Appendix 4.A
Structural Control Measure Fact Sheets

BMP Fact Sheets were developed for each subcategory of structural BMPs.   Each BMP Fact Sheet further details BMP functions, design variations, and typical design components. A relative performance gauge is used to display the BMP performance functions for each subcategory.

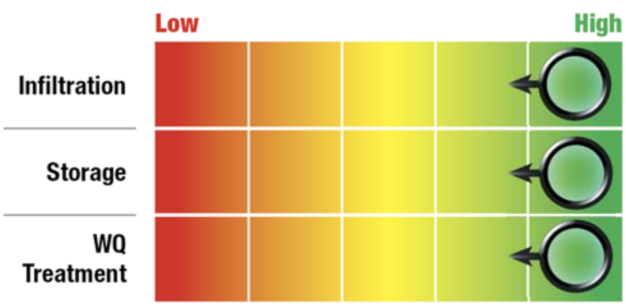
4.A.1 BMP Fact Sheets for Regional BMPs

Regional BMPs are constructed structural practices intended to treat runoff from a contributing area of multiple parcels (normally on the order of 10s or 100s of acres or larger). Regional practices include *infiltration facilities* that promote groundwater recharge and *detention facilities* that encourage settling. Infiltration and detention regional BMPs can be either constructed as open-surface basins or subsurface galleries. Regional practices also include *constructed wetlands,* which use engineered wetland environments to encourage pollutant removal, and *treatment facilities*, which use either conventional or innovative treatment processes to target pollutants of concern or divert flows to sanitary sewer.

Infiltration Facilities (Regional BMP)

Infiltration facilities are designed to decrease runoff volume through groundwater recharge and improve water quality through filtration and sorption. Facilities can incorporate engineered medias to improve percolation into native soils. Infiltration facilities can be open-surface basins or subsurface galleries.

BMP Performance Functions



Design Variations

Several design variations include:

- ***Surface Infiltration Basins:*** depressions designed to infiltrate stormwater into the subgrade soils. Facilities can be vegetated to encourage evapotranspiration and aesthetics. Also known as spreading grounds.
- ***Subsurface Infiltration Galleries:*** underground storage systems designed to infiltrate stormwater into subgrade soils. Subsurface systems are used when limited area is available for BMP implementation.

Typical Design Components

Figure 4.A-1 presents a typical design and highlights potential design variations:

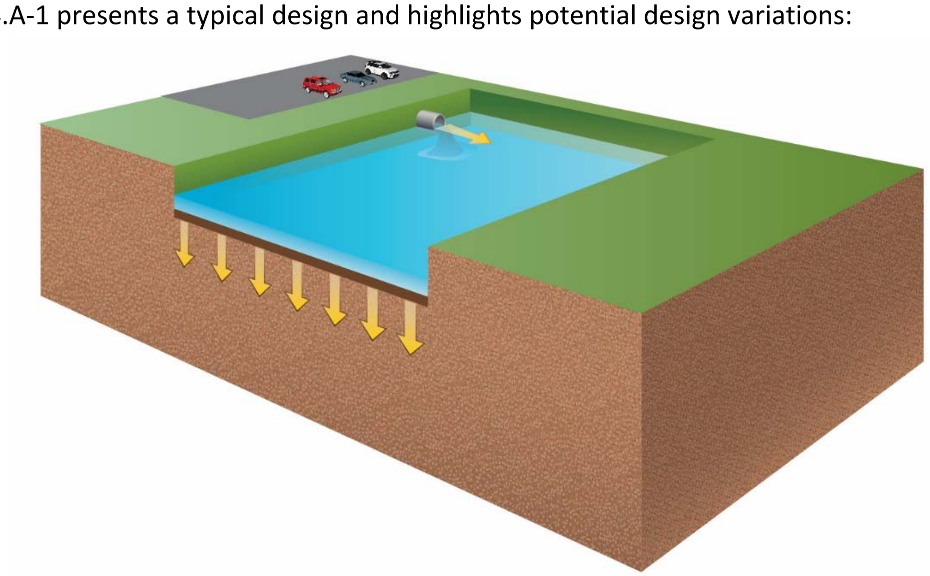
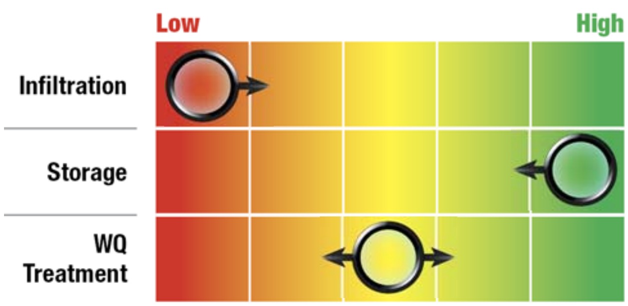


Figure 4.A-1. Typical regional infiltration facility schematic (arrows indicate water pathways).

Detention Facilities (Regional BMP)

Detention facilities are designed to detain runoff and improve water quality through pollutant settling. Facilities encourage settling by decreasing runoff flow rates and allowing ponding to occur. Detention facilities can be open-surface practices or subsurface galleries and can be dry during non-rainy seasons or wet year-round.

BMP Performance Functions



Design Variations

Several design variations include:

- ***Surface Detention Basins:*** basins designed to detain stormwater runoff for a specified time to allow sedimentation of particle-bound pollutants. Surface systems can have permanent pools or fully drain between storms.
- ***Subsurface Detention Galleries:*** underground storage systems designed to detain stormwater. Subsurface systems are used when limited area is available for BMP implementation.

Typical Design Components

Figure 4.A-2 presents a typical design and highlights potential design variations:

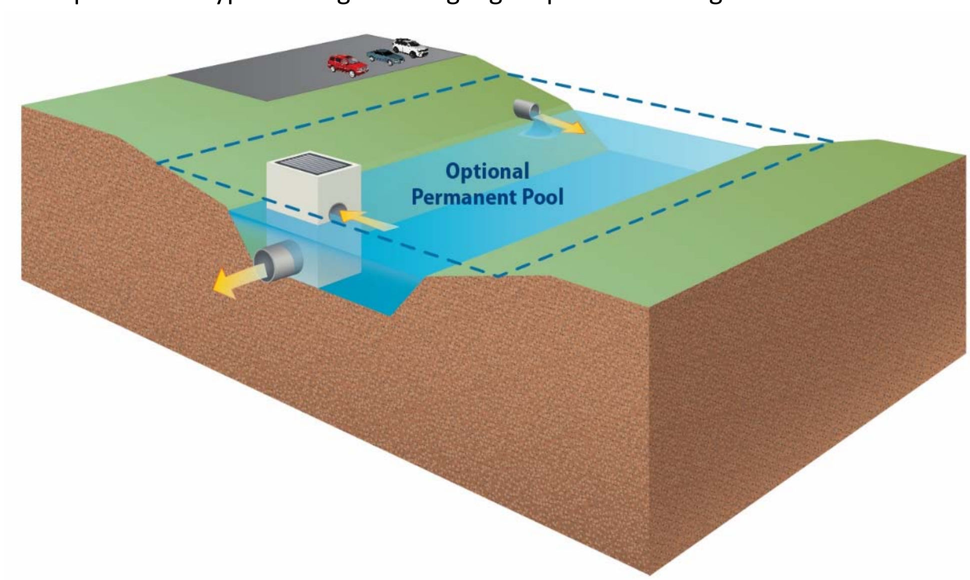
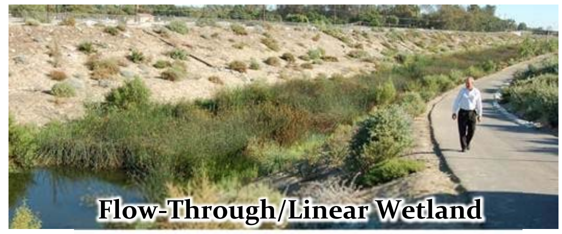


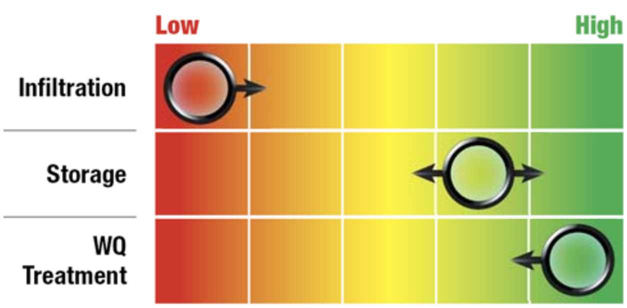
Figure 4.A-2. Typical regional detention facility schematic (arrows indicate water pathways).

Constructed Wetlands (Regional BMP)

Constructed wetlands are engineered, shallow-marsh systems designed to control and treat stormwater runoff. Particle-bound pollutants are removed through settling, and other pollutants are removed through biogeochemical activity. Constructed wetlands must always maintain a baseflow into the system, which can come from an intersected groundwater or an associated low-flow diversion utilizing dry-weather flows.



BMP Performance Functions



Design Variations

Several design variations include:

- ***Wetland Basins:*** basins with shallow permanent pools and a temporary shallow ponding zone. An outlet control structure typically regulates dewatering of the temporary storage volume.
- ***Flow-through/Linear Wetlands:*** wetlands that provide treatment as water passes through a long flow path. These wetlands are typically constructed parallel to existing channels such that water can be easily diverted.

Typical Design Components

Figure 4.A-3 presents a typical design and highlights potential design variations:

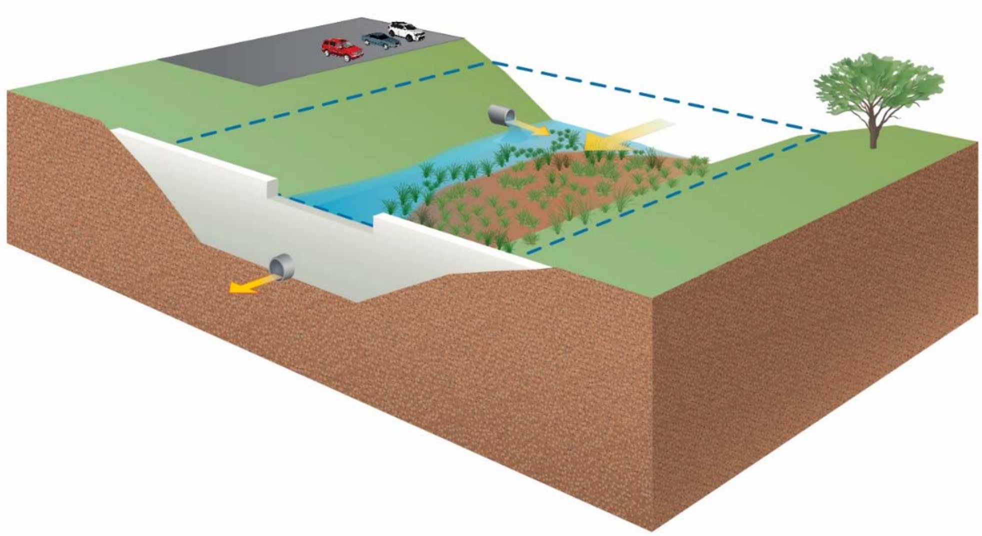
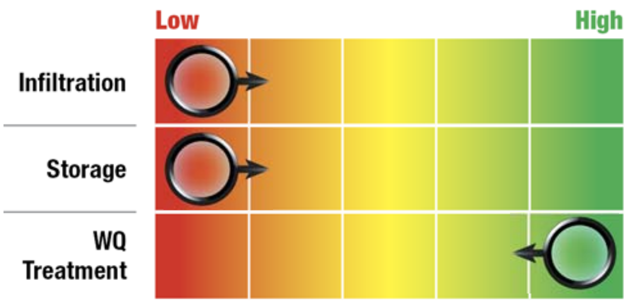


Figure 4.A-3. Typical regional constructed wetland schematic (arrows indicate water pathways).

Treatment Facilities (Regional BMP)

Other regional water quality technology falls into the *treatment facilities* subcategory. These systems typically divert flow from engineered channels to a treatment facility. Water is treated using physical, chemical, or radiological processes and is then used to offset potable water supply, returned to the original channel, or discharged to the treatment plant outfall.

BMP Performance Functions



Design Variations

Treatment facilities design variations include:

- ***Low Flow Diversion:*** a design flow rate (typically dry weather flow) is diverted from the storm drain to a sanitary sewer for treatment.
- ***Treatment and Return:*** water is pumped or conveyed by gravity from a channel to a small-scale wastewater treatment facility where it is treated and discharged back into the original channel. Sometimes a portion of treated water can be diverted for reuse.

Typical Design Components

Figure 4.A-4 presents a typical design and highlights potential design variations:

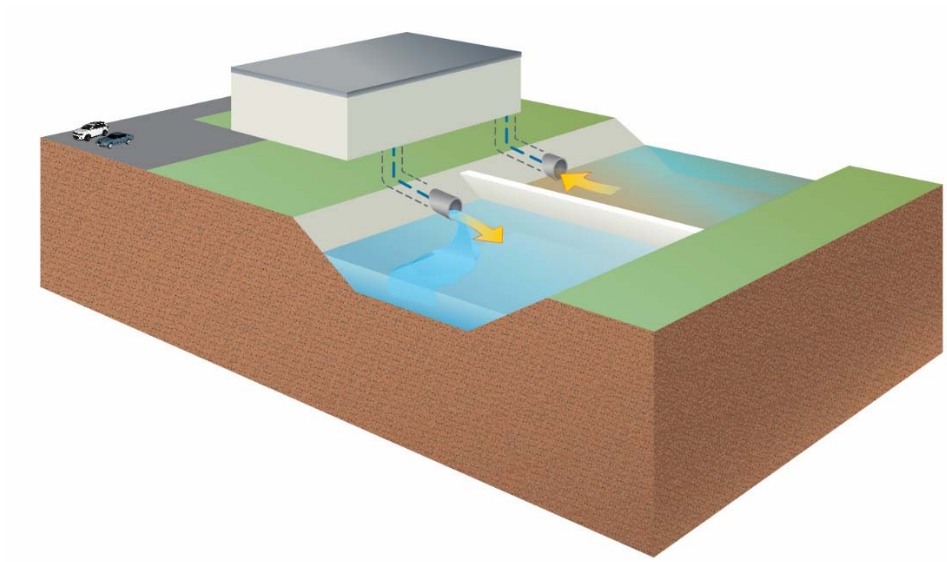


Figure 4.A-4. Typical regional treatment facility schematic (arrows indicate water pathways; a low flow diversion would direct flow to the nearby sanitary sewer).

