FINAL REPORT

PRELIMINARY HYDROLOGY REPORT

160.10.25-030

INTERSTATE 710 CORRIDOR PROJECT

Prepared for

Metro

Los Angeles County
Metropolitan Transportation Authority

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ACRONYMS & ABBREVIATIONS

AC	Asphalt Concrete
BMP	Best Management Practices
Caltrans	California Department of Transportation
cfs	cubic feet per second
Co	County
fps	feet per second
HDM	Highway Design Manual
HM	Hydrology Manual
I-105	Interstate 105
I-405	Interstate 405
I-710	Interstate 710
LA	Los Angeles
N.	North
NB	Northbound
PS&E	Plans, Specifications & Estimate
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
RWQCB	Regional Water Quality Control Board
SR 91	State Route 91
S.	South
SB	Southbound
St	Street
WSPG	Water Surface and Pressure Gradient

1.0 EXECUTIVE SUMMARY

The I-710 Corridor Project Funding Partners[1] propose to improve the I-710 Corridor from Ocean Boulevard in the City of Long Beach to I-5 in East Los Angeles (Project). Alternatives under consideration include five Build Alternatives and a No-Build Alternative. The principal improvements included in the alternatives consist of widening and reconstructing the freeway to ten lanes and adding four separate freight movement lanes adjacent to the freeway.

The objective of this report is to evaluate changes in the on-site hydrology related to the proposed Project improvements. The report also provides preliminary dispositions of the existing storm drain systems that are interconnected to the Project. This analysis is developed to a level sufficient to support the Draft Project Report alternative cost estimates.

For the purpose stated above, the existing drainage systems were categorized into five types; on-site drainage, pumps, inflows, outlets, and transfer systems. In most cases the existing on-site storm drain systems will be removed entirely or significantly altered in conjunction with the proposed improvements. Many of the existing drainage systems also handle off-site flows (inflows to the Project) and outlet to the Los Angeles River directly or through several pump stations. Most of the pump stations have significant off-site tributary drainage areas and efforts should be made to maintain or augment the existing pump stations and associated outlets where possible. Existing outlet locations to the Los Angeles River should also be maintained where ever possible in an effort to minimize impacts to the existing channel walls. The proposed drainage systems within the project limits will be designed to convey storm water runoff from the proposed Project improvements and also transfer flows from legacy off-site drainage areas to existing Los Angeles River outlet locations.

Design flows from off-site storm areas were not always available from research information. Preliminary off-site flows were estimated using information on tributary drainage areas. Off-site hydrology within the City of Long Beach was developed by referencing their storm drain master plan information. Based on information provided by the master plan, some of the existing drainage systems require upgrading. These locations are noted in the tables. Nearly half of the existing drainage outlets and most pump stations will require replacement due to physical impacts of the new freeway alignment and profiles. Calculations are also provided to determine any increase in outflows due to the Project improvements and any related impacts to existing drainage systems. Impacts to the drainage are calculated for Alternative 5 and Alternative 6A.

Proposed Best Management Practice (BMP) water quality treatment systems associated with the I-710 corridor project are not included in this report as they are addressed in detail within the *Storm Water Data Report*. Water quality issues and an evaluation of the anticipated on-site storm water quality characteristics are addressed in the *Water Quality Report*. Potential Project impacts to the Los Angeles River hydraulics and associated flood plain are included in the *LA River Impact Report*.

[1] The I-710 Corridor Funding Partners are the Los Angeles County Metropolitan Transportation Authority (MTA), the California Department of Transportation (Caltrans), the Gateway Cities Council of Governments (GCCOG), the Port of Los Angeles (POLA), the Port of Long Beach (POLB), the Southern California Association of Governments (SCAG), and the I-5 Joint Powers Authority (I-5 JPA).

The preliminary hydrology and hydraulics analysis are performed in accordance with Caltrans Highway Design Manual and LA County Hydrology Manual. The hydrologic and hydraulic calculations consider 50-year and 25-year storm events for existing and proposed conditions.

2.0 INTRODUCTION

2.1 PURPOSE OF REPORT

The objective of this report is to evaluate changes in the on-site hydrology related to the proposed Project improvements. The report also provides preliminary dispositions of the existing storm drain systems that are interconnected to the Project. This analysis is developed to a level sufficient to support the Draft Project Report alternative cost estimates.

2.2 PROJECT INTRODUCTION

The Interstate 710 (I-710) Corridor Project study area includes the portion of I-710 (6 or 8 lanes) from Ocean Blvd. in Long Beach to State Route 60 (SR-60), a distance of approximately 18 miles (see Figure 1). At the freeway-to-freeway interchanges, the study area extends one mile east and west of I-710 for the Interstate 405 (I-405), State Route 91 (SR-91), Interstate 105 (I-105), and Interstate 5 (I-5) interchanges. The I-710 Corridor Project traverses portions of the cities of Bell, Bell Gardens, Carson, Commerce, Compton, Cudahy, Downey, Huntington Park, Lakewood, Long Beach, Los Angeles, Lynwood, Maywood, Paramount, Signal Hill, South Gate, and Vernon, and portions of unincorporated Los Angeles County, all within Los Angeles County, California.

I-710 (also known as the Long Beach Freeway) is a major north/south interstate freeway connecting the City of Long Beach to central Los Angeles. Within the I-710 Corridor Project study area, the freeway serves as the principal transportation connection for goods movement between the Port of Los Angeles (POLA)/Port of Long Beach (POLB) shipping terminals and the Burlington Northern Santa Fe (BNSF)/Union Pacific Railroad (UP) rail yards in the cities of Commerce and Vernon and destinations along I-710 as well as destinations north and east of I-710.

The I-710 Major Corridor Study (MCS), undertaken to address the mobility and safety needs of the I-710 Corridor and to explore possible solutions for transportation improvements, was completed in March 2005 and identified a community-based Locally Preferred Strategy (LPS) consisting of 10 general purpose (GP) lanes next to four separated freight movement lanes. The Los Angeles County Metropolitan Transportation Authority (Metro), the California Department of Transportation (Caltrans), the Gateway Cities Council of Governments (GCCOG), the Southern California Association of Governments (SCAG), POLA, POLB, and the Interstate 5 Joint Powers Authority (I-5 JPA) are collectively known as the I-710 Funding Partners. Through a cooperative agreement, these agencies are funding the preparation of preliminary engineering and environmental documentation for the I-710 Corridor Project to evaluate improvements identified in the Major Corridor Study along the I-710 Corridor from Ocean Blvd. in the City of Long Beach to SR-60. The I-710 Funding Partners have continued this engineering and environmental study effort within the same broad, continuous community participation framework that was used for the MCS.

The environmental impacts of the I-710 Corridor Project will be assessed and disclosed in compliance with both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Caltrans is the Lead Agency for CEQA compliance and the

lead agency for NEPA compliance pursuant to Section 6005 of the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (23 United States Code [USC] 327).

The need for the I-710 Corridor Project is as follows:

- I-710 experiences high heavy-duty truck volumes, resulting in high concentrations of diesel particulate emissions within the I-710 Corridor.
- I-710 experiences accident rates, especially truck-related, that are well above the statewide average for freeways of this type.
- At many locations along I-710, the on and off ramps do not meet current design standards and weaving sections within and between interchanges are of insufficient length.
- High volumes of both trucks and cars have led to severe traffic congestion throughout most of the day (6:00 a.m. to 7:00 p.m.) on I-710 as well as on the connecting freeways. This is projected to worsen over the next 25 years.
- Increases in population, employment, and goods movement between now and 2035 will lead to more traffic demand on I-710 and on the streets and roadways within the I-710 Corridor as a whole.

The purpose of the I-710 Corridor Project is to achieve the following within the I-710 Corridor (2035 time frame):

- Improve air quality and public health
- Improve traffic safety
- Provide modern design for the I-710 mainline
- Address projected traffic volumes
- Address projected growth in population, employment, and activities related to goods movement (based on SCAG population projections and projected container volume increases at the two ports)

2.3 PROJECT ALTERNATIVES

2.3.1 Alternatives Description

This section describes the alternatives based on the Major Corridor Study that were developed by a multidisciplinary technical team to achieve the I-710 Corridor Project purpose and subsequently were reviewed and concurred upon by the various committees involved in the I-710 Corridor Project community participation framework. Alternatives 2, 3, and 4 were

considered but withdrawn from further environmental study as stand-alone alternatives but elements of these alternatives have been included in Build Alternatives 5A, 6A, 6B, and 6C. The alternatives are Alternative 1 (No Build Alternative), Alternative 5A (I-710 Widening up to 10 General Purpose [GP] Lanes), Alternative 6A (10 GP Lanes plus a Four-Lane Freight Corridor), Alternative 6B (10 GP Lanes plus a Zero-Emissions Four-Lane Freight Corridor), and Alternative 6C (10 GP Lanes plus a Four-Lane Freight Corridor Tolled).

