crossing) to provide access through watercourses consistent with permits and agreements.¹ Complete
 - (b) Select from types offered in NS-5 (Clear Water Diversion) to divert watercourse consistent with permits and agreements.¹ Complete
 - (c) Designate as a separate contract bid line item(s). Complete

Other Non-Storm Water Management BMPs

- 2. Are construction activities anticipated that will generate wastes or residues with the potential to discharge pollutants? Yes No
 - (a) Identify potential pollutants associated with the anticipated construction activity and select the corresponding BMP such as NS-1 (Water Conservation Practices), NS-2 (Dewatering Operations), NS-3 (Paving and Grinding Operations), NS-7 (Potable Water/Irrigation), NS-8 (Vehicle and Equipment Cleaning), NS-9 (Vehicle and Equipment Fueling), NS-10 (Vehicle and Equipment Maintenance), NS-11 (Pile Driving Operations), NS-12 (Concrete Curing), NS-13 (Material and Equipment Use Over Water), NS-14 (Concrete Finishing), and NS-15 (Structure Demolition/Removal Over or Adjacent to Water).¹ Complete
 - (b) Verify that costs for non-stormwater management BMPs are identified in the contract documents. Designate BMP as a separate contract bid line item if the requirements in Construction Site Management (SSP 07-346) are anticipated to be inadequate or if requested by Construction. Complete

¹ Coordinate with District Environmental for consistency with US Army Corps of Engineers 404 and 401 permits and Dept. of Fish and Game 1601 Streambed alteration Agreements.

Construction Site BMPs			
Checklist CS-1, Part 6			
Prepared by:	Roberto Ramirez PE	Date:	July 12, 2011
District-Co-Route:	Orange		
PM :	Project ID (or EA):	SAFG	RWQCB: Santa Ana (Region 8)

Waste Management & Materials Pollution Control

Concrete Waste Management (WM-8)

1. Does the project include concrete placement or mortar mixing? Yes No
- (a) Select from types offered in WM-8 (Concrete Waste Management) to provide concrete washout facilities. In addition, consider portable concrete washouts and vendor supplied concrete waste management services. (Coordinate with District Construction for selection and preference of waste management and materials pollution control BMPs.) Complete
- (b) Designate as a separate contract bid line item if the quantity of concrete waste and washout are anticipated to exceed 5.2 yd³ or if requested by Construction. Complete

Other Waste Management and Materials Pollution Controls

2. Are construction activities anticipated that will generate wastes or residues with the potential to discharge pollutants? Yes No
- (a) Identify potential pollutants associated with the anticipated construction activity and select the corresponding BMP such as WM-1 (Material Delivery and Storage), WM-2 (Material Use), WM-4 (Spill Prevention and Control), WM-5 (Solid Waste Management), WM-6 (Hazardous Waste Management), WM-7 (Contaminated Soil Management), WM-9 (Sanitary/Septic Waste Management) and WM-10 (Liquid Waste Management) Complete
- (b) Verify that costs for waste management and materials pollution control BMPs are identified in the contract documents. Designate BMP as a separate contract bid line item if the requirements in Construction Site Management (SSP 07-346) are anticipated to be inadequate or if requested by Construction. Complete

Temporary Stockpiles (Soil, Materials, and Wastes)

3. Are stockpiles of soil, etc. anticipated during construction? Yes No
- (a) Select WM-3 (Stockpile Management), SS-3 (Hydraulic Mulch), SS-4 (Hydroseeding), SS-5 (Soil Binders), SS-7 (Geotextiles, Mats, Plastic Covers, and Erosion Control Blankets), or a combination as appropriate to cover temporary stockpiles of soil, etc. Complete

- (b) Select linear sediment barrier such as SC-1 (Silt Fence), SC-5 (Fiber Rolls), SC-6 (Gravel Bag Berm), SC-8 (Sand Bag Barrier), SC-9 (Straw Bale Barrier), or a combination to encircle temporary stockpiles of soil, etc. (Coordinate with District Construction for selection and preference of BMPs related to stockpiles.) Complete

- (c) Designate as a separate contract bid line item if the requirements in Construction Site Management (SSP 07-346) are anticipated to be inadequate or if requested by Construction. Complete

- 4. Is there a potential for dust and debris from construction material (fill material, etc.) and waste (concrete, contaminated soil, etc.) stockpiles to be transported offsite by wind? Yes No

 - (a) Select SS-7, temporary cover, plastic sheeting or other BMP to cover stockpiles subject to wind erosion year-round, especially when significant wind and dry conditions are anticipated during project construction. (Coordinate with District Construction for selection and preference of wind erosion control BMPs.) Complete

 - (b) Designate as a separate contract bid line item. Complete

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