4.A.2 BMP Fact Sheets for Distributed BMPs

Distributed BMPs are constructed structural practices intended to treat runoff relatively close to the source and typically implemented at a single- or few-parcel level (normally less than one acre). As described in the following BMP Fact Sheets, distributed BMPs include the following subcategories:

- Site-scale detention facilities
- Green infrastructure
- Flow-through treatment BMPs
- Source control structural BMPs

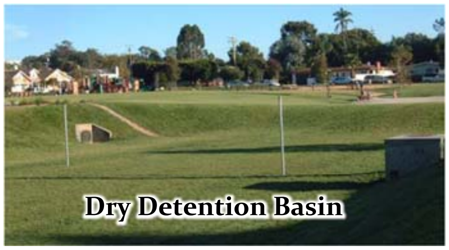
A major subcategory of distributed BMPs is *green infrastructure*. The Permit specifies that EWMPs should "incorporate effective technologies, approaches and practices, including green infrastructure." The primary goal of distributed green infrastructure BMPs is to intercept and treat runoff near its source using resilient natural systems. As opposed to traditional *gray infrastructure,* green infrastructure relies on contact between runoff, soils, and vegetation to accomplish volume and pollutant reduction. Green infrastructure has been shown to cost-effectively reduce the impacts of wet-weather flows while also reducing BMP maintenance requirements (Kloss et al. 2006). In addition, green infrastructure can provide multiple benefits to the surrounding community, including increased property values, increased enjoyment of surroundings and sense of well-being, increased safety, and reduced crime rate (Ward et al. 2008; Shultz and Schmitz 2008; Wolf 2008; Northeastern Illinois Planning Commission 2004; Hastie 2003; Kuo 2003; Kuo et al. 2001a; Kuo et al. 2001b; Wolf 1998).

Structural BMPs incorporated into the green infrastructure subcategory include the following, as described in the BMP Fact Sheets below:

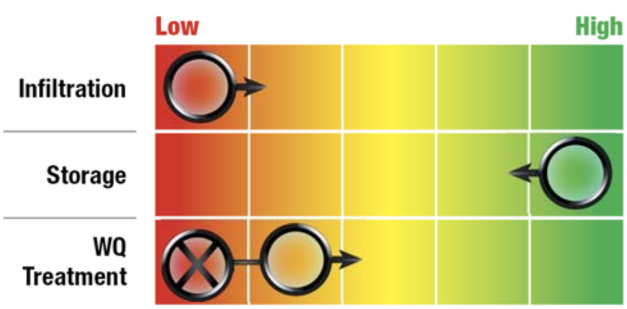
- Bioretention and biofiltration
- Permeable pavement
- Green streets
- Bioswales
- Infiltration BMPs
- Rainfall harvest (green roofs, cisterns and rain barrels)

Site-Scale Detention (Distributed BMP)

Site-scale detention facilities are designed to detain runoff from an individual parcel and improve water quality through pollutant settling. Site-scale detention facilities can reduce peak flows and improve water quality by storing water in a basin before slowly draining the water through an orifice to the downstream waterway. Settling of sediment and sediment-bound pollutants is the primary pollutant removal mechanism.



BMP Performance Functions



Design Variations

Several design variations include:

- ***Dry Detention Basins:*** Runoff ponds on the basin surface and fully drains between storm events. The drawdown orifice is located at the bottom of the basin.
- ***Wet Detention Pond:*** Runoff is captured in a temporary storage zone above a permanent pool. The drawdown orifice sets the depth of the permanent pool.
- ***Detention Chambers:*** Subsurface chambers or vaults designed to detain captured runoff.

Typical Design Components

Figure 4.A-5 presents a typical design and highlights potential design variations:

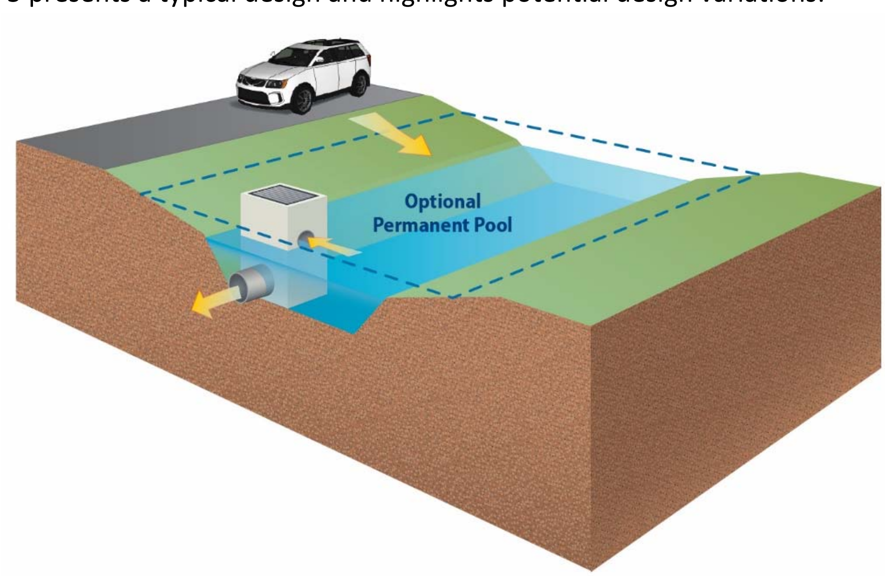
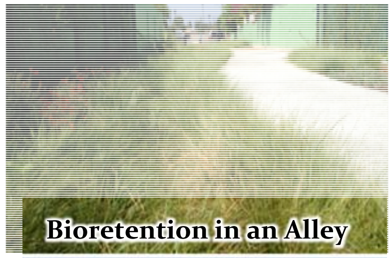


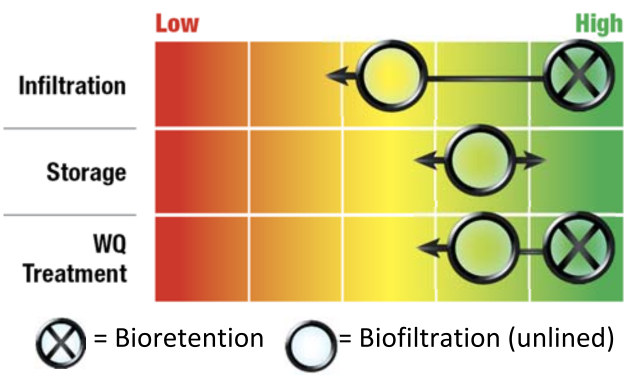
Figure 4.A-5. Typical distributed site-scale detention schematic (arrows indicate water pathways).

Bioretention and Biofiltration (Green Infrastructure BMP)

Bioretention and biofiltration are vegetated BMPs designed to capture and filter stormwater runoff through a soil layer. Following filtration, treated runoff infiltrates underlying soils (bioretention), or, if the subgrade has poor permeability, exits through an underdrain to the downstream conveyance network (biofiltration). Vegetation can enhance biological treatment processes.



BMP Performance Functions



Design Variations

Several design variations include:

- ***Bioretention:*** shallow, depressed, vegetated basins with permeable soil media. Runoff temporarily ponds on the surface before filtering through the soil. Bioretention does not include underdrains.
- ***Biofiltration:*** bioretention areas with underdrains. Infiltration is considered incidental, although substantial infiltration can occur in some unlined systems.

Typical Design Components

Figure 4.A-6 presents a typical design and highlights potential design variations:

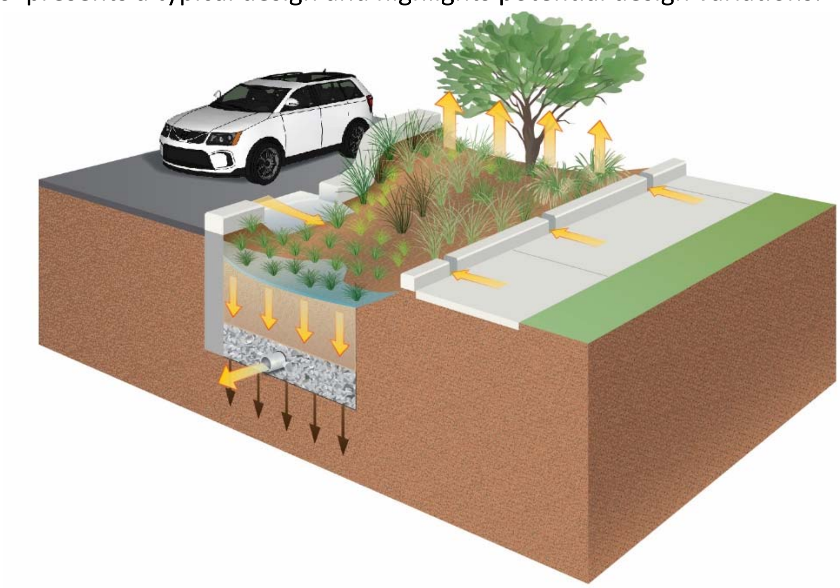
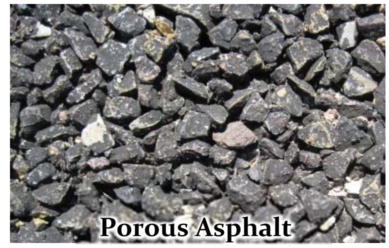


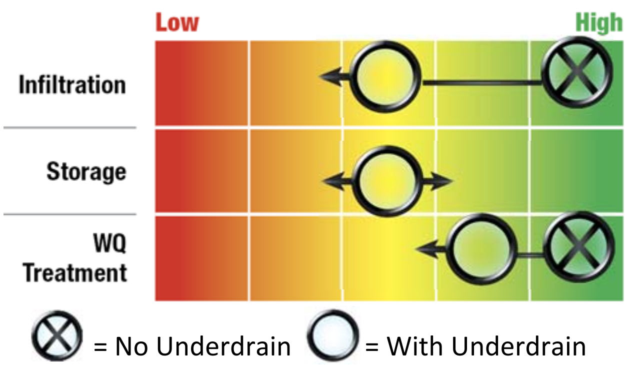
Figure 4.A-6. Typical distributed bioretention and biofiltration schematic showing underdrain option (arrows indicate water pathways).

Permeable Pavement (Green Infrastructure BMP)

Permeable pavement is a stable load-bearing surface that allows for stormwater infiltration. Beneath the permeable surface is a crushed-rock reservoir that provides structural support while allowing runoff to percolate to the underlying soils. Permeable pavement can be fully infiltrating or can have an underdrain like bioretention and biofiltration practices, respectively?



BMP Performance Functions



Design Variations

Several design variations include:

- ***Pervious Concrete:*** fines are excluded from typical concrete aggregate to create permeable void space within the section.
- ***Porous Asphalt:*** fines are excluded from typical hot-mix asphalt to create pores within the section.
- ***Permeable Interlocking Concrete Pavers:*** Pavers that allow infiltration of rainwater through joints between the blocks.

Typical Design Components

Figure 4.A-7 presents a typical design and highlights potential design variations:

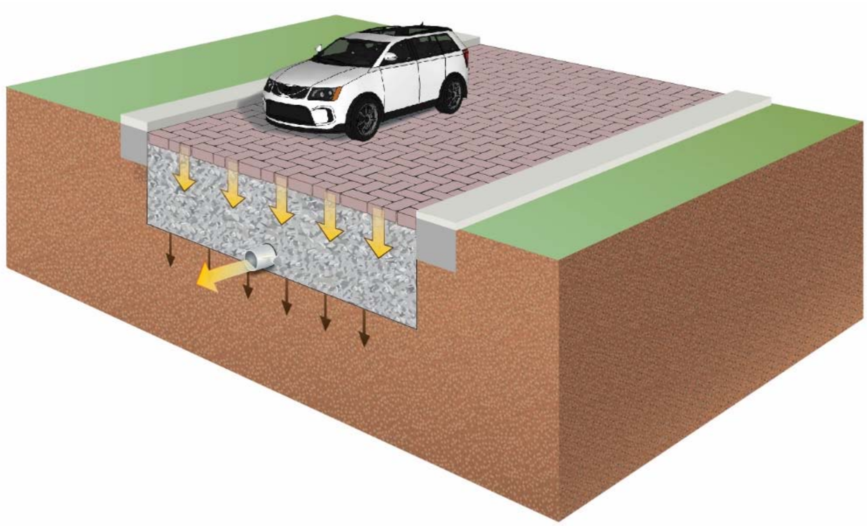
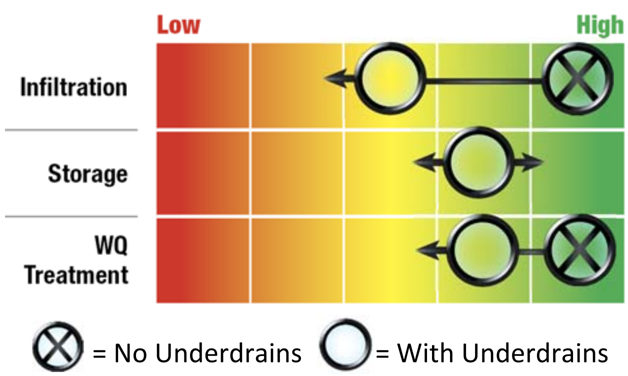


Figure 4.A-7. Typical distributed permeable pavement schematic showing underdrain option (arrows indicate water pathways).

Green Streets (Green Infrastructure BMP)

Green streets are systems of multiple BMPs arranged in a linear fashion within the street right-of-way (as opposed to a parcel-based implementation). Green streets are designed to reduce runoff and improve water quality for the runoff from the roadway and adjacent parcels. Bioretention, biofiltration, and permeable pavement BMPs are commonly used in conjunction and can be hydraulically connected using subsurface stone reservoirs.

BMP Performance Functions



Design Variations

Green streets can feature several design variations. Some common features include:

- ***Linear Bioretention/Biofiltration:*** BMPs can be incorporated as linear systems between the road and parcel to intercept runoff from both roadways and properties.
- ***Curb Extensions:*** bioretention/biofiltration BMPs "bumpouts" can intercept gutter flow.
- ***Permeable Parking Lanes:*** street parking can be designed with permeable pavement to intercept roadway runoff.

Typical Design Components

Figure 4.A-8 presents a typical design and highlights potential design variations:

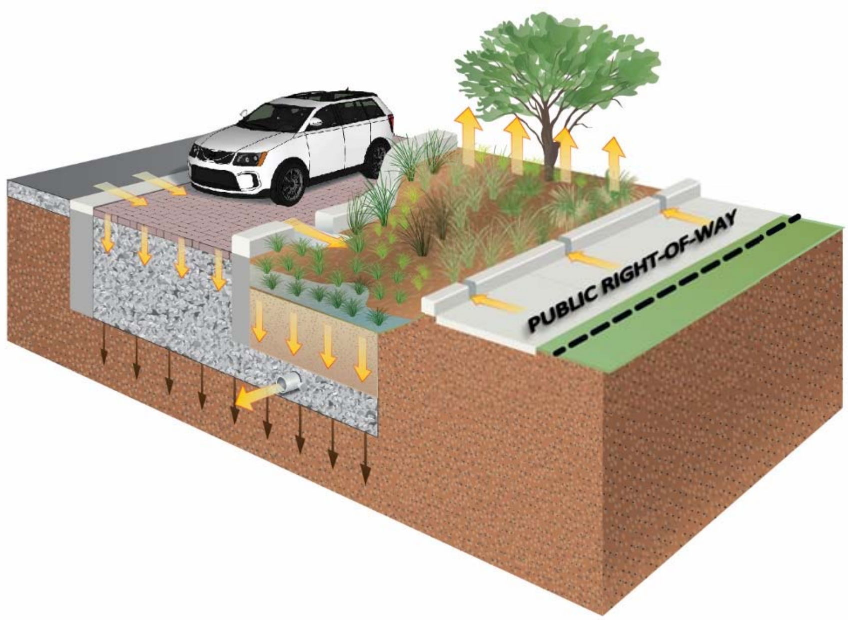
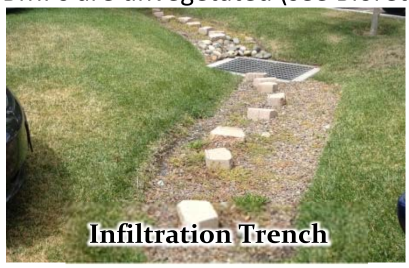


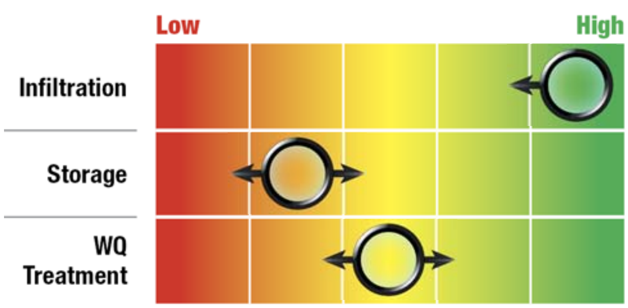
Figure 4.A-8. Typical distributed green street schematic (arrows indicate water pathways).