2.3.2 Alternative 1 – No Build Alternative

The No Build Alternative does not include any improvements within the I-710 Corridor other than those projects that are already planned and committed to be constructed by or before the planning horizon year of 2035. The projects included in this alternative are based on Southern California Association of Governments (SCAG's) 2008 Regional Transportation Improvement Program (RTIP) project list, including freeway, arterial, and transit improvements within the SCAG region. This alternative also assumes that goods movement to and from the ports make maximum utilization of existing and planned railroad capacity within the I-710 Corridor. Alternative 1 is the baseline against which the Build Alternatives proposed for the I-710 Corridor Project will be assessed. The existing I-710 mainline generally consists of eight GP lanes north of I-405 and six GP lanes south of I-405.

2.3.3 Alternative 5A – Freeway Widening up to 10 GP Lanes

Alternative 5A proposes to widen the I-710 mainline to up to ten GP lanes (northbound [NB] I-710 and southbound [SB] I-710). This alternative will:

- Provide an updated design at the I-405 and State Route 91 (SR-91) interchanges (no improvements to the I-710/Interstate 5 [I-5] interchange are proposed under Alternative 5A)
- Reconfigure all local arterial interchanges within the project limits that may include realignment of on and offramps, widening of on and offramps, and reconfiguration of interchange geometry
- Eliminate local street connections over I-710 (9th to 6th St. and 7th to 10th St.) in the City of Long Beach
- Eliminate a local interchange at Wardlow Ave. in the City of Long Beach
- Add a local street connection under I-710 to Thunderbird Villas at Miller Way in the City of South Gate
- Add a local street connection (bridge) over I-710 at Southern Ave. in the City of South Gate
- Add a local arterial interchange at NB and SB I-710/Slauson Ave. in the City of Maywood
- Shift the I-710 centerline at several locations to reduce right-of-way requirements.

Additionally, various structures such as freeway connectors, ramps, and local arterial overcrossings, structures over the Los Angeles River and structures over the two rail yards throughout the project limits will be replaced, widened, or added as part of Alternative 5A.

In addition to improvements to the I-710 mainline and the interchanges, Alternative 5A also includes Transportation Systems/Transportation Demand Management (TSM/TDM), Transit, and Intelligent Transportation Systems (ITS) improvements. TSM improvements include provision of or future provision of ramp metering at all locations and the addition of improved arterial signage for access to I-710. Parking restrictions during peak periods (7:00 a.m.–9:00 a.m.; 4:00 p.m.–7:00 p.m.) will be implemented on four arterial roadways: Atlantic Blvd. between Pacific Coast Hwy. and SR-60; Cherry Ave./Garfield Ave. between Pacific Coast Hwy. and SR-60; Eastern Ave. between Cherry Ave. and Atlantic Blvd.; and Long Beach Blvd. between San Antonio Dr. and Firestone Blvd. Transit improvements that will be provided as part of the I-710 Corridor Project include increased service on all Metro Rapid routes and local bus routes in the study area. ITS improvements include updated fiber-optic communications to interconnect traffic signals along major arterial streets to provide for continuous, real-time adjustment of signal timing to improve traffic flow as well as other technology improvements.

Alternative 5A also includes improvements to 42 local arterial intersections within the I-710 Corridor Project study area. These improvements generally consist of lane restriping or minimal widening to provide additional intersection turn lanes that will reduce traffic delay and improve intersection operations for those intersections with projected Level of Service (LOS) F.

In addition to the transportation system improvements described above, Alternative 5A also includes:

- Aesthetic Enhancements: Landscaping and irrigation systems would be provided within the corridor where feasible. Urban design and aesthetic treatment concepts for community enhancement will be integrated into the design of the I-710 Corridor Project. These concepts will highlight unique community identities within a unified overall corridor theme; strengthen physical connections and access/mobility within and between communities; and implement new technologies and best practices to ensure maximum respect for the environment and natural resources. They will continue to evolve and be refined through future phases of project development.

- Drainage/Water Quality Features: Alternative 5A includes modifications to the Los Angeles River levee; new, extended, replacement, and additional bents and pier walls in the Los Angeles River; additional and extended bents and pier walls in the Compton Channel; modifications to existing pump stations or provision of additional pump stations; and detention basins and bioswales that will provide for treatment of surface water runoff prior to discharge into the storm drain system.

2.3.4 Alternative 6A – 10 GP Lanes plus a Four-Lane Freight Corridor

Alternative 6A includes all the components of Alternatives 1 and 5A described above. (The alignment of the GP lanes in Alternative 6A will be slightly different than Alternative 5A in a few locations.) In addition, this alternative includes a separated four-lane freight corridor (FC) from

Ocean Blvd. northerly to its terminus near the UP and BNSF railyards in the City of Commerce. The FC would be built to Caltrans highway design standards and would be restricted to the exclusive use of heavy-duty trucks (5+ axles). In Alternative 6A these trucks are assumed to be conventional" trucks (conventional trucks are defined to be newer [post-2007] diesel/fossil-fueled trucks [new or retrofitted engines required per new regulations and standards].

The FC would be both at-grade and on elevated structure with two lanes in each direction. There are exclusive, truck only ingress and egress ramps to and/or from the FC at the following locations:

- Harbor Scenic Dr. (NB ingress only)
- Ocean Blvd. (NB ingress only)
- Pico Ave. (NB ingress and SB egress only)
- Anaheim St. (NB ingress and SB egress only)
- SB I-710 GP lanes just south of Pacific Coast Hwy (SB egress only)
- NB I-710 GP lanes north of I-405 at 208th St. (NB ingress only)
- SB I-710 GP lanes north of I-405 at 208th St. (SB egress only)
- Eastbound (EB) SR-91 (NB egress only)
- Westbound (WB) SR-91 (SB ingress only)
- Patata St (NB egress and SB ingress only)
- SB I-710 GP lanes at Bandini Blvd. (SB ingress only)
- NB I-710 GP lanes at Bandini Blvd. (NB egress only)
- Washington Blvd. – (NB egress and SB ingress only) (Design Options 1 and 2)
- Washington Blvd. (NB egress and SB ingress via Indiana Ave) (Design Option 3)
- Sheila St – (NB egress only) (Design Option 3)

In addition to the FC feature, Alternative 6A includes:

- Partial modification to the I-5 interchange, notably the replacement of the NB I-710 to NB I-5 connector (right-side ramp replacement of left-side ramp) and a realigned SB I-5 to SB I-710 connector and 5 SB GP lanes from SR-60 to Washington Blvd.
- 3 NB GP lanes from I-5 to SR-60
- Retention of and modification to the I-710 SB on and offramps at Eastern Ave. to slightly realign them.

- A local connection over I-710 at Patata St. in the cities of South Gate and Bell Gardens.

As with Alternative 5A, Alternative 6A will include additional aesthetic enhancements, and drainage/water quality features as follows:

Aesthetic Enhancements: In addition to the aesthetic enhancements described above for Alternative 5A, specific aesthetic treatments will be developed for the FC, including use of screen walls and masonry treatments on the FC structures (including soundwalls).

Drainage/water quality features: Alternative 6A includes features to capture and treat the additional surface water runoff from the FC, as well as some modifications to the Los Angeles River levees in order to accommodate electrical transmission line relocations.

2.3.5 Alternative 6B – 10 GP Lanes plus a Zero-Emissions Freight Corridor

Alternative 6B includes all the components of Alternative 6A as described above, but would restrict the use of the FC to zero-emission trucks rather than conventional trucks. This proposed zero emission truck technology is assumed to consist of trucks powered by electric motors in lieu of internal combustion engines and producing zero tailpipe emissions while traveling on the freight corridor. The specific type of electric motor is not defined, but feasible options include linear induction motors, linear synchronous motors or battery technology. The power systems for these electric propulsion trucks could include, but is not limited to, hybrid with dual-mode operation (ZEV Mode), Range Extender EV (Fuel Cell or Turbine with ZEV mode), Full EV (with fast charging or infrastructure power), road-connected power (e.g., overhead catenary electric power distribution system), alternative fuel hybrids, zero NOx dedicated fuel engines (CNG, RNG, H2 ICE), and range extender EV (turbine). For purposes of the I-710 environmental studies, the zero-emission electric trucks are assumed to receive electric power while traveling along the FC via an overhead catenary electric power distribution system (road-connected power).

Alternative 6B also includes the assumption that all trucks using the FC will have an automated control system that will steer, brake, and accelerate the trucks under computer control while traveling on the FC. This will safely allow for trucks to travel in “platoons” (e.g., groups of 6–8 trucks) and increase the capacity of the FC from a nominal 2,350 passenger car equivalents per lane per hour (pces/ln/hr) (as defined in Alternative 6A) to 3,000 pces/ln/hr in Alternative 6B.

The design of the FC will also allow for possible future conversion, or be initially constructed, as feasible (which may require additional environmental analysis and approval), of a fixed-track guideway family of alternative freight transport technologies (e.g., Maglev). However, this fixed-track family of technologies has been screened out of this analysis for now, as they have been determined to be inferior to electric trucks in terms of cost and ability to readily serve the multitude of freight origins and destinations served by trucks using the I-710 corridor.

2.3.6 Alternative 6C – 10 GP Lanes plus a Four-Lane Freight Corridor with Tolls

Alternative 6C includes all the components of Alternative 6B as described above, but would toll trucks using the FC. Although tolling trucks in the FC could be done under either Alternative 6A or 6B; for analytical purposes, tolling has only been evaluated for Alternative 6B as this

alternative provides for higher FC capacity than Alternative 6A due to the automated guidance feature of Alternative 6B.

Tolls would be collected using electronic transponders which would require overhead sign bridges and transponder readers like the SR-91 toll lanes currently operating in Orange County, where no cash toll lanes are provided. The toll pricing structure would provide for collection of higher tolls during peak travel periods.

2.3.7 Design Options

For alternatives 6A, 6B, and 6C, three design options for the portion of I-710 between the I-710/Slauson Ave interchange to just south of the I-710/I-5 interchange are under consideration. These configurations will be fully analyzed so that they can be considered in the future selection of a Preferred Alternative for the project. These options are as follows:

Design Option 1

Design Option 1 applies to Alternatives 6A, 6B and 6C and provides access to Washington Blvd using three ramp intersections at Washington Blvd.

Design Option 2

Design Option 2 applies to Alternatives 6A, 6B, and 6C and provides access to Washington Blvd. using two ramp intersections at Washington Blvd.

Design Option 3

Design Option 3 applies only to Alternative 6B[2] and removes access to Washington Blvd. at its current location. The ramps at the I-710/Washington Blvd. interchange would be removed to accommodate the proposed FC ramps in and out of the railyards. The SB off-ramp and NB-on-ramp access would be accommodated by Alternative 6B in the vicinity of the existing interchange by the proposed new SB off-ramp and NB on-ramp at Oak St. and Indiana St. These two ramps are proposed as mixed-flow ramps (freight connector ramps that would also allow automobile traffic). However, the SB on-ramp and NB off-ramp traffic that previously used the Washington Blvd. interchange would be required to access the Atlantic Blvd./Bandini Blvd. interchange located south of the existing Washington Blvd. interchange to ultimately reach I-710.

Because the similar physical features associated with Alternatives 6A, 6B, and 6C and inconsequential hydrological differences in the Options, these alternatives are collectively described herein as Alternative 6A. The analysis and results of this report apply to all these alternatives.

[2] Design Option 3 only applies to Alternative 6B because it was not included in the travel demand modeling for either Alternative 6A or 6C.

2.4 PROJECT SEGMENTS

To facilitate design, analysis, and organization, this report breaks down the project geographically into seven segments. Table 2-1 provides the segment limits and interchange locations. The Segment/Package Key Map included in Appendix A illustrates the segment and package (sub-area) limits.

Table 2-1
I-710 Segments

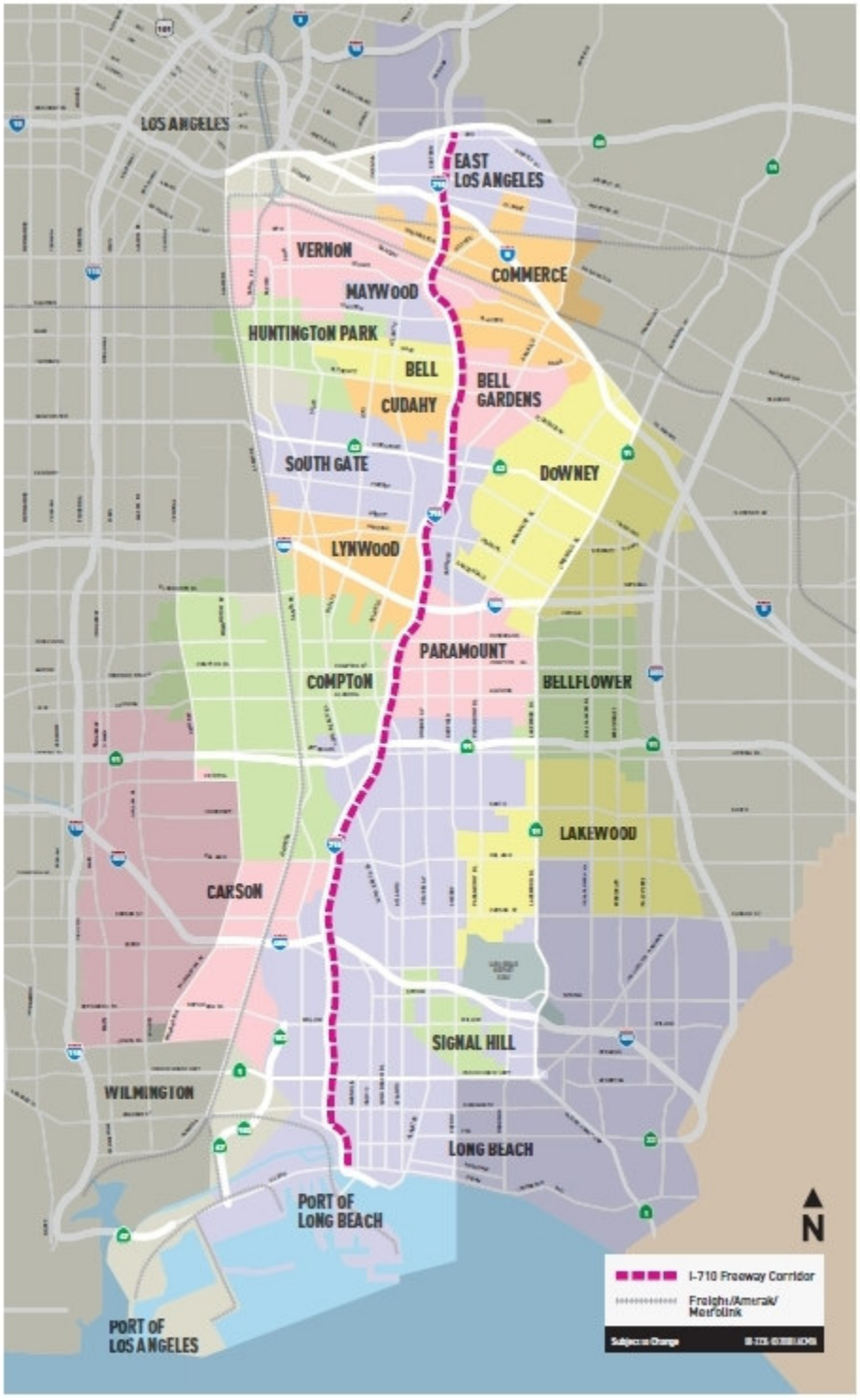
Segment	Limits	Interchanges
1	Ocean Blvd to Willow Street *City of Long Beach*	▪ Ocean Blvd ▪ Harbor Scenic Drive ▪ Pico Avenue ▪ Shoreline Drive (Downtown) ▪ Anaheim Street ▪ Pacific Coast Highway ▪ Willow Street
2	Wardlow Road to Del Amo Blvd *City of Long Beach* *City of Carson* *County of Los Angeles*	▪ Wardlow Road ▪ Interstate 405 ▪ Del Amo Boulevard ▪ Santa Fe Avenue (at I-405) ▪ Pacific Place (at I-405)
3	Long Beach Blvd to Alondra Blvd *City of Long Beach* *City Of Compton* *City of Paramount*	▪ Long Beach Boulevard ▪ Artesia Boulevard ▪ State Route 91 ▪ Alondra Boulevard ▪ Long Beach Boulevard (at SR91)
4	Rosecrans Avenue to Firestone Blvd *City of Paramount* *City of Lynwood* *City of South Gate*	▪ Rosecrans Avenue ▪ Interstate 105 ▪ Martin Luther King Jr Boulevard ▪ Imperial Highway ▪ Firestone Boulevard
5	Clara Street to Slauson Avenue *City of Bell Gardens* *City of Cudahy* *City of Bell* *City of Maywood* *City of Vernon*	▪ Florence Avenue ▪ Slauson Avenue (New)
6	Atlantic Blvd to Washington Blvd *City of Vernon* *City of Commerce* *County of Los Angeles*	▪ Atlantic Boulevard ▪ Bandini Boulevard ▪ Washington Boulevard
7	I-5 to SR60 *City of Commerce* *City of East Los Angeles* *County of Los Angeles*	▪ Interstate 5 ▪ Olympic Boulevard ▪ 3rd Street ▪ State Route 60

Hydrology for Segment 7 is prepared by others and included in Appendix 12. The analysis follows the same methodology applied in this report.