Infiltration BMPs (Green Infrastructure BMP)

Infiltration BMPs capture and infiltrate runoff into underlying soils. Runoff is typically stored in subsurface trenches or pits filled with engineered soil media, gravel, or concrete chambers. Some infiltration BMPs that inject water into subsurface reservoirs are considered class V injection wells and must be registered as such. Infiltration BMPs are unvegetated (see Bioretention for vegetated practices).



BMP Performance Functions



Design Variations

Several design variations include:

- ***Infiltration Trench:*** a media-filled trench that captures runoff in the pore space of gravel or soil prior to infiltration.
- ***Dry/Wet Well:*** a gravel-surrounded vault with perforated walls that receives runoff from a pipe and allows direct infiltration into the ground.
- ***Rock Well:*** a gravel-filled pit that receives runoff from a pipe. This BMP is essentially a dry well without a concrete vault.

Typical Design Components

Figure 4.A-9 below presents a typical design and highlights potential design variations:

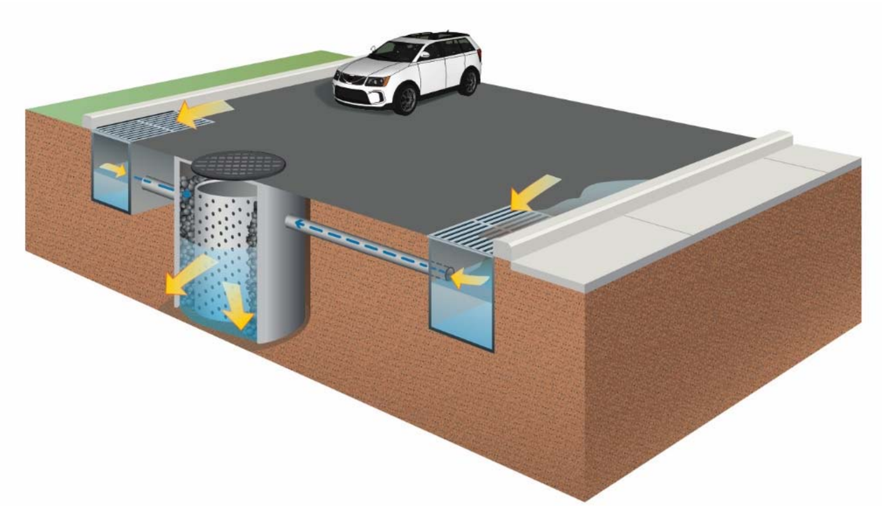
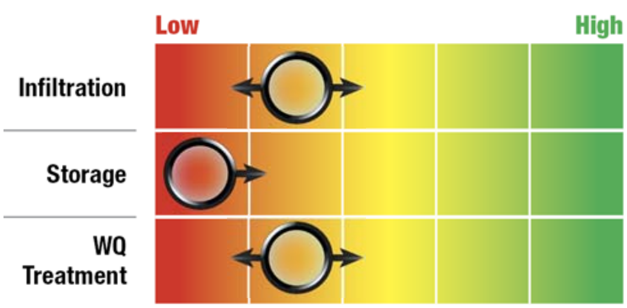


Figure 4.A-9. Typical distributed infiltration BMP schematic showing perforated concrete dry well variation (arrows indicate water pathways; for infiltration trenches, see Figure 4.A-6 and omit vegetation).

Bioswales (Green Infrastructure BMP)

Bioswales are practices that convey uniform sheet flow through vegetated, shallow depressions to remove sediment-associated pollutants by settling and straining. Infiltration and filtration through soil media are not key components of bioswales; rather, bioswales are typically implemented to act as pretreatment and used to transport runoff to an associated structural BMP.

BMP Performance Functions



Design Variations

Several design variations include:

- ***Vegetated Swale:*** linear, vegetated channels used to convey concentrated flow from the contributing area to a structural BMP. Check dams can be added in areas of steep slopes or to further decrease the flow rates and spread the runoff over a larger area.
- ***Vegetative Filter Strip:*** broad-sloped, vegetated areas used to convey sheet flow from the contributing area to a structural BMP or other conveyance channel.

Typical Design Components

Figure 4.A-10 presents a typical design and highlights potential design variations:

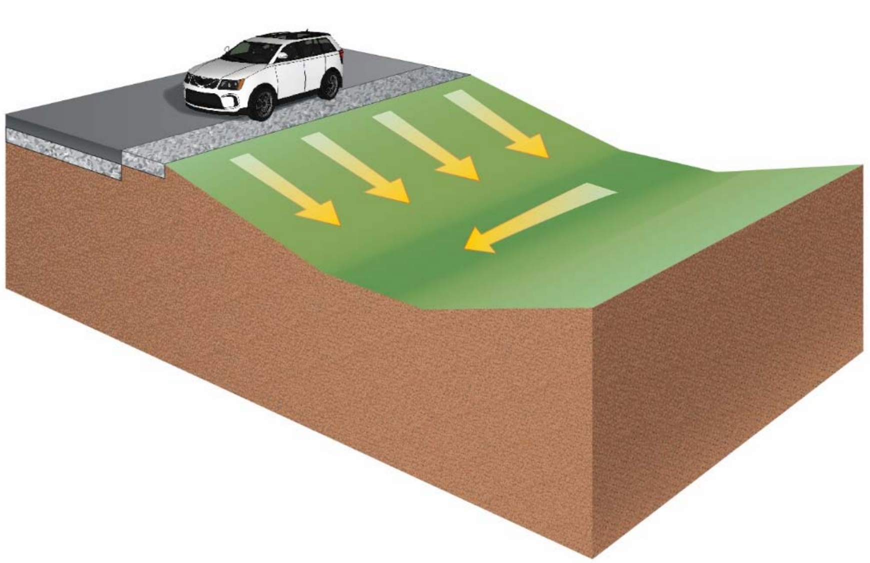
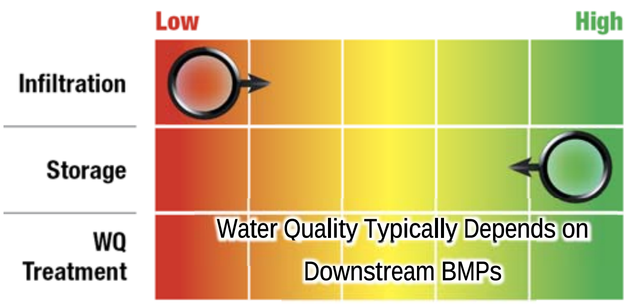


Figure 4.A-10. Typical distributed bioswale schematic (arrows indicate water pathways).

Rainfall Harvest (Green Infrastructure BMP)

The primary goal for rainfall harvest is improving water quality by intercepting rooftop runoff and lowering the overall impervious impact of a developed site. Runoff can be reduced through interception and evapotranspiration on green roofs or used for alternative uses with a cistern or rain barrel.

BMP Performance Functions



Design Variations

Several design variations include:

- ***Green Roof:*** engineered, vegetated roof structures intended to intercept rainfall in a growing medium. Rooftop detention can be incorporated if structures allow.
- ***Cisterns and Rain Barrels:*** storage tanks used to intercept and store rooftop runoff. Captured runoff can be reused to offset non-potable water uses such as irrigation and toilet flushing. Alternatively, stored water can be slowly released to a pervious surface.

Typical Design Components

Figure 4.A-11 presents a typical design and highlights potential design variations:

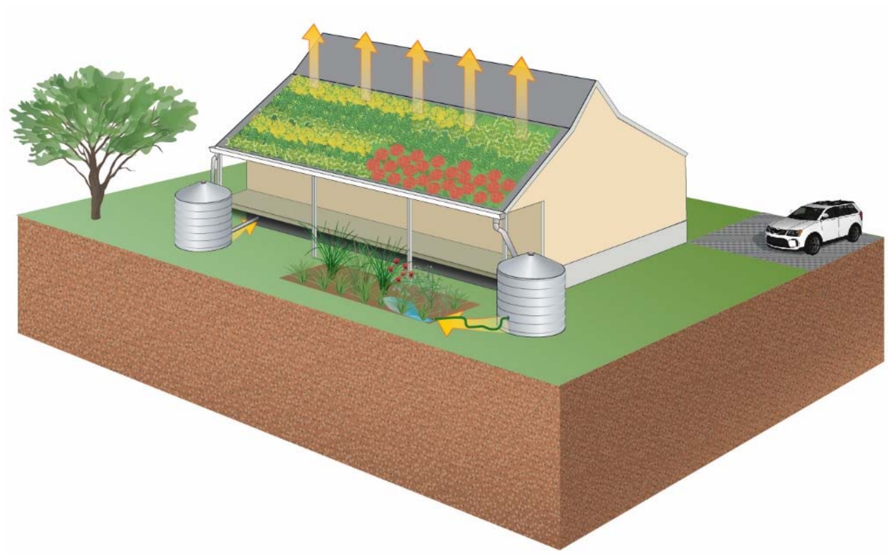


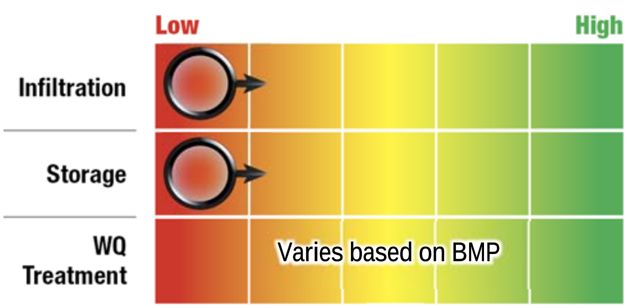
Figure 4.A-11. Typical distributed rainfall harvest schematic (arrows indicate water pathways).

Flow-Through Treatment BMP (Distributed BMP)

Manufactured flow-through devices are commercial products that aim to provide stormwater treatment using patented, innovative technologies. Typical types of manufactured devices for stormwater management include cartridge filters, media filters, and high-flow biotreatment devices.

(photo source: Jonathan Page, NCSU-BAE)

BMP Performance Functions



Design Variations

Several design variations include:

- ***Media/Cartridge Filters:*** proprietary filtration devices used to remove pollutants.
- ***High-Flow Biotreatment Device:*** modular, vault-type practices containing high-flow media. Typically incorporate vegetation.

Typical Design Components

Figure 4.A-12 presents a typical design and highlights potential design variations:

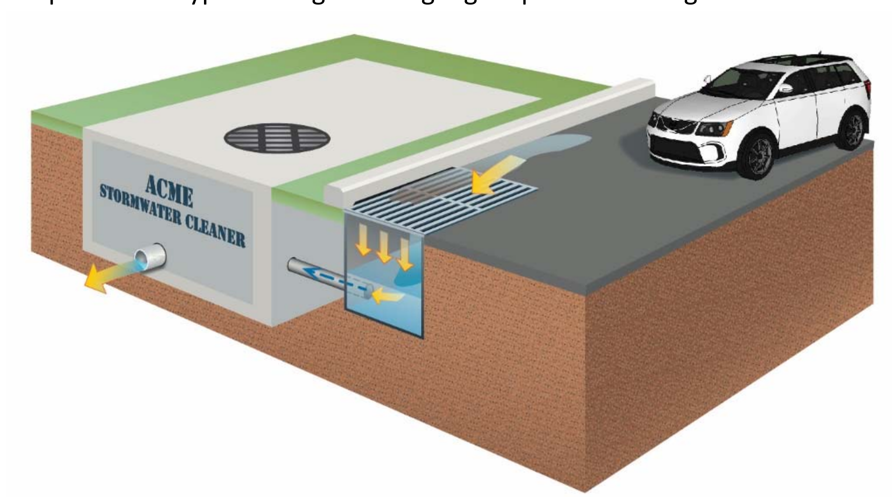
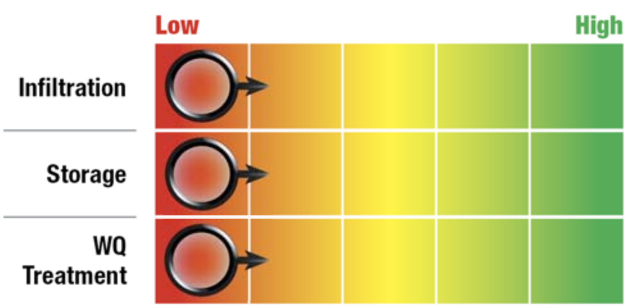


Figure 4.A-12. Typical distributed flow-through treatment BMP schematic (arrows indicate water pathways).

Source Control Structural BMPs (Distributed BMP)

Source control structural BMPs are commercial products designed to treat runoff in highly urbanized environments. Mechanical separation, or more complex physicochemical processes, provides separation of gross solids and other pollutants. Many models feature media or materials designed to sequester hydrocarbons and other pollutants. Also includes trash full-capture devices.

BMP Performance Functions



Design Variations

Several design variations include:

- ***Hydrodynamic Separators:*** mechanical devices that use screens, baffles, and/or vortical flow to separate sediment and gross solids.
- ***Catch Basin Inserts:*** inserts that use nets, screens, fabric, and/or filtration media to gross solids, fine sediments, oils, and/or grease from runoff entering a catch basin.