2.5 SITE DESCRIPTION

I-710 Corridor is located at the north end of the Peninsular Ranges physiographic province in the central and south-central coastal plain area of the Los Angeles Basin. The land use along I-710 Corridor generally consists of residential south of the 105 freeway and mixed north to the I-5 freeway. Within the City of Long Beach, the drainage area tributary to the 710 is approximately 64% residential land use and 18% commercial land use. Three regional drainages including the Los Angeles River, Rio Hondo, and Compton Creek confluence within the I-710 Corridor. The Los Angeles River has the largest watershed and covers over 830 square miles. I-710 Corridor is located on the west side of Los Angeles River from Ocean Boulevard in City of Long Beach to Imperial Highway in City of Southgate and on the east side of Los Angeles River from Imperial Highway in City of Southgate to Washington Boulevard in City of Commerce. The I-710 corridor runs parallel to the Los Angeles River from Ocean Boulevard to past Slauson Avenue. In addition to the drainage systems located within the I-710 Corridor, there are significant drainage areas that pass through the I-710 Corridor before entering into the Los Angeles River. Figure 1 shows the project location.

Figure 1
I-710 EIR/EIS Corridor Study Area



3.0 EXISTING CONDITIONS AND FACILITIES

This section describes the existing on-site and off-site drainage conditions identified from as-built information, site visits, aerial photos and other information obtained from Caltrans, LA County and City of Long Beach.

3.1 EXISTING DRAINAGE FACILITIES

The I-710 Corridor contains a complex series of interconnected drainage systems that handle comingled flows from both on-site and off-site drainage areas. There are several drainage outlet scenarios depending on the relative elevation differential to the Los Angeles River levee and other physical constraints presented along the Project corridor. Most drainage areas are handled by pump stations located adjacent to the LA River. These pump stations handle commingled flows from on-site and off-site drainage areas. A listing of the existing pump stations affected by the Project is included in Appendix 3. As the terrain and freeway profile rise relative to the river levee height, more gravity drainage systems handle drainage from the freeway ROW and adjacent off-site drainage areas. Existing drainage systems that traverse the Project boundary fall into three categories; Inflows, outlets, and transfer flows. See Appendix 4 for tables of the existing drainage systems affected by the Project. Existing drainage systems located within the Project footprint are generally assumed to require replacement due to the revised geometrics. The disposition of existing drainage systems is discussed in more detail below. The Pico Avenue interchange area drains to the Port of Long Beach through two pump stations. Segments 1-3 and half of segment 4 drain easterly to the Los Angeles River. Above the midpoint of segment 4, the drainage pattern is generally westerly to the Los Angeles River. A brief description of the existing drainage facilities located in each freeway segment is provided here:

- Segment 1 – The terrain in this segment is lower than the Los Angeles River levee height and large drainage areas are handled by a series of pump stations situated in the Long Beach Harbor and at the major arterial interchanges including Anaheim Street, PCH, and Willow Street.

- Segment 2 – Due to higher terrain, this segment contains several gravity-flow drainage systems that outlet to the Los Angeles River. The Dominguez Basin, located north of the 405 interchange, serves to meter outflow from off-site drainage areas located west of the interchange. A Caltrans' pump station located at the Blue Line Overcrossing handles drainage from a low point in the freeway profile. There are several existing gravity outlets that enter the Southern California Edison right-of-way and Compton Creek that will be affected by the I-710 improvements.

- Segment 3 – This segment includes pump stations located at Long Beach Boulevard, 91 Freeway Interchange, and Alondra Boulevard that handle large off-site drainage areas.

- Segment 4 – This segment has several gravity systems that outlet to the Los Angeles River. A Caltrans' pump station is located at the South Gate UP Crossing. The Bandini Trunk storm drain is a 20' x 10' concrete drainage channel and is located between the I-710 and the Los Angeles River. This drainage system transfers off-site flows to the LA River and also receives flows from several smaller drainage pipes.

- Segment 5 – This segment has Caltrans' pump stations located at Clara Street, Gage Avenue, and Slauson Avenue to handle low points in the freeway profile.

- Segment 6 – The freeway is elevated through this segment. Smaller, localized drainage systems typically drain to city streets or connect to two major County flood control drains. Drainage District Improvement (DDI) 23 is a 25' by 7' Reinforced Concrete Box (RCB) that generally runs north/south within Ayers Avenue. DDI 26 is 20' x 9' RCB aligned north/south and is located just west of the I-710 alignment near the BNSF rail yard. Both DDI's traverse under the existing UP and BNSF rail yards west of the I-710 alignment and run south to the LA River.

- Segment 7 – See Appendix 12.

3.2 AS-BUILT INFORMATION

Available as-built plan information collected for the existing drainage systems was incorporated into Drainage Base Maps. While the maps indicate the majority of the existing drainage systems within the I-710 corridor project, the existing drainage systems displayed were limited to what was illustrated on the as-built plans and the City of Long Beach storm drain atlas maps. The City of Long Beach also provided information from their Stormwater Management System *Conveyance Facilities* database regarding the hydraulic capacity of the existing stormwater systems and required replacement sizing for segments of the existing system that were deemed undersized. A more detailed review of as-built information will be required as a part of the design phase of the project. As-built data containing information utilized for this report are tabulated in Appendix 2.

3.3 ON-SITE CONDITIONS

The existing I-710 is an eight-lane freeway in LA County providing a vital north-south connection from the Ports of Los Angeles and Long Beach to inland destinations all over the Los Angeles basin.

The on-site stormwater runoff is conveyed through drainage facilities or pump stations to outlets located in the Los Angeles River, Compton creek, or the Long Beach Harbor before eventually discharging into the Pacific Ocean. Each of the existing Pump Stations that are utilized by the Project drainage area are identified and tabulated in Appendix 3.

Compton Creek confluences with the Los Angeles River just South of the Del Amo Boulevard / I-710 interchange. The Compton Creek Watershed is predominantly residential, comprised of

small single family homes, multifamily units, and significant areas of commercial and industrial facilities.

The Rio Hondo confluences with the Los Angeles River just north of the Imperial Highway / I-710 Interchange. The Rio Hondo, a distributary of the San Gabriel River, is a flood control channel operating in conjunction with the Whittier Narrows dam.

The Dominguez Gap Recharge Basins are located in the northeast quadrant of I-710/I-405 interchange. There are basins located on the east and west sides of the Los Angeles River. A siphon originating from the east basin travels under the Los Angeles River and supplies the west basin. The west facility includes two linked retention basins that serve as recharge facilities and water quality basins. The west basin is served by a 54" storm drain entering a pump station located between the two basins. The 54" pipe collects runoff from the interchange and off-site areas west of the I-710 Corridor. A 60" outlet is located at the south end of the southerly basin under the northbound 405 to the northbound 710 connector. The retention basin located on the west side of the Los Angeles River will be affected by the project. The existing basins located on the east side of the Los Angeles River will not be affected by the project.

The on-site drainage areas are defined based on the topography, roadway profiles, super-elevation, and existing drainage systems. These drainage areas may feed multiple drainage systems before reaching an outlet or pump station. The existing on-site drainage systems consist of a complex series of drainage inlets, cross culverts, AC dikes, over-side drains, concrete and earthen channels, pump stations, and detention basins located within the vicinity of or directly within the I-710 right-of-way. The I-710 lanes and ramps generally sheet flow to the shoulders where drainage collects along curbs before entering into underground pipes or down-drains. In super-elevated sections of the I-710 corridor, storm water may drain to the median shoulders where drainage inlets convey the runoff to the cross drainage facilities. Underground storm drain systems generally confluence flows into larger pipes before entering a pump station or the Los Angeles River. In some cases the underground systems outlet onto vegetated areas adjacent to the Corridor right-of-way or City Streets.

Drainage subarea maps for the existing condition were developed and are included in Appendix 9. The drainage maps show on-site tributary area to the systems, direction of flow within each tributary area, outlet locations, pump locations, and tributary area designation. Hydrologic data and calculations were performed to determine the on-site runoff during the 25-year and 50-year storm events. A tabulation of the existing drainage subareas is included in Table 3-1 and detailed calculations are included in Appendix 6. Outlet capacity calculations and recommendations for upsizing are included in Appendix 7.