Typical Design Components

Figure 4.A-13 presents a typical design and highlights potential design variations:

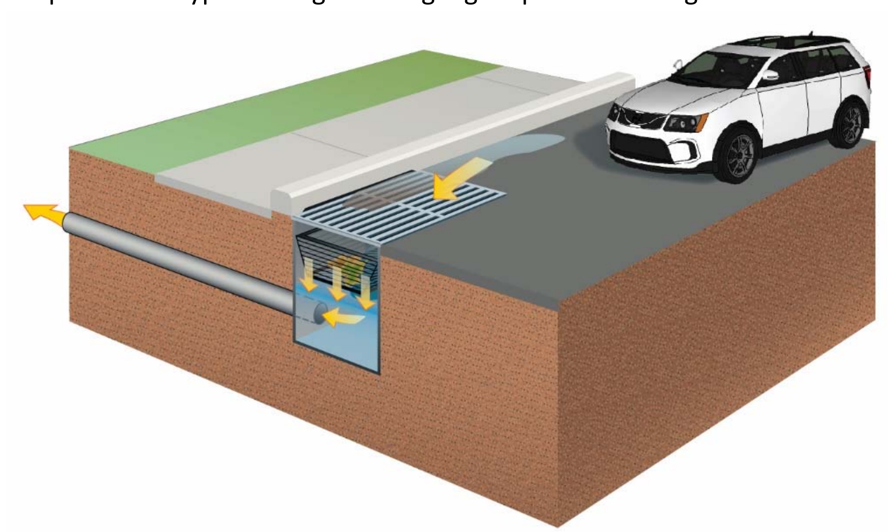


Figure 4.A-13. Typical distributed source control structural BMP (arrows indicate water pathways).

Appendix 4.B

Regional Project Selection Process & Preliminary List of Projects

FINAL TECHNICAL MEMORANDUM

REGIONAL PROJECT SELECTION PROCESS AND PRELIMINARY LIST OF PROJECTS

PREPARED FOR

Upper Los Angeles River
Watershed Management Group

JUNE 15 2015

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Building a world of difference.®

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FIGURES

ATTACHMENTS

1 Background

The purpose of this memo is to describe the outcome of the process used by the Upper Los Angeles River (ULAR) Watershed Management Group (WMG) to select a preliminary list of regional projects that will be evaluated for inclusion in the Enhanced Watershed Management Plan (EWMP) to be submitted to the Regional Board in June 2015. The results of this process will be used to develop a set of regional projects, as well as to develop a set of potential regional project locations that can be evaluated for inclusion during future EWMP updates through adaptive management.

The EWMP development process defined on page 48 of the MS4 permit allows for: "… collaboration among Permittees and other partners on multi-benefit regional projects that, wherever feasible, retain (i) all non-storm water runoff and (ii) all storm water runoff from the 85th percentile, 24-hour storm event for the drainage areas tributary to the projects, while also achieving other benefits including flood control and water supply, among others."

In discussions with WMG members, it was determined that it would be useful to identify and include the broadest group of all potential regional BMP projects and locations, and not simply the subset of projects that could capture the 85th percentile storm, referred to as Regional EWMP Projects. Goals of the regional projects selection process include the following:

- To demonstrate regulatory progress: The regional projects envisioned by the WMG are structural BMPs intended to collect and treat runoff from a large contributing area, normally composed of multiple land uses and many parcels. These projects will provide progress towards compliance, and their effectiveness will be quantified by the Reasonable Assurance Analysis. Even regional projects that are unable to retain the 85th percentile, 24-hour storm can be quite cost-effective for stormwater management.
- To provide a road map: The EWMP is intended to be a road map which guides WMG members and their respective Public Works Departments, Planning Departments, and elected officials on specific projects and project locations being considered in their jurisdictions. Through the process of identifying and evaluating potential regional BMPs, the WMG members and the consultant team will suggest specific potential project locations (both Regional EWMP Projects and regional BMPs) for inclusion in the EWMP. The EWMP will then serve as a useful tool to WMG members who are developing and implementing capital improvement programs.
- To illustrate a vision for the future: The EWMP is expected to provide a clear vision for the future of stormwater management in the watershed, including signature regional projects. These projects will clearly demonstrate value and progress, and their success will help build public support and momentum for additional projects and the funding needed to support them.

The following sections present the methodology employed to develop the list of potential regional project locations for initial screening and the resulting preliminary list of regional projects.

2 Methodology for Developing a Set of Regional Projects

The process for selecting regional project locations was developed based on the input and guidance of the WMG at monthly meetings, as well as individual discussions with many of the member agencies. The process for identifying potential regional project locations and selecting the preliminary list of potential regional projects in the ULAR Watershed is described below.

2.1 STEP 1 – COMPILE EXISTING/PLANNED REGIONAL PROJECT LOCATIONS

Planned and potential regional BMPs have been identified in a number of watershed management or TMDL implementation plans developed by public agencies or organizations in the watershed over the past decade or more. A summary list of these planning documents and a detailed list of these planned regional BMPs were compiled as a part of the process to develop the EWMP Work Plan and submitted to the Regional Board in June 2014. While some of the projects in these plans have been implemented, many are still in the planning stages and not yet implemented. These potential or "planned" regional BMPs identified in Step 1 represent projects that could be incorporated into the EWMP. This compiled list of planned regional BMPs was combined with the list of potential new regional project locations identified in Step 2 below, and evaluated together in Step 3 below.

2.2 STEP 2 – IDENTIFY NEW/POTENTIAL REGIONAL PROJECT LOCATIONS

In addition to developing a comprehensive list of planned regional projects in Step 1, a more comprehensive analysis was conducted in Step 2 to identify other/new potential regional project locations that were not known to have been previously identified as candidates. Opportunities and constraints for potential regional project locations were identified in discussions with WMG members. Corresponding datasets were identified to assist with this initial screening analysis including the Los Angeles County parcel land base geographic information system (GIS), the 2013 Los Angeles County tax assessor information, and other watershed data. All parcels within the watershed were evaluated according to GIS criteria such as: parcel ownership, land use, parcel size, slope, proximity to 36" storm drain or open channel, tributary drainage area and other criteria described in more detail below. Each parcel was scored according to these criteria with the intent of developing a repeatable and transparent methodology. A summary is presented in Table 2-1 below of the initial GIS screening criteria, and the "fatal flaws" used in the analysis.

It should be noted that although the screening process is presented below as a series of criteria in a stepwise manner, multiple iterations and queries enabled WMG members to evaluate alternatives and make decisions throughout the process. The summary presented below is intended to characterize the process in the simplest manner, and the order of the criteria presented does not represent order of importance.

Table 2-1 Initial GIS Screening Summary

CRITERIA	FATAL FLAWS (EXCLUDE FROM FURTHER ANALYSIS)	SCORE				
		Low Priority				High Priority
		1	2	3	4	5
Ownership	Privately-owned Federally-owned State-owned Cemeteries Jails/prisons Fire stations	Airports Public Schools (K-12)		Colleges Universities	Everything else	Park Golf courses
Upstream Tributary Land Use	Un-urbanized area: • Vacant • Undifferentiated • Undeveloped local/regional park • Mineral & oil Production	---	---	---	---	All Urbanized Areas
Parcel Size	< 1/4 acre	0.50 to 0.49 acre	0.50 to 0.99 acre	1.0 to 4.9 acre	5.0 to 24.9 acre	>=25 acres
Slope	>20%	15-19%	---	5-15%	---	0-5%
Proximity to 36" Storm Drain or Open Channel	>= 1000'	500-1000'	---	100-499'	---	<100'
Soil Contamination/ Liquefaction Potential	---	Within 100'	Liquefaction Area	---	---	Everything else
Tributary Drainage Area Size	---	Beyond 1000' of WMMS sub-watershed outlet	Sub-watershed Area < 25th Percentile	Subwatershed Area 26-50th Percentile	Sub-watershed Area 51-75th Percentile	Sub-watershed Area > 75th Percentile
Water Quality Benefit (based on zinc loading)	---	Less than 0.20 lbs/ac/yr	0.20 - .049	0.5 - .69	.70 - .99	Greater than 1
Impervious Area (acres of impervious area in sub-watershed)	---	Beyond 1000' of WMMS sub-watershed outlet	Under 100 acres	100-400 acres	400-800 acres	800-2100 acres

Furthermore, the MS4 permit describes that EWMP projects should be implemented “where feasible” and thus, reasons for infeasibility will be documented. These fatal flaws were defined by the WMG and serve as the basis for determining where projects are feasible. They may be revisited in future iterations of EWMP updates. For example, privately-owned parcels were excluded from this initial analysis because of significant issues that would need to be addressed before WMG members can enter into agreements to develop projects on these sites. In addition, parcels less than ¼-acre were excluded, because of the initial assumption that the footprint available for a regional BMP would not be large enough to allow for a significant project. These parcels were excluded from further analysis during this initial GIS screening process.

The following sections (2.2.1 – 2.2.10) provide further details on the initial GIS screening process and the criteria used to select and rank the potential regional project locations. Figure 2-1 presents a depiction of the sequential results generated during this initial screening process.

2.2.1 Parcel Ownership

The County of Los Angeles Office of the Assessor published the Local Roll Release in July 2013 from its Property Assessment Information System (PAIS). The publication indicates a total of 773,620 parcels are located within the Upper Los Angeles River watershed. This dataset includes only parcels with an APN number, and does not include easements, alleys, or right-of-way. Public ownership was the initial selection criterion chosen by the WMG members, based on the assumption that it is infeasible at this time for WMG members to commit to developing regional BMPs on privately-owned parcels.

A subset of 13,216 parcels was identified as publicly-owned (as officially defined by the tax assessor with a 900 suffix in the APN numbering system). At the direction of the WMG members, 659 additional publicly-owned parcels were initially removed from consideration because they were either state or federally-owned, a cemetery, prison, or fire station, and deemed infeasible for further consideration at this time.

2.2.2 Upstream Tributary Land Use

The resulting 12,557 publicly-owned parcels were then evaluated using Land Use Dataset as published in 2005 by Southern California Association of Governments (SCAG). The following land use types were excluded from further analysis: vacant undifferentiated, undeveloped local/regional park, and mineral-oil facilities. As a result, 2,833 parcels were excluded, with 9,724 potential regional site locations remaining.

2.2.3 Parcel Size

Small parcels (less than ¼ acre in size) were excluded from the analysis as inappropriate for further analysis at this time. This resulted in 4,800 candidate parcels. A histogram of the data for all remaining candidate parcels was developed and parcels were assigned relative scores based on parcel size (larger parcels = 5, smaller parcels = 1).

2.2.4 Slope

USGS's Digital Elevation Model (40 foot contour quad map) was used to estimate the average slope of each parcel in the watershed. The grid size used in the analysis was 100 feet. Any parcels with an average slope greater than 20% were excluded in further screening as infeasible, resulting in 4,685 parcels. Remaining parcels were then scored according to slope (flat slope = 5, steeper slope = 1).

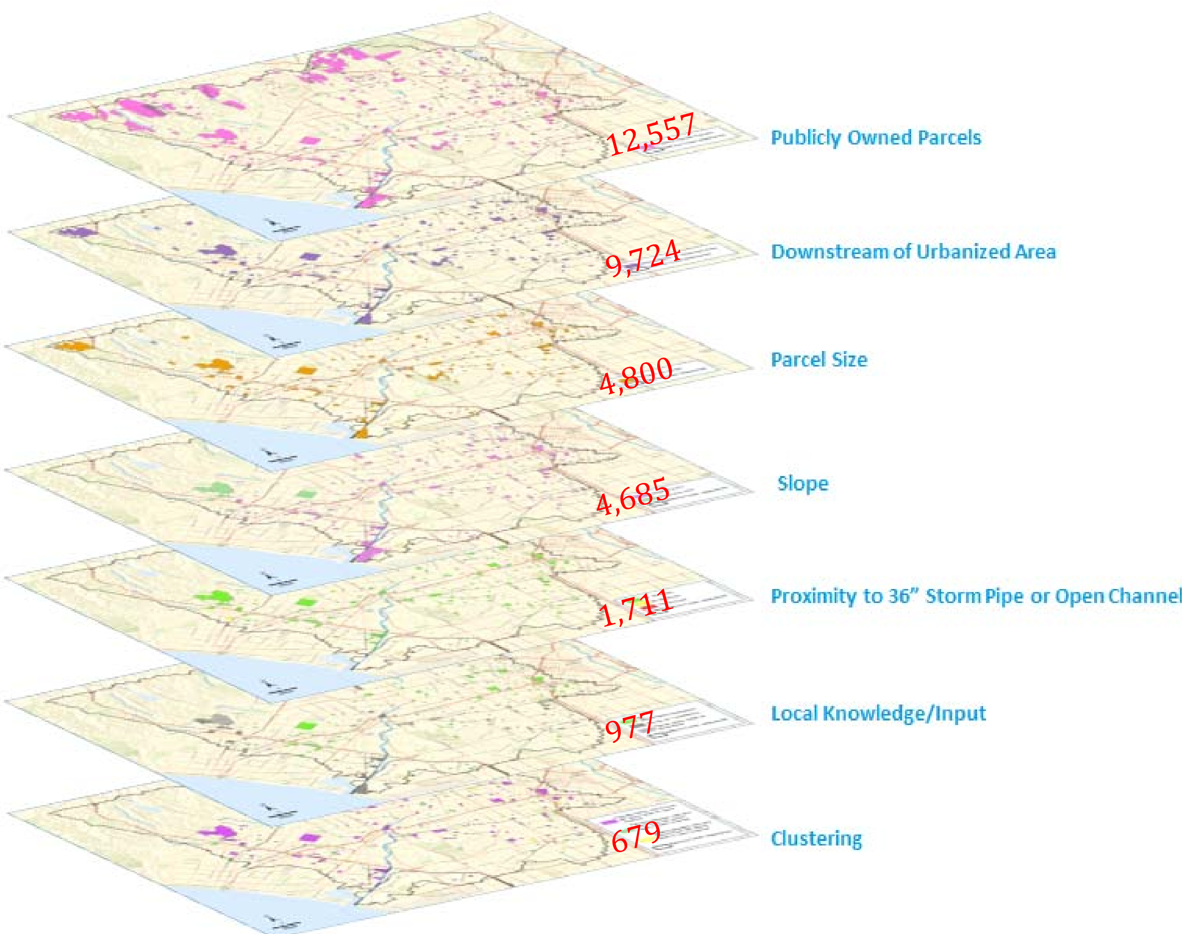
2.2.5 Proximity to Storm Drain or Open Channel

The Los Angeles County storm drain system is represented within a geometric network model. This GIS data (published 6/2014) was used to determine proximity to a 36-inch storm drain (or larger). In addition, the National Hydrography Dataset was used as the data source for the location of all open channels in the watershed. Any parcel beyond 1,000-feet of a 36-inch storm drain or open channel was excluded from further analysis. The resulting 1,711 parcels were then scored with a relative proximity to a storm drain or open channel (proximity greater than 500 feet = 1, proximity within 100 feet = 5).

2.2.6 Soil Contamination and Liquefaction Potential

Brownfield site locations were obtained directly from the State of California's Department of Toxic Substances Control. LA County's Liquefaction GIS layer was also used to evaluate relative value of parcels for potential regional project locations. Parcels within 100 feet of a brownfield site or liquefaction area received a 1 or 2 score, respectively. All other parcels were assigned a high score (5). No parcels were excluded during this analysis, thus resulting in 1,711 potential regional project locations.