Table 3-1
Existing Drainage Subareas

Segment 1 (Ocean Blvd to Willow Street)

Area Designation	Existing Tributary Area (Acres)	50 Year Flow, Q_{50} (cfs)	25 Year Flow, Q_{25} (cfs)	Outlet
1A	21.65	62.0	54.4	To pump station P1.
1B	18.82	55.1	48.4	To pump station P2.
1C	4.57	14.3	12.6	O1, outlet into Long Beach Harbor Dept. Channel #3.
1D	11.41	29.8	25.5	
1E	4.31	14.1	12.4	O2, outlet into Long Beach Harbor Dept. Channel #2.
1F	6.55	18.4	16.2	18” to pump station P3.
1G	11.57	31.2	27.4	21” to pump station P3.
1H	2.78	9.3	8.2	To local drainage system.
1I	22.77	105.6	92.7	To pump station P4.
1J	2.17	6.8	5.9	To local drainage system.
1K	43.11	117.3	102.9	To pump station P5.
1L	2.52	8.5	7.4	To pump station P6.
1M	42.51	121.5	106.7	To pump station P7.

Segment 2 (Wardlow Road to Del Amo Blvd)

Area Designation	Existing Tributary Area (Acres)	50 Year Flow, Q_{50} (cfs)	25 Year Flow, Q_{25} (cfs)	Outlet
2A	3.37	10.1	8.9	To local drainage system.
2B	34.61	93.6	82.1	O3, 36” pipe (Permit No. 58404B)
2C	19.52	57.5	50.5	To local drainage system.
2D	41.66	116.6	102.4	O4, 60” pipe
2E	5.33	15.9	13.9	O4, 60” pipe
2F	24.79	75.0	65.9	O4, 60” pipe
2G	6.03	18.1	15.9	O5
2H	15.0	44.1	38.7	O4
2I	14.1	43.4	38.1	Pump station P9
2J	5.1	15.6	13.7	O9
2K	2.9	8.2	7.2	O10
2L	6.5	19.5	17.2	O10
2M	3.26	8.9	7.8	O10
2N	1.95	6.3	5.5	O10, 24” RCP
2O	23.7	74.6	65.5	O10

Segment 3 (Long Beach Blvd to Alondra Blvd)

Area Designation	Existing Tributary Area (Acres)	50 Year Flow, Q_{50} (cfs)	25 Year Flow, Q_{25} (cfs)	Outlet
3A	4.25	13.13	11.53	P11
3B	23.78	75.59	66.37	P11
3C	0.77	2.84	2.49	Long Beach Blvd.
3D	3.09	11.42	10.03	P12
3E	9.08	31.09	27.30	O12
3F	3.52	12.38	10.87	O12
3G	2.74	7.43	6.53	P13
3H	44.91	141.78	124.49	P13
3I	11.31	35.16	30.87	P14
3J	3.85	13.52	11.87	P13
3K	24.50	74.88	65.74	Long Beach Blvd.
3L	11.78	36.43	31.98	Long Beach Blvd.
3M	7.14	21.68	19.03	P13
3N	9.11	28.34	24.88	O13
3O	2.21	7.90	6.93	O13
3P	32.93	103.32	90.71	P16
3Q	4.02	14.28	12.54	Alondra Blvd.

Segment 4 (Rosecrans Avenue to Firestone Blvd)

Area Designation	Existing Tributary Area (Acres)	50 Year Flow, Q_{50} (cfs)	25 Year Flow, Q_{25} (cfs)	Outlet
4A	24.53	72.97	64.07	O14
4B	1.21	4.49	3.94	O14
4C	10.17	26.70	23.44	O15
4D	17.02	49.67	43.61	O16
4E	12.28	35.07	30.79	O17
4F	8.68	25.98	22.81	O17
4G	87.08	258.69	227.13	P17
4H	45.81	135.96	119.37	O18
4I	1.60	5.93	5.20	Imperial Hwy.
4J	4.50	12.81	11.25	O19
4K	18.88	56.67	49.75	O20
4L	4.35	15.56	13.66	O20
4M	1.26	4.05	3.56	NA
4N	17.13	47.11	41.36	P18
4O	0.82	2.92	2.57	Firestone Blvd.
4P	20.92	62.50	54.87	P18
4Q	9.43	23.88	20.97	P18

Segment 5 (Clara Street to Slauson Avenue)

Area Designation	Existing Tributary Area (Acres)	50 Year Flow, Q_{50} (cfs)	25 Year Flow, Q_{25} (cfs)	Outlet
5A	9.28	29.43	25.84	P19
5B	32.12	86.11	75.60	P20
5C	1.26	4.36	3.83	Florence Ave.
5D	1.21	4.20	3.68	Florence Ave.
5E	19.86	58.99	51.79	P21
5F	18.42	54.08	47.48	P22
5G	2.92	10.12	8.88	Slauson Ave.
5H	2.78	9.60	8.43	Slauson Ave.

Segment 6 (Atlantic Blvd to Washington Blvd)

Area Designation	Existing Tributary Area (Acres)	50 Year Flow, Q_{50} (cfs)	25 Year Flow, Q_{25} (cfs)	Outlet
6A	9.92	27.69	24.31	O22
6B	32.47	91.40	80.25	O22
6C	8.15	28.22	24.77	Bandini Blvd.
6D	9.29	29.81	26.18	O22
6E	13.57	40.90	35.91	Washington Blvd.
6F	5.81	17.88	15.70	O22
6G	0.98	3.40	2.99	O22

Segment 7 (I-5 to SR-60) – See Appendix 12

3.4 OFF-SITE CONDITIONS

Because of the I-710's proximity to the LA River, significant off-site drainage areas are tributary to the drainage systems located within the Project limits. The off-site areas tributary to the I-710 drainage systems consist mainly of commercial, residential and vacant land parcels in the southern reaches of the Project. A demarcation is made at the Project boundary, and the existing drainage systems that cross the boundary are categorized by function. Dispositions of the existing drainage systems are based in-part on their function and are discussed later in this report. The existing off-site drainage systems include inflows, outlets, and transfer systems. Summary tables of existing off-site drainage systems that traverse the Project right-of-way are included in Appendix 4.

4.0 HYDROLOGIC ANALYSIS

4.1 DESIGN CRITERIA

Hydrologic calculations for watersheds affected by the Project were computed in accordance with the parameters outlined in LA County Hydrology Manual and *Caltrans Highway Design Manual, Topic 830* to estimate the 25-year and 50-year storm events. Specifically, the rational method was used exclusively to determine all design discharges.

4.1.1 Design Storm

According to Table 831.3 of the *Caltrans Highway Design Manual*, hydrologic calculations for roadway drainage are based upon maintaining the 25-year return frequency design water spread within the shoulder for areas within the freeway traveled-way and 10-year return frequency design water spread within the shoulder for ramps and frontage roads. As a conservative approach, all hydrologic calculations including those for the on- and off-ramps and adjacent local streets were based upon a 25-year return frequency for this project. In instances where roadway depressions require pumping, a 50-year return frequency was used.

4.1.2 Initial Time of Concentration

Per Section 832.3 of the *Caltrans Highway Design Manual*, a 5-minute time of concentration was used for watersheds within the project limits to determine rainfall intensity.

4.1.3 Rainfall Intensities

The 50-year 24-hour isohyet values were determined using Figures 1-H1.5, 1-H1.9, and 1-H1.19 (See Appendix 5) of the *Los Angeles County Hydrology Manual*. The corresponding 25-year 24-hour isohyet values were determined using a reduction factor of 0.878 as specified in the *Los Angeles County Hydrology Manual*. The peak 5-minute intensity for the 50-year and 25-year storm was determined using Equation 5.1.2 of the *Los Angeles County Hydrology Manual*.

4.1.4 Runoff Coefficients

The runoff coefficient used for impervious materials such as concrete or asphalt was 1.00 per Section 819.2 of the *Caltrans Highway Design Manual*. An average runoff coefficient of 0.60 for pervious surfaces such as cut and fill slopes was calculated from Figure 819.2A of the *Caltrans Highway Design Manual* and used for the entire I-710 corridor project based on estimated 4H to 1V cut and fill slopes, normal soil infiltration, poor to fair vegetal cover and low surface storage. Runoff coefficients for off-site areas were determined based on the land use and in accordance with *Los Angeles County Hydrology Manual*.

4.2 RAINFALL CHARACTERISTICS

The climate of this region is classified as Mediterranean – generally dry in the summer with mild, wet winters. The average annual rainfall is approximately 38 centimeters (15 inches) with most precipitation occuring during the winter months between November and March. The rainy season for the project area has been defined by the Regional Water Quality Control Board as October 1 through May 1.

For Gateway cities such as City of Long Beach and City of Los Angeles, the 49-year average minimum and average maximum temperatures recorded during the period 1958 – 2007 is 46°F and 83°F, respectively. The average annual precipitation over the same 49-year period is 11.96 inches.

4.3 SOIL TYPES AND INFILTRATION

Based on the U.S. Soil Conservation Services criteria, soils are classified into four hydrological soil groups: A, B, C, D, where Group A is the most pervious with low runoff potential (such as sands or gravel's) and Group D is the least pervious with high runoff potential (such as clay soils).