Figure 2-1 Process Overview



2.2.7 Tributary Drainage Area

In recognition that larger tributary drainage areas will very likely generate greater pollutant loadings in this heavily urbanized watershed, estimates of tributary area within 1000 feet of the outlet of each subwatershed were generated. The subwatershed GIS layer from the RAA model Watershed Management Modeling System (WMMS) was used as the primary data source for estimating tributary drainage area. In Upper LA River, there are 783 subwatersheds. For parcels within 1000 feet of a subwatershed outlet, the subwatershed area was used as a surrogate for potential drainage area that could be captured by a regional BMP on the parcel. Parcels were scored according to estimated tributary drainage area based on the relative size of the nearby WMMS subwatershed (high tributary drainage area = 5, and low drainage area = 2) for parcels within 1000 feet from the outlet of a WMMS subwatershed. For parcels not within 1000 feet of a subwatershed outlet, a score of 1 was assigned.

2.2.8 Water Quality Benefit

To estimate the potential water quality benefit associated with implementing a project on each parcel, the Loading Simulation Program – C++ (LSPC) watershed model in the Watershed Management Modeling System (WMMS) was used to quantify the yield of total zinc [lbs/acre/year] for each of the 783 subwatersheds in the Upper LA River watershed. Zinc was used because it has been identified as a limiting pollutant for the RAA. Subwatersheds with greatest zinc yield (greater than 1 lb/ac/year) were assigned a high score (5), and areas with progressively smaller zinc loadings were assigned progressively smaller scores (from 4 to 1). Parcels within those subwatersheds were assigned the same zinc-ranked scores to highlight areas where the most BMP capacity is likely needed to address Water Quality Priorities.

2.2.9 Impervious Area

The subwatershed GIS layer from the Watershed Management Modeling System (WMMS) was also used as the primary data source for estimating impervious area. In recognition that tributary areas with greater imperviousness will generate higher runoff volumes, estimates of the amount of impervious area (acres) for each of 783 subwatersheds were developed. Similar to tributary drainage area, the impervious area of the subwatershed was used to assign a score to each parcel. High impervious values were assigned a high score (5) and low impervious values were assigned a low score (2). Parcels beyond 1000-feet of an outlet of a WMMS subwatershed were assigned a value of (1).

2.3 STEP 3 – EVALUATE/PRIORITIZE REGIONAL PROJECT LOCATIONS

2.3.1 Local Knowledge and Input from Member Agencies

The initial GIS screening analysis identified 1,711 parcels not subject to fatal flaws, which were scored and ranked for each WMG member and for the watershed as a whole, utilizing the scoring criteria described in Section 2.2 above. Maps and corresponding lists were distributed to each of the member agencies, and each member agency then used local knowledge to further refine the initial screening.

Based on written and verbal feedback from the member agencies, many additional parcels were removed from consideration as infeasible at this time, primarily due to the single criterion that the parcels were not owned by them. (The WMG members originally requested a database of all publicly-owned parcels within their jurisdictions. Many publicly-owned parcels are owned by public agencies other than the WMG members.) Other reasons used to determine infeasibility during this step in the process included: recent improvements to the site, buildings not identified on the GIS layer, known contamination or other local constraints, or simply the GIS layer was inaccurate. A total of 977 parcels were confirmed to be strong candidates for potential regional project locations. WMG members chose to include school sites that met the GIS screening criteria in their list, even though these sites are owned by school districts which are separate government agencies. The rationale for including these sites as a special case is discussed in further in the next section.

2.3.2 Final Score & Ranking

A final score was calculated for each parcel using a subset of the criteria in Table 2-1 above in order to emphasize potential *water quality benefit*. Based on discussions with the WMG members, the other criteria such as soil contamination, slope and other constraints were not used in the final scoring to ensure sites with the highest potential water quality benefit were emphasized. The criteria used for final score and ranking were the following:

- Parcel Size
- Tributary Drainage Area
- Water Quality (Zinc)
- Impervious Area

2.3.3 Clustering

To emphasize opportunities rather than parcels, parcels located directly adjacent to each other were "clustered" together into groups for the purposes of identifying potential regional project locations. A total of 977 individual parcels were further refined into 679 clusters, each with a unique ID numbering system. The score for each parcel within each cluster was area-weighted to develop a cumulative score for each cluster. Each cluster was then ranked within each WMG jurisdiction, as well as throughout the watershed as a whole, to allow WMG members to evaluate the relative value of each potential regional project location. Maps and summary tables for each of the 679 clusters can be found in Attachments A – E.

3 STEP 4 – Recommend Projects for Implementation

The process of identifying potential regional project locations has generated a large list of opportunities that will be useful in capital planning for years to come. The WMG members determined it would be helpful to define several tiers of opportunities within that large list to assist them with planning and implementation. Using the scoring system and local knowledge, three tiers were created based on an understanding that multiple planning horizons are being addressed through the EWMP process and its regional project selection process. As a general guide, the following three tiers were defined:

Table 3-1 Tier Classification

TIER	DEFINITION	
	Potential Planning Horizon for Further Evaluating Project Feasibility	**Approach for Project Inclusion during EWMP Development**
Very High	0 – 2 years	Projects will be included in EWMP, with details on each. Project effectiveness will be analyzed individually by the RAA. A subset of eight (8) projects will be subject to feasibility screening.
High	2 – 5 years	Projects will be included in EWMP but details on individual projects will not be presented. Overall effectiveness of entire tier of projects will be evaluated in bulk (not individually) by the RAA.
Medium	> 5 years	Projects will not be included in EWMP, but potential bulk effectiveness of this tier of projects will be quantified by the RAA modeling system to support future planning discussions.

The WMG recognizes that development of regional projects can take many years to permit, design, fund, and construct. However, in order to meet the aggressive compliance deadlines required by the MS4 Permit and TMDLs, details on a subset of projects (Very High) will be provided to the WMG in order to "jump start" the planning process. A second tier of project opportunities (High) will be included in the EWMP with less detail but will still provide the WMG with an understanding of the likely next set of projects to be considered for implementation. A third category of project opportunities (Medium, including school properties) will be provided to the WMG for future consideration, recognizing that agreements with other land owners can be developed.

3.1.1 Tier Classification for Regional Projects

Planned projects from previous watershed plans and TMDL Implementation Plans identified in Step 1 were mapped in GIS and overlaid with the 679 clusters identified as potential new regional project locations in Step 2. The majority of the planned projects were confirmed through the initial GIS initial screening analysis to be strategically located to accomplish significant water quality benefits. Each WMG member agency received an updated map and list which was a compilation of planned projects from Step 1 and potential new regional project locations from Step 2. Based on discussions with WMG members, regional project opportunities were classified into the three tiers as follows:

- Very High: Parcels (or clusters of parcels) previously identified as Planned Projects in Step 1, and also identified as having scored highly in Step 2 for potential new regional project locations were placed in the "Very High" tier. In addition, some agencies nominated projects/locations to this tier due to local interest, public acceptance or political momentum.
- High: Parcels (or clusters of parcels) which scored highly and owned by WMG members were placed in the "High" tier.

- Medium: Parcels (or clusters of parcels) which met the initial GIS screening criteria, but not owned by WMG members, were placed in the "Medium" tier. For example, schools identified in either Step 1 or Step 2 were placed in the "Medium" tier, with the recognition that while these sites could likely provide significant water quality benefits, there are institutional challenges that must be addressed in the coming years to develop appropriate agreements with local school districts to move forward with regional projects on these sites.

WMG members could elect to move a regional project location to a higher or lower tier based on local knowledge, project readiness, or other factors, such as their jurisdiction did not include a site which met the Very High. The recommended projects are summarized in Section 3.1.2 below.

Table 3-2 Tier Selection Criteria

TIER	SELECTION CRITERIA			WMG INPUT
	Scored Highly in the GIS Screening Criteria and also a Planned Project	**Met GIS Screening Criteria and Owned by WMG Member**	**Met GIS Screening but not Owned by WMG Member**	**Met GIS Screening and the agency chose to nominate the site to Very High**
Very High	X			X
High		X		
Medium			X	

3.1.2 Resulting Regional Project List

This section includes a series of tables and figures that present a summary of the number of regional projects, or potential regional project locations, to be evaluated for inclusion in the EWMP for each WMG Member. It is important to note that while regional project candidates are organized by jurisdiction, many of the projects would be multi-jurisdictional because they manage runoff from large upstream areas. The following tables and figures show the results of initial screening for regional projects:

- Table 3-2: WMG Summary - Number of Regional Project Opportunities by Tier
- Figure 3-1: Regional Project Opportunities - Location Map
- Figure 3-2: Regional Project Opportunities - Location by Subwatershed
- Table 3-3: Regional Project Opportunities – Very High Tier
- Figure 3-3: Regional Project Opportunities - Very High Tier Locations

Additional detailed lists and maps can be found in Attachment A through E.

Table 3-3 WMG Summary – Number of Regional Project Opportunities by Tier

MEMBER AGENCY	VERY HIGH TIER	HIGH TIER	MEDIUM TIER
City of Alhambra	1	0	17
City of Burbank	0	0	40
City of Calabasas	0	2	2
City of Glendale	1	6	70
City of Hidden Hills	0	0	0
City of La Canada Flintridge	0	6	20
County of Los Angeles	2	9	153
City of Los Angeles	8	15	85
City of Montebello	0	15	21
City of Monterey Park	1	2	6
City of Pasadena	0	2	93
City of Rosemead	0	3	19
City of San Fernando	1	0	21
City of San Gabriel	0	7	15
City of San Marino	1	0	3
City of South Pasadena	1	0	20
City of Temple City	0	3	8
SUBTOTAL	16	70	593
	TOTAL (CLUSTERS) = 679		