The majority of the project area has been classified as Soil Type A, B, and C and are consistent with *Los Angeles County Hydrology Manual* soil classification of 003, 006, 014, and 015. These types of soils are defined as follows;

- 003 – CHINO SILT LOAM (NRC Soil Group C) - The Chino series have gray, calcareous, silt loam A horizons and gray and light gray, calcareous silty clay loam C horizons. *Poorly to somewhat poorly drained. Many areas have been drained by stream channel entrenchment or reduction of ground water level by pumping. Runoff is slow to very slow. Permeability is moderately slow.*

- 006 – HANFORD FINE SANDY LOAM (NRC Soil Group B) - The Hanford series consists of very deep, well drained soils that formed in moderately coarse textured alluvium dominantly from granite. Hanford soils are on stream bottoms, floodplains and alluvial fans and have slopes of 0 to 15 percent. The mean annual precipitation is about 12 inches and the mean annual air temperature is about 63 degrees F. *Well drained; negligible to low runoff; moderately rapid permeability.*

- 014 – RAMONA SANDY LOAM (NRC Soil Group C) - The Ramona series is a member of the fine-loamy, mixed, thermic family of Typic Haploxeralfs. Typically, Ramona soils have brown, slightly and medium acid, sandy loam and fine sandy loam A horizons, reddish brown and yellowish red, slightly acid, sandy clay loam B2t horizons, and strong brown, neutral, fine sandy loam C horizons. *Well-drained; slow to rapid runoff; moderately slow permeability.*

- 015 – TUJUNGA FINE SANDY LOAM (NRC Soil Group A) - The Tujunga series consists of very deep, somewhat excessively drained soils formed in alluvium weathered mostly from granitic sources. Tujunga soils are on alluvial fans and flood plains and have slopes of 0 to 9 percent. The mean annual precipitation is about 16 inches and the mean annual air temperature is about 62 degrees F. *Somewhat excessively or excessively drained; negligible or very low runoff; rapid permeability. Flooding is none to frequent.*

4.4 LAND USE

In determining the land use, aerial photography, field investigation, and topographic data were utilized. The existing topography is a highly developed urbanized area. The freeway is constrained on both sides with residential/commercial/industrial areas and LA River.

On-site Drainage – Caltrans defines on-site drainage as the storm water runoff, which originates within the Caltrans right-of-way. The on-site drainage consists of paved areas assigned the "Commercial" runoff coefficient and vegetated areas assigned the "Unpaved" runoff coefficient. Proposed drainage subareas were separated into paved and un-paved portions to support hydrology calculations.

Off-site Drainage – Caltrans defines off-site drainage as the storm water runoff, which originates outside the Caltrans right-of-way. Off-site hydrology was developed using available information on tributary areas and associated land-use.

For Rational Method calculations, a composite of 65% impervious area was used to calculate off-site peak flows. This is calculated using 64% high density residential, 18% commercial, and 18% miscellaneous land use.

4.5 FLOW PATTERNS

Most of the I-710 corridor resides between existing developed areas and their respective drainage outlets to the various regional flood control facilities. In locations where there are existing pump stations that outlet to the LA River there are substantial off-site drainage areas that are tributary to each pump station. Off-site tributary areas are collected in underground storm drains and outlet into the forebay located at each pump station. The on-site drainage is collected in a similar manner. On-site drainage systems include inlets, paved channels and underground storm drain systems. While the proposed freeway improvements may alter the location of existing pump stations and on-site flow patterns in localized areas, the confluence locations will remain in the general vicinity and existing LA River outlets will be utilized whenever possible to minimize impacts to the river channel. The existing inflow drainage connections will be maintained and accommodated with the proposed on-site drainage systems. Existing drainage patterns on the arterial streets will be maintained by utilizing existing underground drains wherever possible.

The drainage subareas for the proposed alternatives 5 and 6 are shown in Appendix 9.

4.6 METHODOLOGY AND COMPUTATION PROCEDURES

The on-site runoff flows for the 25-year and 50-year storm event were calculated according to the Rational Method hydrologic procedures mentioned in the *Los Angeles County Hydrology Manual* and *Caltrans Highway Design Manual* using an excel spreadsheet. The on-site drainage area was divided into subareas based on the existing outlet locations and the proposed roadway profiles. Subareas were then confluence to the corresponding historical outlet locations. The hydrology calculations for the 25-year peak discharges were performed to determine any increase in the on-site flow and determine the impact on existing outlets. The hydrology calculations for the 50-year peak discharges were performed to determine the impact

on sumps and the existing pump stations. Off-site flows were included in the evaluation at historical confluence points and pump stations.

4.7 SUMMARY OF HYDROLOGY CALCULATIONS

The hydrologic calculations of the two storm events were calculated for the existing condition and the proposed Alternatives 5A and 6A. Alternative 6A is cumulative, in that, it includes Alternative 5A drainage areas and Alternative 6A drainage areas. The construction of the freight corridor was not evaluated as a stand-alone project alternative in this report. The project's total on-site peak flow for each case are shown in Table 4-1 hereon. For detail calculations see Appendix 6.

Table 4-1
Total Project Runoff

Alternatives	Q_{50} (cfs)	Q_{25} (cfs)
Existing	3,415	2,998
Alternative 5A	3,523	3,094
Alternative 6A	4,222	3,707

In order to determine the impact of the project alternatives on the existing drainage outlet facilities, the peak flows of Alternatives 5 and Alternative 6A were compared with the existing condition peak flows to determine if the differential was significant. Any significant increase in the drainage area peak flow was considered a factor in determining if outlets will require reconstruction. Other factors included physical impacts to the existing drainage systems and local agency recommendations to upgrade already deficient facilities. The City of Long Beach has included recommendations for upgrading existing storm drain pipes in their Stormwater Management System database. Any recommendations for upgrading existing facilities that are impacted by the Project alternatives are included in the tables in Appendix 7 & 8. The project's overall changes in peak flows are as follows; Alternative 5A will generate additional 108 cfs during the 50-year storm event and 96cfs during 25-year storm event while Alternative 6A will generate additional 807 cfs and 709 cfs for the 50- and 25-year storm events respectively. Table 4-2 summarizes the drainage differences for the various project outlets within each sub area.

Table 4-2
Peak Flow Comparison at Project Outlets

Proposed Outlet ID	Proposed Area ID	Existing Area ID	Exiting Condition		Alternative 5A		Alternative 6A		Alternative 5A		Alternative 6A	
			Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)
P1	1A	1A	62	54.4	42.1	36.9	42.1	36.9	-19.9	-17.5	-19.9	-17.5
P2	1B	1B	55.1	48.4	32	28.1	29.9	26.3	-23.1	-20.3	-25.2	-22.1
P3A	1D	-	-	-	4.6	4.1	19.8	17.4				
P3A	1E	-	-	-	5	4.4	5.3	4.6				
P3A	-	1E	14.1	12.4	-	-	-	-				
Outlet Total			14.1	12.4	9.6	8.5	25.1	22				
O1	1F	1F	18.4	16.2	29.3	25.8	34.6	30.4	10.9	9.6	16.2	14.2
O2	1C	-	-	-	8.9	7.9	8.9	7.9				
O2	1G	1G	31.2	27.4	10.3	9	14.5	12.7				
Outlet Total			31.2	27.4	19.2	16.9	23.4	20.6	-12	-10.5	-7.8	-6.8
O3	1I	NA			24	21.1	40.8	35.8				
O4	1S	1H	9.3	8.2	9.9	8.6	13.4	11.8	0.6	0.4	4.1	3.6
P4	1H	-	-	-	24.3	21.4	25.4	22.3				
P4	1J	-	-	-	48	42.2	59.9	52.6				
Outlet Total			-	-	72.3	63.6	85.3	74.9				
O5	1K	-	-	-	7.6	6.7	7.6	6.7				
O5	-	1J	6.8	5.9	-	-	-	-				
Outlet Total			6.8	5.9	7.6	6.7	7.6	6.7	0.8	0.8	0.8	0.8
P5	1L	-	-	-	20.2	17.7	20.3	17.8				
P5	1M	-	-	-	97.4	85.5	116.6	102.4				
P5	-	1K	117.2	102.9	-	-	-	-				
Outlet Total			117.2	102.9	117.6	103.2	136.9	120.2	0.4	0.3	19.7	17.3

Proposed Outlet ID	Proposed Area ID	Existing Area ID	Exiting Condition		Alternative 5A		Alternative 6A		Alternative 5A		Alternative 6A	
			Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)
P6	-	1L	8.5	7.4	-	-	-	-				
P6	1O	-	-	-	10.6	9.4	10.6	9.3				
Outlet Total			8.5	7.4	10.6	9.4	10.6	9.3	2.1	2	2.1	1.9
O6 & O7	2A	-	-	-	39.4	34.6	48.2	42.3				
O6 & O7		2B	93.6	82.1	-	-	-	-				
O6 & O7	2C	2C	57.5	50.5	21.6	18.9	21.7	19				
O6 & O7	2D	-	-	-	151.3	132.8	158.5	139.1				
Outlet Total			151.1	132.6	212.3	186.3	228.4	200.4	61.2	53.7	77.3	67.8
P7		1M	121.5	106.7	-	-	-	-				
P7	1N	-	-	-	34.4	30.2	37.9	33.4				
P7	1P	-	-	-	12.1	10.6	12.1	10.6				
P7	1Q	-	-	-	39.2	34.4	43.4	38.1				
P7	1R	-	-	-	42.9	37.6	57.1	50.2				
Outlet Total			121.5	106.7	128.6	112.8	150.5	132.3	7.1	6.1	29	25.6
O8	2E	-	-	-	78.4	68.8	78.6	69				
O8	-	2G	18.1	15.9	-	-	-	-				
O8	-	2H	44.1	38.7	-	-	-	-				
Outlet Total			62.2	54.6	78.4	68.8	78.6	69	16.2	14.2	16.4	14.4
P8	2G	-	-	-	9.7	8.5	44.9	39.5				
P8	2H	-	-	-	10.2	8.9	10.2	8.9				
P8	-	2J	15.6	13.7	-	-	-	-				
Outlet Total			15.6	13.7	19.9	17.4	55.1	48.4	4.3	3.7	39.5	34.7
O9	-	2D	116.6	102.4	-	-	-	-				
O9	2F	-	-	-	86.6	75.9	93.8	82.4				

Proposed Outlet ID	Proposed Area ID	Existing Area ID	Exiting Condition		Alternative 5A		Alternative 6A		Alternative 5A		Alternative 6A	
			Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)
Outlet Total			116.6	102.4	86.6	75.9	93.8	82.4	-30	-26.5	-22.8	-20
P9	2I	-	-	-	76.2	66.9	94.3	82.8				
P9	-	2I	43.4	38.1	-	-	-	-				
Outlet Total			43.4	38.1	70.1	61.6	88.3	77.5	26.7	23.5	44.9	39.4
P10	-	3A	13.1	11.5								
P10	3B	3B	75.6	66.4	20.2	17.7	21.5	18.9				
Outlet Total			88.7	77.9	20.2	17.7	21.5	18.9	-68.5	-60.2	-67.2	-59
P11	3C				9.4	8.3	9.3	8.2				
P11		3D	11.4	10	-	-	-	-				
Outlet Total			11.4	10	9.4	8.3	9.3	8.2	-2	-1.7	-2.1	-1.8
P12		3M	21.7	19								
O13	2K	TBD	-	-	14	12.3	15.4	13.5				
O13	2L	TBD	-	-	21.4	18.8	31.9	27.9				
Outlet Total			-	-	35.4	31.1	47.3	41.4				
P13		3G	7.4	6.5	-	-	-	-				
P13	3H	-	-	-	23.3	20.5	26.9	23.7				
P13		3I	35.2	30.9	-	-	-	-				
Outlet Total			42.6	37.4	23.3	20.5	26.9	23.7	-19.3	-16.9	-15.7	-13.7
P14	3D	-	-	-	38.7	34	49.4	43.4				
P14	3G	-	-	-	185.4	162.8	207.9	182.6				
P14	-	3H	141.8	124.5	-	-	-	-				
P14	-	3O	7.9	6.9	-	-	-	-				
Outlet Total			149.7	131.4	224.1	196.8	257.3	226	74.4	65.4	107.6	94.6
O14	2J	TBD			17.6	15.5	17.6	15.5				

Proposed Outlet ID	Proposed Area ID	Existing Area ID	Exiting Condition		Alternative 5A		Alternative 6A		Alternative 5A		Alternative 6A	
			Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)
O15	2N	TBD			15	10	15	10				
P15	3L	-	-	-	97.3	85.5	103.2	90.6				
O16	2N				77.9	71.6	110.9	100.5				
O17	3A	-	-	-	106.3	93.3	147.3	129.3				
O17	-	3E	31.1	27.3	-	-	-	-				
O17	-	3F	12.4	10.9	-	-	-	-				
Outlet Total			43.5	38.2	106.3	93.3	147.3	129.3	62.8	55.1	103.8	91.1
P17	4L	-	-	-	106.9	93.9	118.5	104.5				
O18	3F	-	-	-	12.8	11.3	12.8	11.2				
O18		3J	13.5	11.9	-	-	-	-				
Outlet Total			13.5	11.9	12.8	11.3	12.8	11.2	-0.7	-0.6	-0.7	-0.7
P18	5A	5A	29.4	25.8	126.8	111.4	142.6	125.2				
P18	5B	5B	86.1	75.6	3.2	2.8	3.2	2.8				
P18	-	5C	4.4	3.8	-	-	-	-				
P18	5D	-	-	-	14.6	12.8	14.6	12.8				
P18		5E	4.2	3.7	-	-	-	-				
Outlet Total			124.1	108.9	144.6	127	160.4	140.8	20.5	18.1	36.3	31.9
O19	3E	-	-	-	43	37.8	43	37.8				
O19	-	3K	74.9	65.7	-	-	-	-				
O19	-	3L	36.4	31.9	-	-	-	-				
Outlet Total			111.3	97.6	43	37.8	43	37.8	-68.3	-59.8	-68.3	-59.8
P19	5E	5E	58.9	51.8	69.9	61.4	77.5	68				
P19	5F		-	-	3.7	3.3	3.8	3.3				
Outlet Total			58.9	51.8	73.6	64.7	81.3	71.3	14.7	12.9	22.4	19.5

			Exiting Condition		Alternative 5A		Alternative 6A		Alternative 5A		Alternative 6A	
Proposed Outlet ID	Proposed Area ID	Existing Area ID	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)
P20		5F	54.1	47.5								
P20	5I	-	-	-	21.5	18.9	27.6	24.2				
P20	5G	-	-	-	53.2	46.8	76	66.7				
Outlet Total			54.1	47.5	74.7	65.7	103.6	90.9	20.6	18.2	49.5	43.4
O20	3I				59	51.8	61.7	54.2				
O20		3N	28.3	24.5	-	-	-	-				
Outlet Total			28.3	24.5	59	51.8	61.7	54.2	30.7	27.3	33.4	29.7
O21	3J	-	-	-	18.5	16.2	18.5	16.2				
O22	3M	-	-	-	19.7	17.3	21.3	18.7				
O22	4A	4A	73	64.1	46.1	40.4	51.2	44.9				
O22	4B	4B	4.5	3.9	12.2	10.7	12.2	10.7				
Outlet Total			77.5	68	78	68.4	84.7	74.3	0.5	0.4	7.2	6.3
O23 & O24	4C	4C	26.7	23.4	8.5	7.5	8.5	7.5				
O23 & O24	4D	4D	49.7	43.6	96.3	84.5	121.3	106.5				
O23 & O24	-	4E	35.1	30.8	-	-	-	-				
O23 & O24	-	4F	26	22.8	-	-	-	-				
Outlet Total			137.5	120.6	104.8	92	129.8	114	-32.7	-28.6	-7.7	-6.6
O25	4E	-	-	-	281.1	246.8	296.3	260.2				
O25		4G	258.7	227.1	-	-	-	-				
Outlet Total			258.7	227.1	281.1	246.8	296.3	260.2	22.4	19.7	37.6	33.1
O26	4F	-	-	-	118.5	104	150.2	131.8				
O26	4H	4H	136	119.4	22.3	19.6	22.3	19.6				
Outlet Total			136	119.4	140.8	123.6	172.5	151.4	4.8	4.2	36.5	32
O27	4I				19.7	17.3	25.6	22.4				

Proposed Outlet ID	Proposed Area ID	Existing Area ID	Exiting Condition		Alternative 5A		Alternative 6A		Alternative 5A		Alternative 6A	
			Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)	Delta Q_{50} (cfs)	Delta Q_{25} (cfs)
O27	4J	4J	12.8	11.3	20.4	17.9	20.4	17.8				
O27	4K	4K	56.7	49.8	72.9	64	74.1	65.1				
O27	-	4L	15.6	13.7								
Outlet Total			85.1	74.8	113	99.2	120.1	105.3	27.9	24.4	35	30.5
O28		4Q	23.9	21	-	-	-	-				
O28	4M	-	-	-	9.7	8.5	9.7	8.5				
O28	4N	-	-	-	19.9	17.5	19.9	17.5				
O28	4O	-	-	-	13.3	11.7	13.3	11.7				
Outlet Total			23.9	21	42.9	37.7	42.9	37.7	19	16.7	19	16.7
O29	5J				46.1	40.5	82.8	72.7				
O29	6A	6A	27.7	24.3	28.3	24.8	31.4	27.6				
Outlet Total			27.7	24.3	74.4	65.3	114.2	100.3	46.7	41	86.5	76
O30	6B	6B	91.4	80.3	60.6	53.2	68.2	59.9				
O30	6C	6C	28.2	24.8	52.2	45.8	112.2	98.5				
Outlet Total			119.6	105.1	112.8	99	180.4	158.4	-6.8	-6.1	60.8	53.3
O31	6D	-	-	-	4.9	4.3	31.9	28				
O31	6E	6E	40.9	35.9	47.3	41.6	42.3	37.1				
O31	-	6F	17.9	15.7	-	-	-	-				
Outlet Total			58.8	51.6	52.2	45.9	74.2	65.1	-6.6	-5.7	15.4	13.5

Table Notes:

P3 is downstream of O2.
Area 2B goes to Warlow street SD.
Area 2M goes to the Del Amo Street SD.
Area 3B goes to LBB street SD.
Area 3K goes to the Alondra street SD.
Area 4G goes to Imperial street SD.
Area 5C, 5D goes to the Florence street SD.Area 5H, 5I goes to the Slauson street SD.
P9 drains to the O10 LA river outlet.
P16 is connected to Outlet O25.
O11 & O12 are secondary outlets to the LA River.