Figure 3-1 Regional Project Opportunities - Location Map

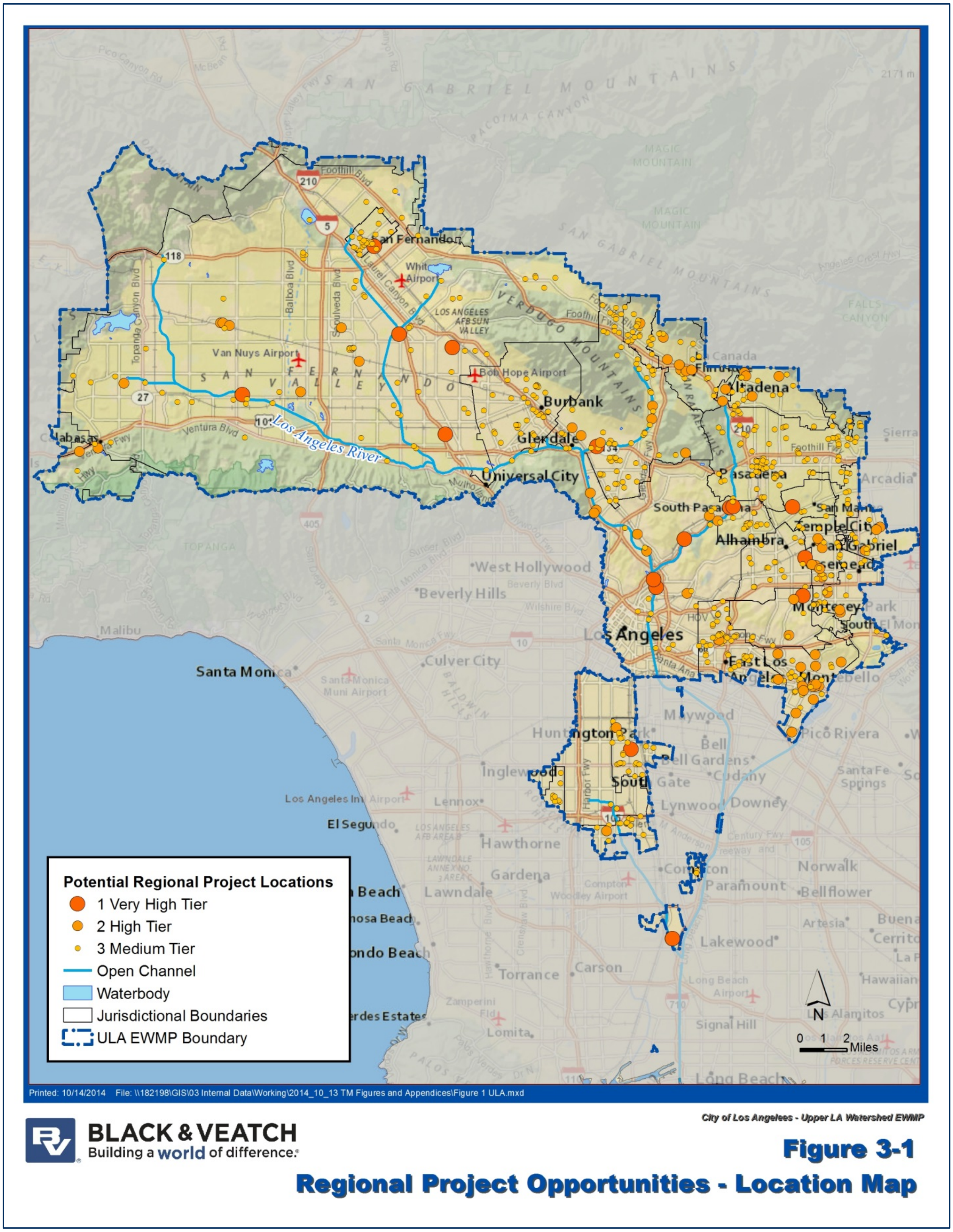


Figure 3-2 Regional Project Opportunities - Location by Subwatershed

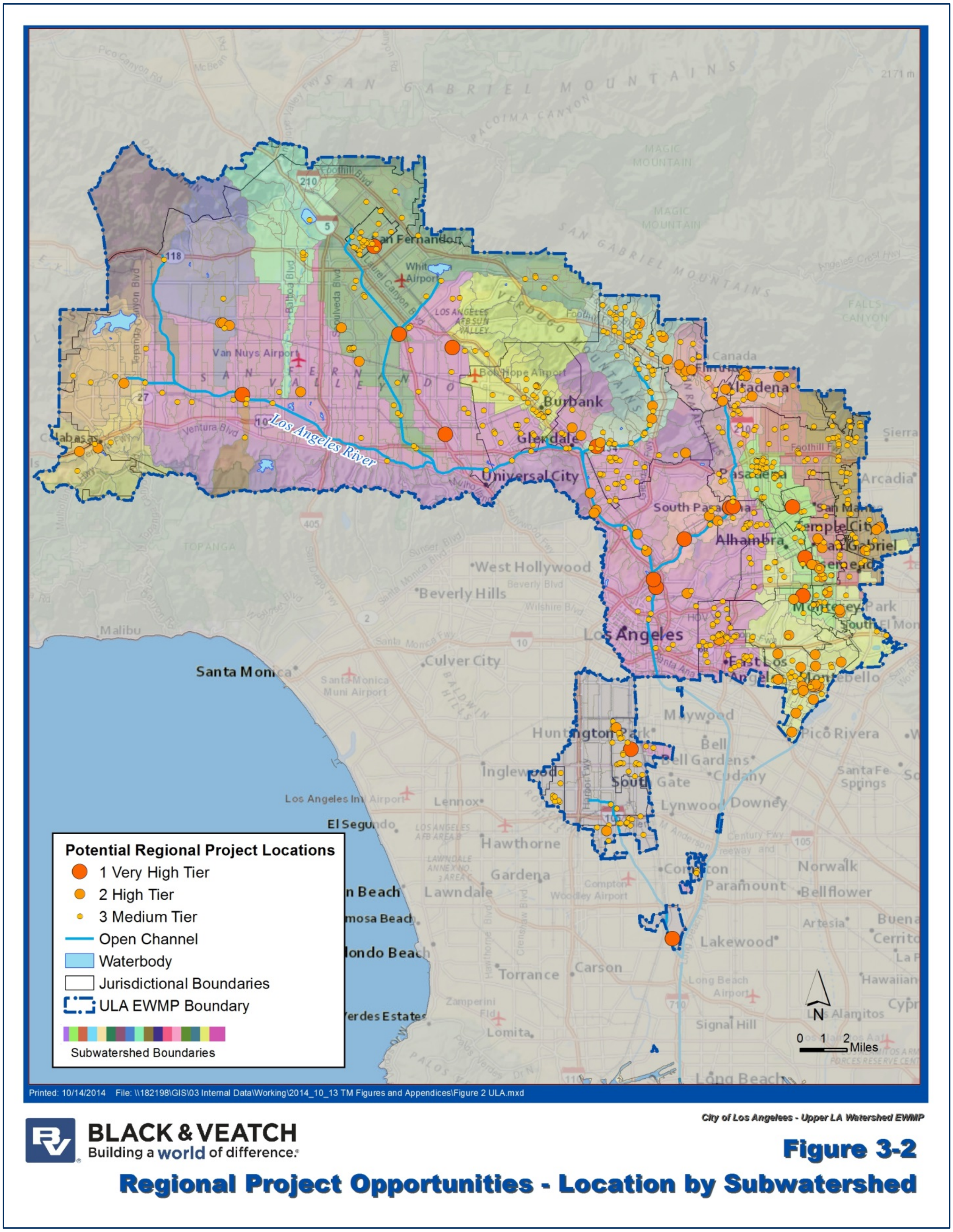
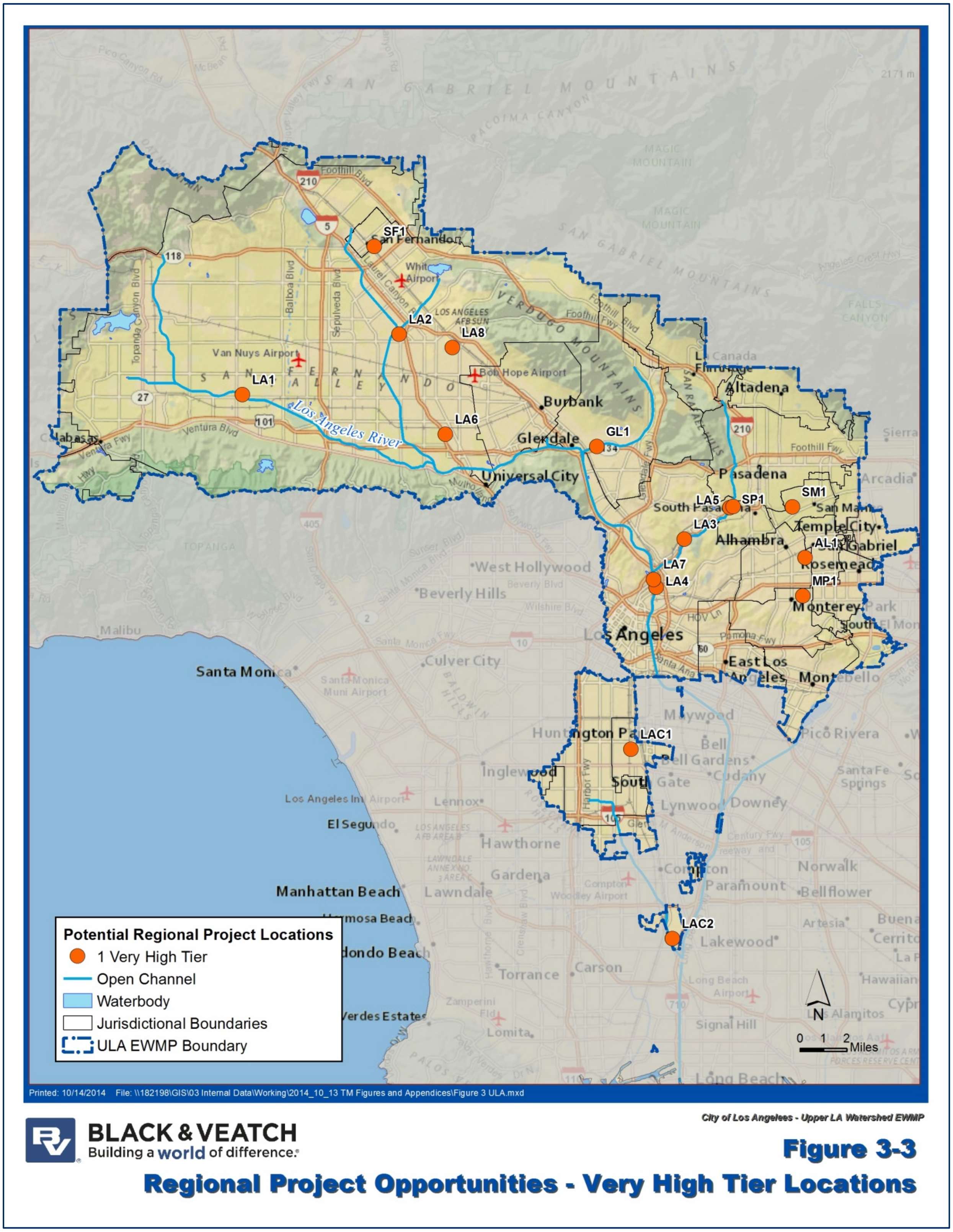


Table 3-4 Regional Project Opportunities - Very High Tier Locations

	MEMBER AGENCY	CLUSTER ID	ACRES	DESCRIPTION
1	City of Alhambra	AL01	133.63	Alhambra Golf Course 700 S Almansor St
2	City of Glendale	GL01	9.41	Fremont Park 600 W Hahn Ave
3	City of Los Angeles	LA01	70.85	Callero Creek & Los Angeles River Confluence Park 18230 Kittridge St
4	City of Los Angeles	LA02	135.67	Tujunga-Sun Valley Tujunga Wash Diversion #2 8801 Arleta Ave
5	City of Los Angeles	LA03	16.36	Arroyo Seco Urban Runoff Project No. 2 4580 N Figueroa St
6	City of Los Angeles	LA04	1.23	Albion Dairy Park 1739 Albion St
7	City of Los Angeles	LA05	9.31	Lower Arroyo Park
8	City of Los Angeles	LA06	51.96	North Hollywood Park
9	City of Los Angeles	LA07	21.33	Humboldt Stormwater Greenway
10	City of Los Angeles	LA08	63.62	Rory M. Shaw Wetlands Park
11	County of Los Angeles	LAC01	24.35	Roosevelt Park 7600 Graham Ave
12	County of Los Angeles	LAC02	8.52	South Compton Creek Wetland
13	City of Monterey Park	MP01	1.88	Sierra Vista Park
14	City of San Fernando	SF01	10.69	208 Park Ave
15	City of San Marino	SM01	26.69	Lacy Park Infiltration/Retention Basin
16	City of South Pasadena	SP01	25.54	Lower Arroyo Park

Figure 3-3 Regional Project Opportunities - Very High Tier Locations



4 Next Steps

The results of the regional project selection process will be used to support the following next steps in the development of the EWMP:

- A subset of eight potential regional project locations will be selected from the list of Regional Projects - Very High Tier, and additional engineering feasibility will be performed, including an initial environmental study and preliminary soils infiltration assessment. A site concept will also be developed for each of the eight projects and included in the EWMP.
- The list of potential regional project locations will be used as input for several RAA model runs to allow WMG members information to make decisions, as well as to inform non-WMG members about the value of their publicly owned parcels.
  - The water quality effectiveness of individual projects in the Very High Tier, will be analyzed individually by the RAA.
  - The water quality effectiveness of the set of regional project opportunities in the High Tier of will be evaluated in bulk (not individually) by the RAA.
  - The water quality effectiveness of the set of regional project opportunities in the Medium Tier, with and without schools, will be evaluated in bulk (not individually) by the WMMS modeling system. It is anticipated these projects will not be included in the draft EWMP submitted in 2015.

Additionally, there are parallel planning efforts ongoing in the ULAR watershed including development of the Stormwater Capture Master Plan (SCMP) led by the City of Los Angeles Department of Water and Power, and the Los Angeles River Ecosystem Restoration Feasibility Study (LAR ERFS) led by the City of Los Angeles Bureau of Engineering. It will be important to integrate the results of the EWMP regional project selection process with any projects being proposed in those studies. For example, parcels targeted for ecosystem restoration projects along the Los Angeles River could be analyzed to determine whether multi-benefit solutions could be implemented on those parcels, such that the objectives of both the EWMP and the LAR ERFS could be accomplished together. Similarly, projects identified in the SCMP could be analyzed to determine whether multi-benefit solutions could be implemented in those projects, such that the objectives of both the EWMP and the SCMP could be accomplished together.

5 References

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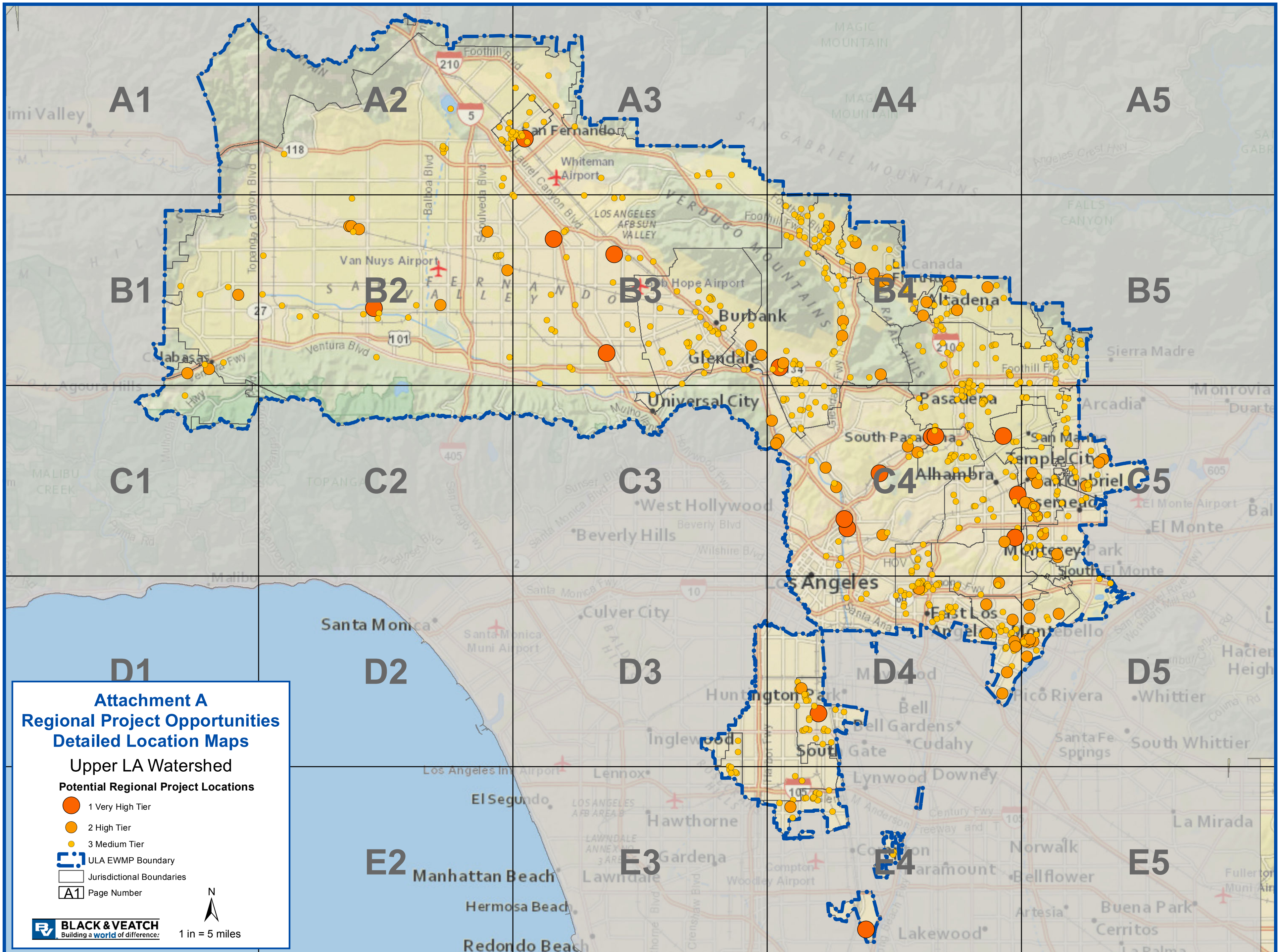
LIST OF ATTACHMENTS



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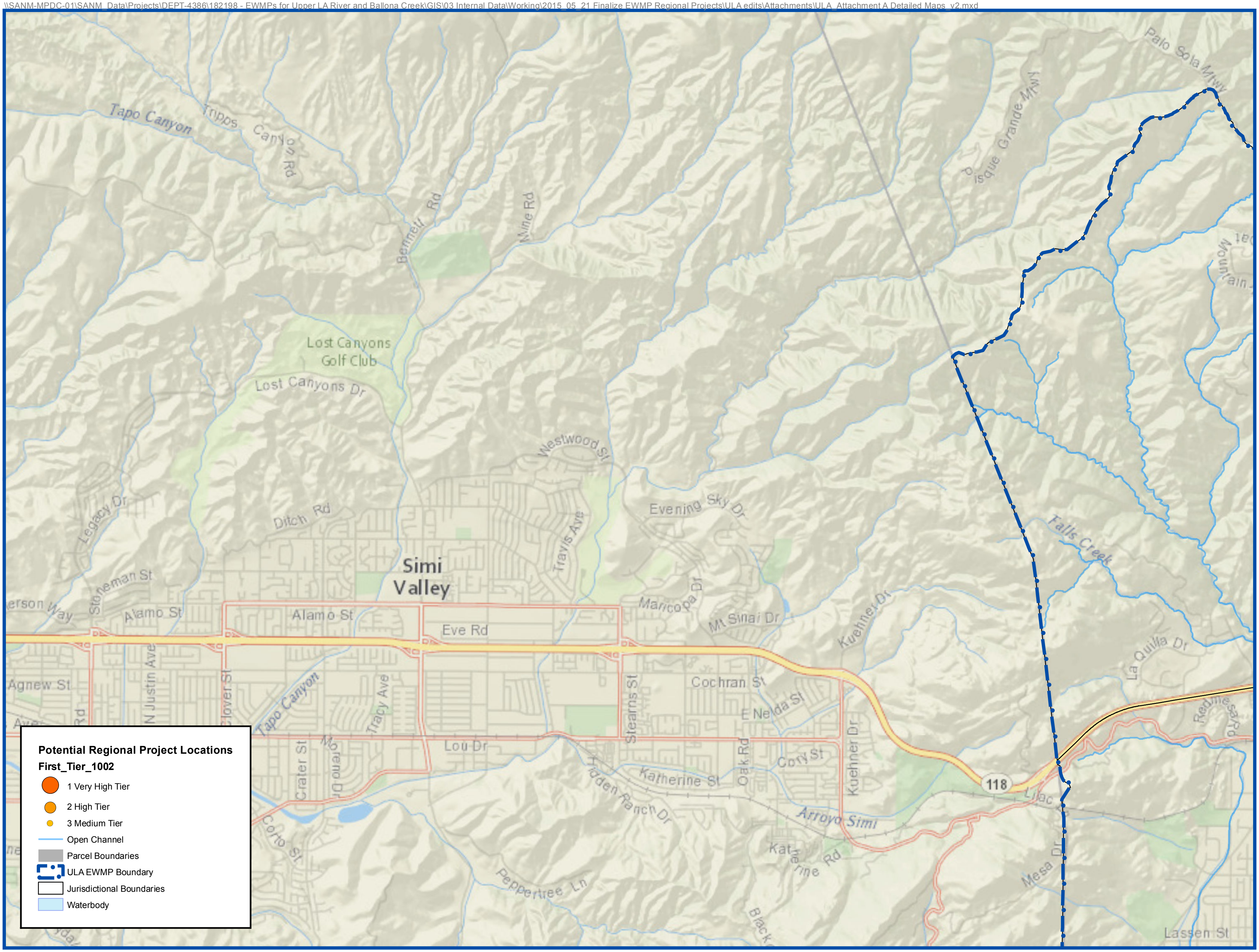