5.0 HYDRAULIC ANALYSIS

5.1 DESIGN CRITERIA

All hydraulic analyses were performed in accordance with the Caltrans HDM and LA County Hydrology Manual.

The design standards are summarized as follows:

- Since most of the existing on-site drainage facilities will be reconstructed, only the outlet systems were analyzed for existing capacity in order to determine the need for replacement. Existing Project inflows are assumed to be accommodated by the proposed Project drainage systems.

- Where existing calculations are not available, Manning's equation was utilized to determine the maximum flow capacity (Full flow) of the outlet. A manning coefficient of 0.013 was utilized for concrete outlet and 0.025 for corrugated metal outlet.

- Size and slope of pipe or box was based on available as-built drawings and atlas. A slope of 0.5% was used for outlets where data is not available.

5.2 METHODOLOGY AND COMPUTATION PROCEDURES

After the design storm peak flow rates were developed using the County's hydrology method, drainage subareas were summed up at their historical outlet locations. The adequacy of the existing outlets were evaluated based on the proposed design flows and the capacity of the existing outlets.

The proposed flow for both Alternative 5A and Alternative 6A were compared to the capacity of the outlet and any deficiencies were identified. The recommended sizes were then selected for the proposed facilities.

Existing pump stations that are required to be relocated due to proposed freeway geometrics were not evaluated. Detailed hydraulic analysis for relocated pump stations and associated outlet structures will be performed as a part of final design.

Pump stations that are proposed to be protected-in-place will require evaluation for hydraulic capacity sufficient to accommodate proposed 50-year peak Project flows. For the purpose of developing a disposition of the existing facilities, this evaluation was done simply by conservation of flow. The pump capacity was compared to the peak inflow considering both on-site and off-site contributing flows in a steady state condition.

5.3 SUMMARY OF RESULTS

There are 30 existing drainage outlets impacted by the proposed improvements. These range in size from 18" pipes to a double 6' x 12' reinforced concrete box. Of the 30 existing outlets identified, 18 are proposed to be utilized by the proposed improvements. This determination was made based on hydraulic sufficiency and detailed engineering is required to determine the

most efficient drainage scheme for the proposed improvements. The remaining outlets will require removal and reconstruction based on the physical impacts by the proposed improvements or based on the need to increase hydraulic capacity of the outlet.

There are 22 existing pump stations impacted by the proposed Project. Out of the 22 locations 19 require modification including upgrading facilities to accommodate projected peak flows, relocation due to proposed improvements, or reconstruction due to freeway widening and/or profile changes. Detailed hydraulic analysis will be required to determine any necessary upgrades to existing facilities and to determine the most efficient method of accommodating the project peak flows. All pump stations located on the east side of the Los Angeles River are assumed to be protected-in-place as part of the Project improvements.

The detailed calculations and evaluation of the existing outlets and pump stations are tabulated in Appendix 7 and Appendix 8 respectively.

6.0 PROPOSED DRAINAGE SYSTEMS

6.1 IMPACTS ON EXISTING DRAINAGE SYSTEMS

The Project improvements along the I-710 corridor will require substantial reconstruction of the existing drainage systems including drainage inlets, storm drains, cross culverts, AC dikes, overside drains, concrete & earthen channels, pump stations and detention basins. Most of the existing on-site drainage systems will be replaced with new facilities. Some existing facilities may be extended to accommodate the wider freeway. The existing Dominguez Basin wetland located in the northeast quadrant of the I-710/I-405 interchange will not be impacted by the I-710 corridor improvements associated with Alternative 5A as there are no proposed improvements adjacent to the existing basin. In the Alternative 6A improvements, the existing basin and levees will be impacted by the proposed freight corridor alignment, retaining walls, and slopes which are below the Los Angeles River levee grade in the vicinity of the basin. Any loss in capacity within the existing basins due to the proposed alignment will be addressed by mitigation measures. Mitigation measures are the subject of the I-710 EIR/EIS Los Angeles River Impact Report. The increase in on-site storm water runoff contributing to the Dominguez Basin associated with the proposed improvements is inconsequential in comparison to the amount of storm water runoff from off-site tributary watersheds and transfer flows from the basins located on the east side of the Los Angeles River.

Most off-site drainage systems that convey flows from the adjacent neighborhoods, cross the I-710 corridor, and receive on-site flows, will be replaced within the Caltrans right-of-way. Off-site systems crossing the corridor that do not receive on-site runoff will be protected-in-place where possible.

6.2 PROPOSED ON-SITE DRAINAGE SYSTEMS

The proposed on-site drainage systems within the project limits will be designed to intercept the storm water runoff from I-710 corridor improvements and the areas within Caltrans right-of-way. The proposed project will maintain the existing on-site flow patterns along a majority of the I-710 corridor. New drainage systems consisting of drainage inlets, cross culverts, AC dikes, overside drains, concrete & earthen channels and pump stations will be proposed to accommodate the increased on-site storm water runoff. The storm water runoff from the proposed freight corridor associated with Alternative 6A will be captured by drainage inlets and deck drains and discharged to the adjacent drainage systems through the proposed structural columns. To satisfy the storm water quality requirements, various treatment systems will be placed within Caltrans right-of-way as outlined in the Storm Water Data Report. The on-site storm water runoff will be conveyed through drainage systems and pump stations into the LA River and then eventually discharged into the Pacific Ocean. The design of the on-site drainage facilities will be performed in the design phase of the project

6.3 OFF-SITE DRAINAGE SYSTEMS

The existing off-site drainage areas and associated drainage systems that are tributary to the Project have been identified in Appendix 4. As part of the proposed improvements along the I-710 corridor, the existing off-site drainage peak flows will be accommodated. Some existing drainage systems that handle off-site flows will require reconfiguration in conjunction with the relocation of existing pump stations. Other facilities that transfer off-site flows will be extended or reconfigured to maintain the drainage pattern. The proposed project will maintain the existing off-site flow patterns where practical. In locations where existing peak flows exit the Caltrans right-of-way directly onto local streets, new Project drainage systems will be designed to allow for treatment prior to discharging into appropriate underground systems. The off-site storm water runoff will be conveyed through underground drainage systems and pump stations into the LA River and then subsequently discharged into the Pacific Ocean. The design of the off-site drainage facilities will be performed in the design phase of the project

7.0 WATER QUALITY ISSUES

Water quality issues are addressed in the I-710 corridor project's Water Quality Report. Treatment of on-site storm water runoff is addressed in the Storm Water Data Report. To the maximum extent practicable and in coordination with LA RWQCB and Caltrans water quality requirements, several BMP's such as bioswales, biofiltration strips, and detention basins will be featured in the proposed project alternatives. The BMPs will be located within proposed Caltrans right-of-way and are expected to treat the majority of the on-site storm water runoff generated by the project alternatives.

8.0 REPORT LIMITATIONS

This report has been prepared for the I-710 Corridor EIR/EIS Project and is to be used solely in the planning of the project described in this report. This report may not contain sufficient information for other uses or the purposes of other parties.

The conclusions presented in this report are based upon the assumption that the hydrological and hydraulic conditions do no deviate substantially from those described in the report. The possibility of different hydrological and hydraulic conditions cannot be discounted.

Professional judgments presented in this report are based on an evaluation of the technical information gathered, the understanding of the proposed construction and general experience in the field of hydrology. The consultant does not guarantee the performance of the project in any respect, only that the engineering work and judgments rendered meet the standard of care in the profession.

9.0 REFERENCES

Caltrans Highway Design Manual (HDM), September 2006

Caltrans Storm Water Quality Handbook, Project Planning and Design Guide, May 2007

Los Angeles County Hydrology Manual, January 2006

U.S. Geological Survey, 2006, Quad Maps and Aerial Photography

City of Long Beach Stormwater Management Model