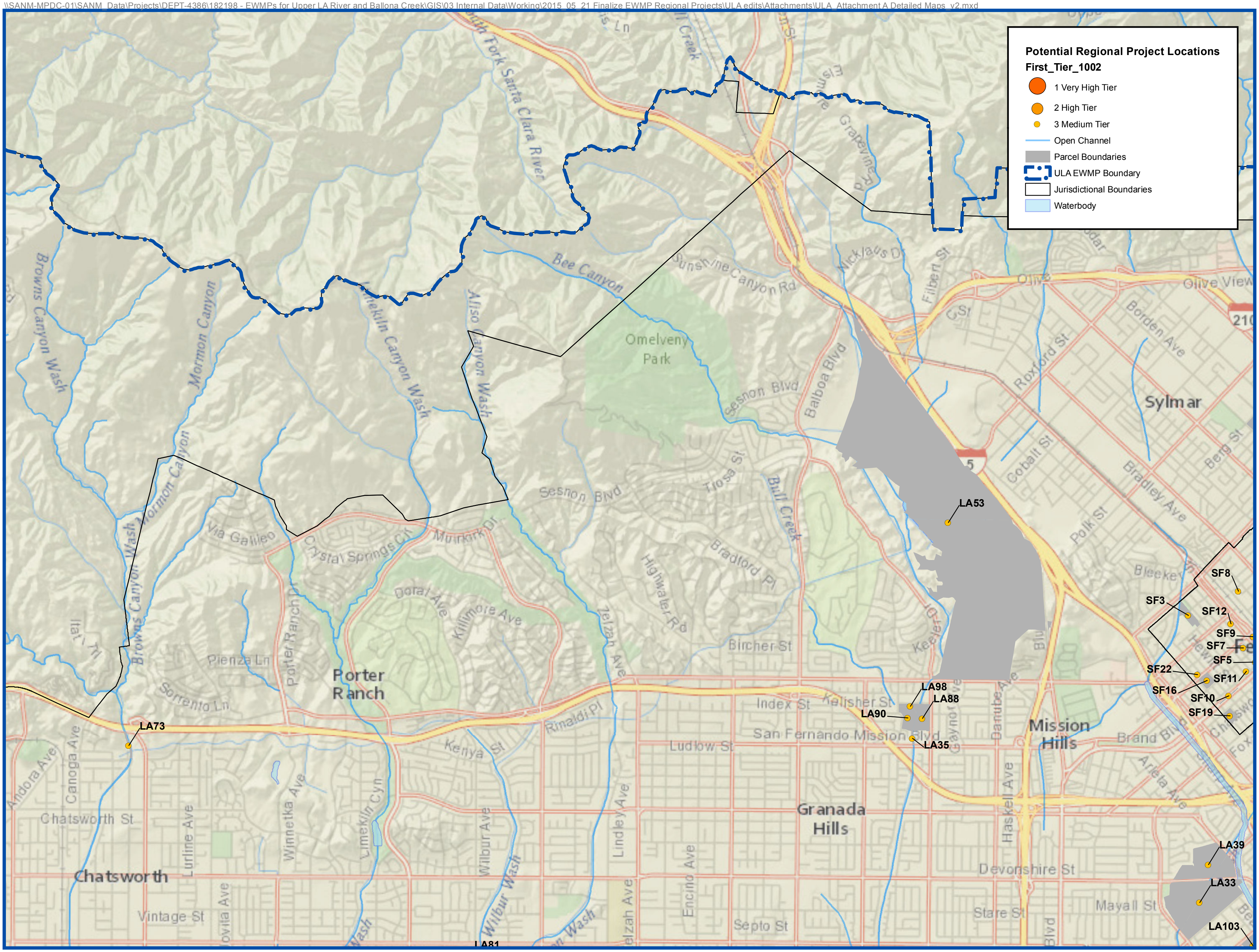
Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
LA53
LA98
LA88
LA90
LA35
LA73
LA39
LA33
LA103
LA81
SF8
SF3
SF12
SF9
SF7
SF5
SF22
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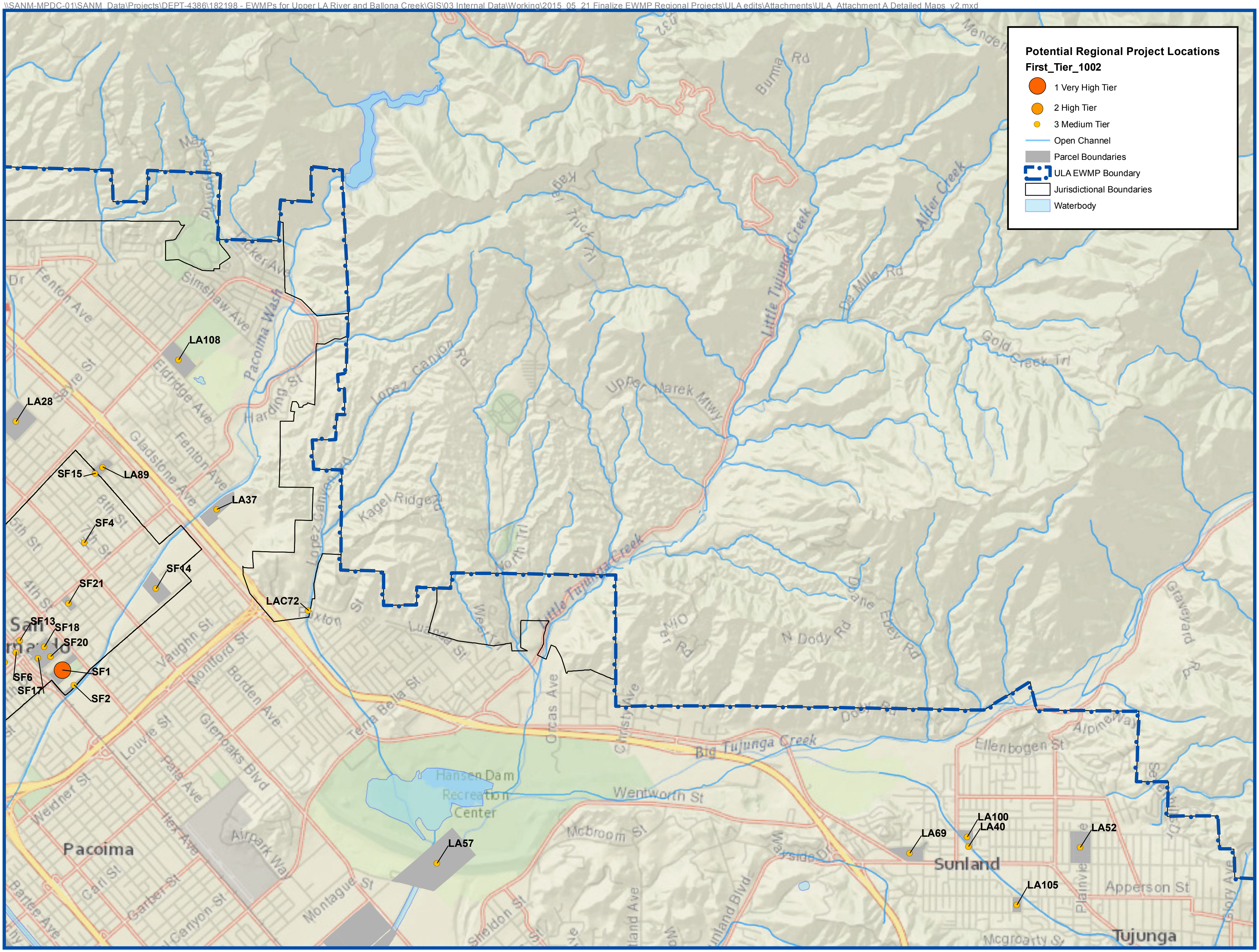
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LA89
LA37
SF4
SF14
SF21
LAC72
SF13
SF18
SF20
SF6
SF1
SF17
SF2
LA57
LA69
LA100
LA40
LA52
LA105
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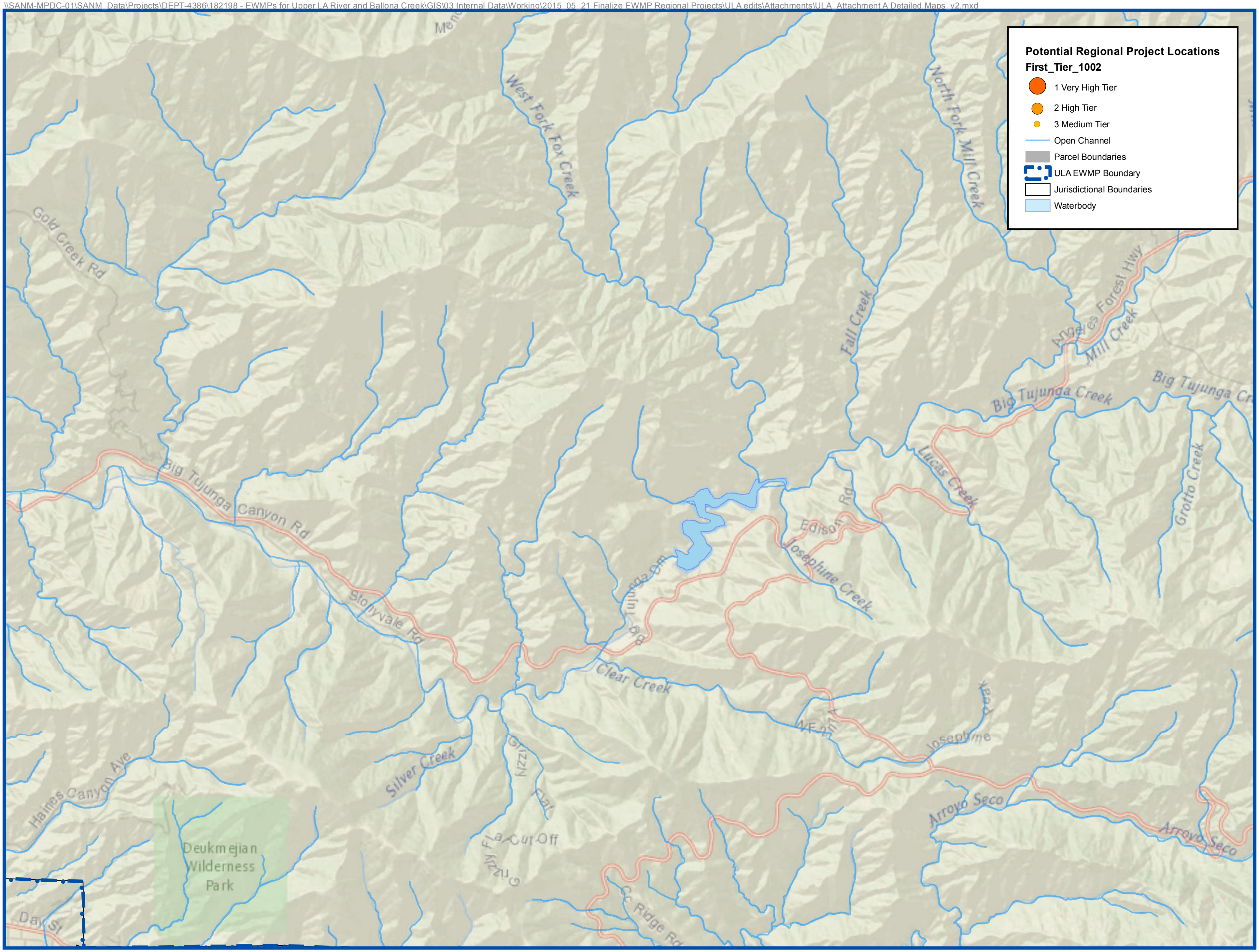
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ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
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North Fork Mill Creek
Gold Creek Rd
Fall Creek
Angeles Forest Hwy
Mill Creek
Big Tujunga Creek
Big Tujunga Canyon Rd
Lucas Creek
Grotto Creek
Edison Rd
Josephine Creek
Stonyvale Rd
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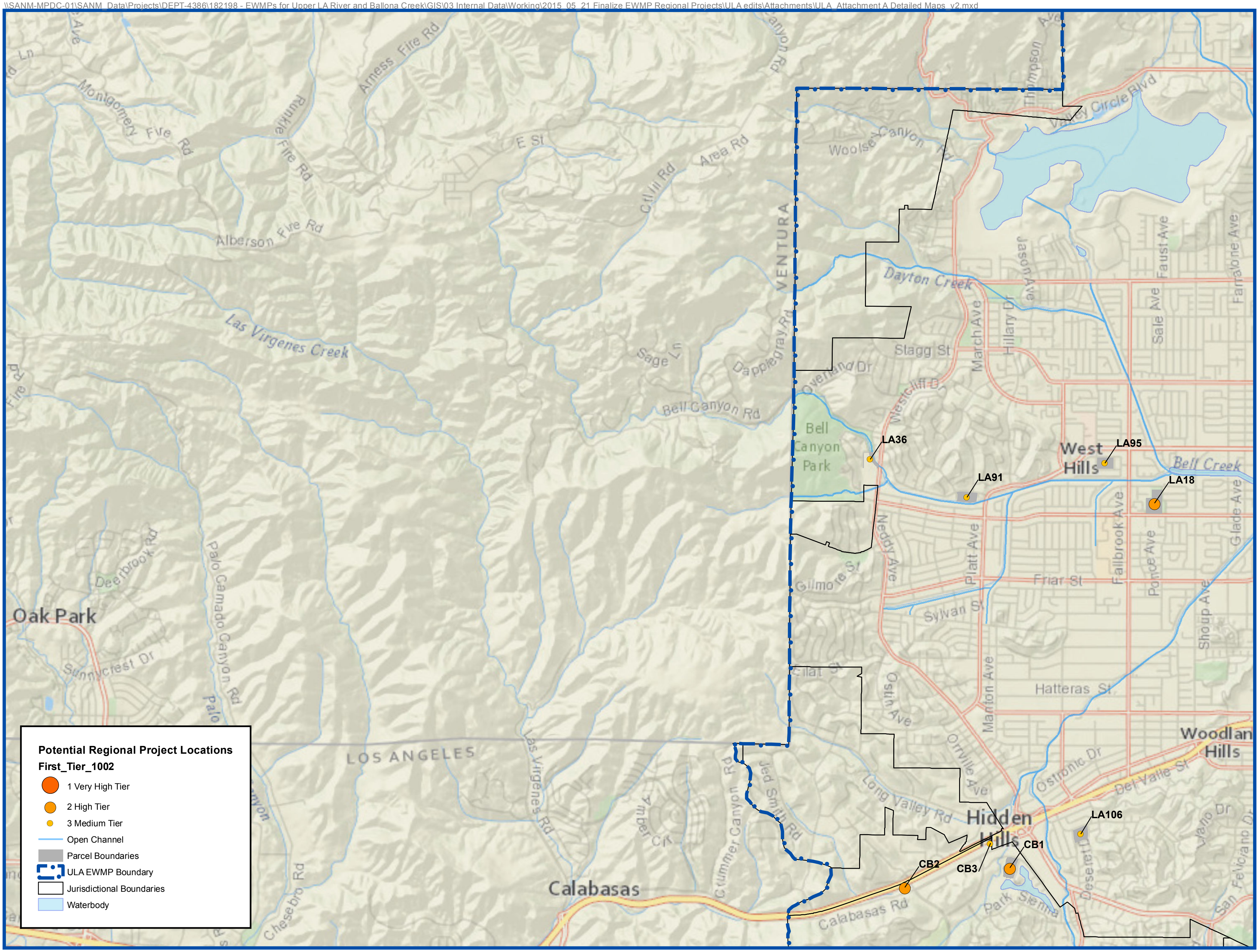

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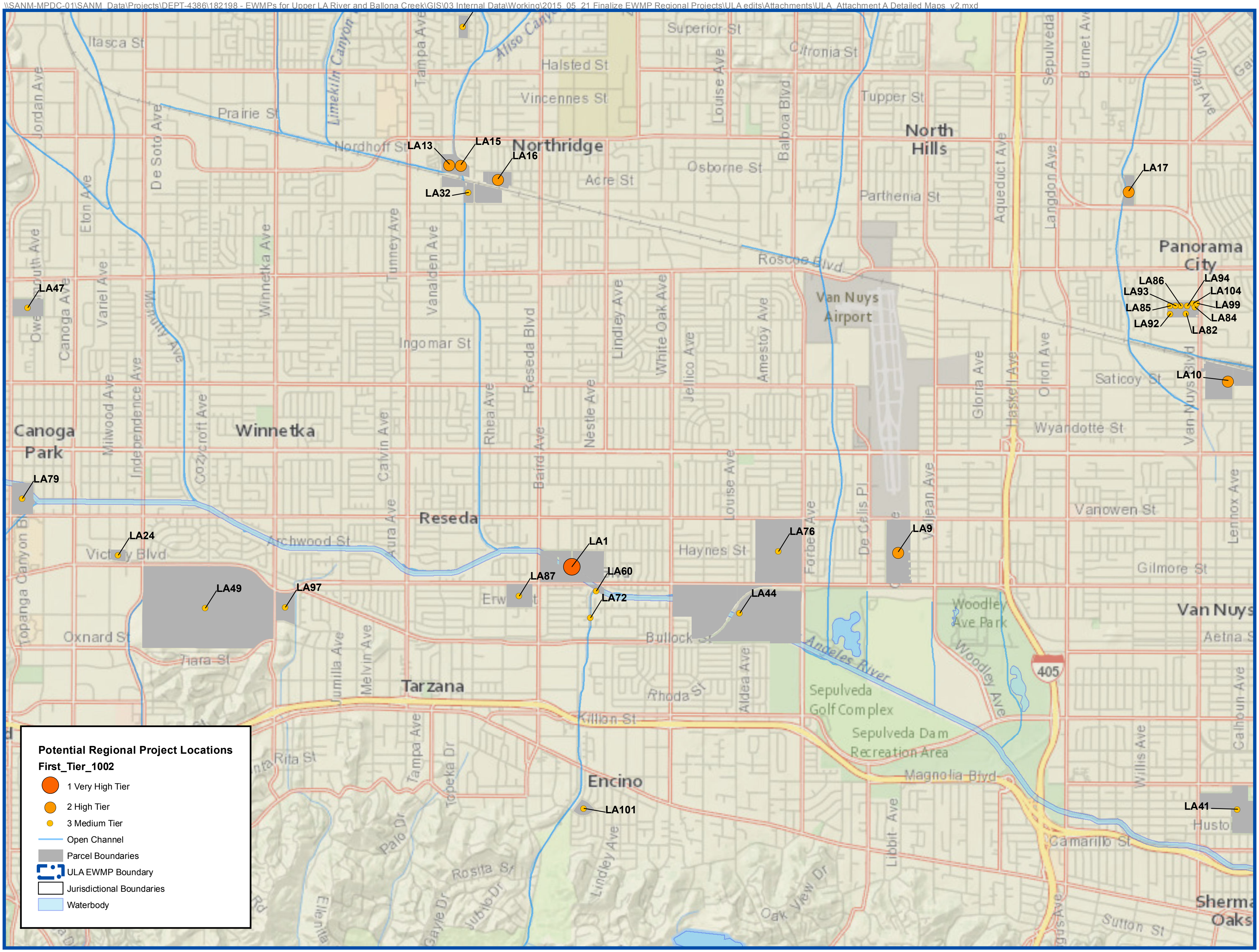
Attachment A - Regional Project Opportunities - Detailed Location Maps

Attachment A - B1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LA9
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North Hills
Panorama City
Van Nuys Airport
Canoga Park
Winnetka
Reseda
Tarzana
Encino
Van Nuys
Sherman Oaks
Sepulveda Golf Complex
Sepulveda Dam Recreation Area
Woodley Ave Park
Los Angeles River
Itasca St
Superior St
Citronia St
Halsted St
Vincennes St
Tupper St
Prairie St
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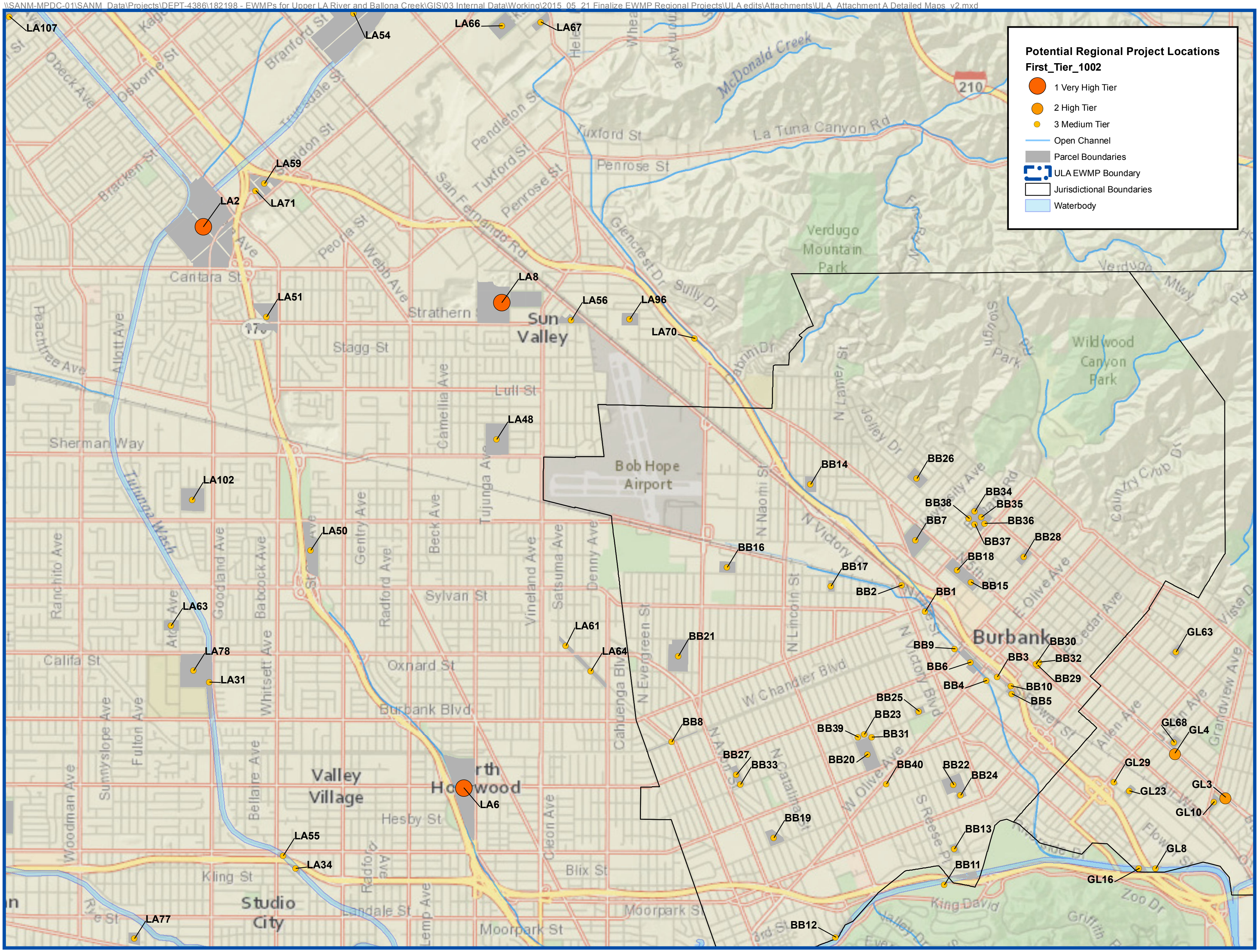

Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
LA107
LA54
LA66
LA67
LA59
LA71
LA2
LA8
LA51
LA56
LA96
LA70
LA48
LA102
LA50
LA63
LA78
LA31
LA61
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LA55
LA34
LA77
BB26
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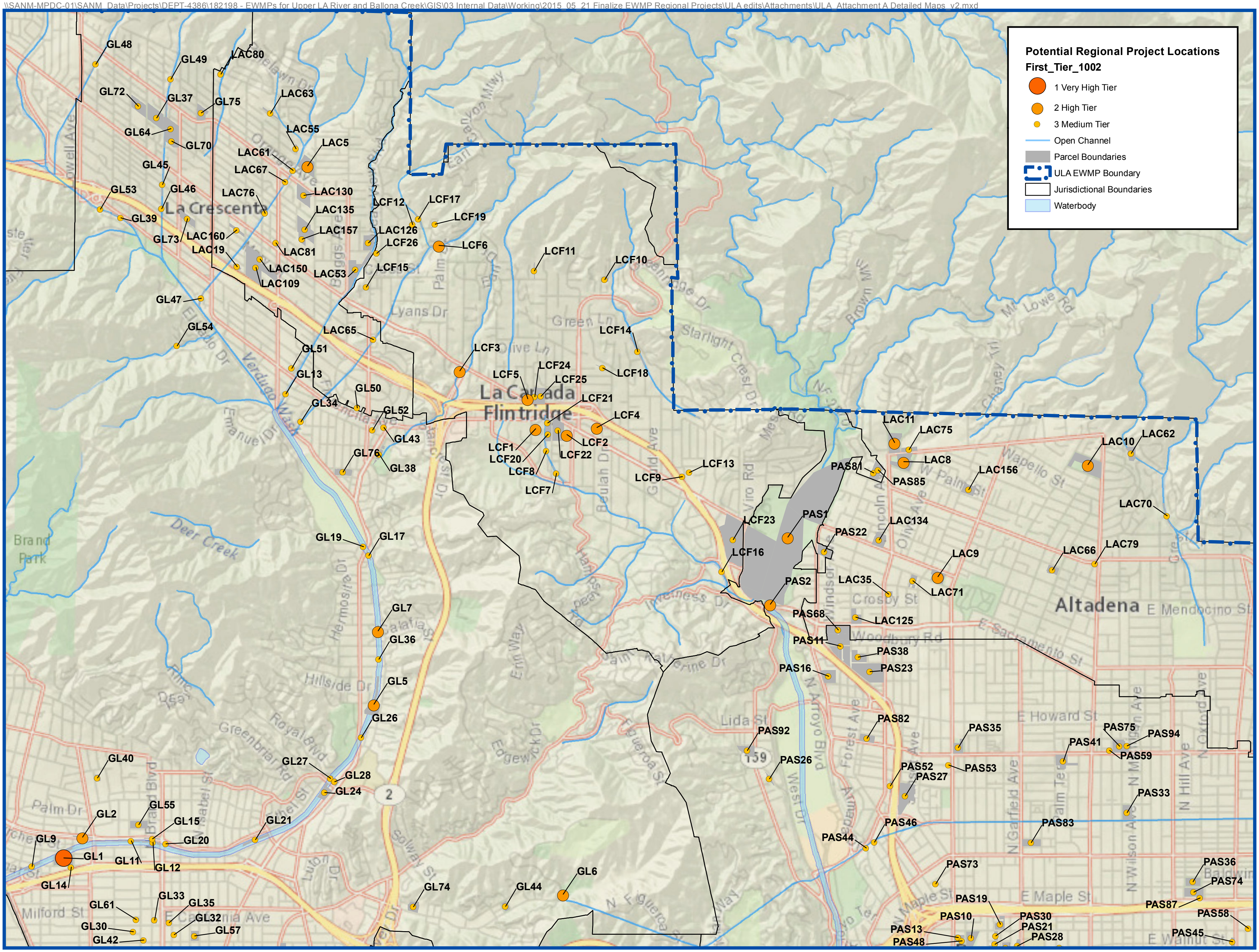
BB32
BB6
BB29
BB4
BB10
BB5
BB25
BB23
BB8
BB39
BB31
BB27
BB33
BB20
BB40
BB22
BB24
BB19
BB13
BB11
BB12
GL63
GL68
GL4
GL29
GL23
GL3
GL10
GL8
GL16
Verdugo Mountain Park
Wildwood Canyon Park
Sun Valley
Bob Hope Airport
Burbank
Valley Village
North Hollywood
Studio City
McDonald Creek
La Tuna Canyon Rd
Tujunga Wash
Sherman Way
Burbank Blvd
W Chandler Blvd
Oxnard St
Moorpark St
210

\\SANM-MPDC-01\SANM_Data\Projects\DEPT-4386\182198 - EWMPs for Upper LA River and Ballona Creek\GIS\03 Internal Data\Working\2015_05_21 Finalize EWMP Regional Projects\ULA edits\Attachments\ULA_Attachment A Detailed Maps_v2.mxd



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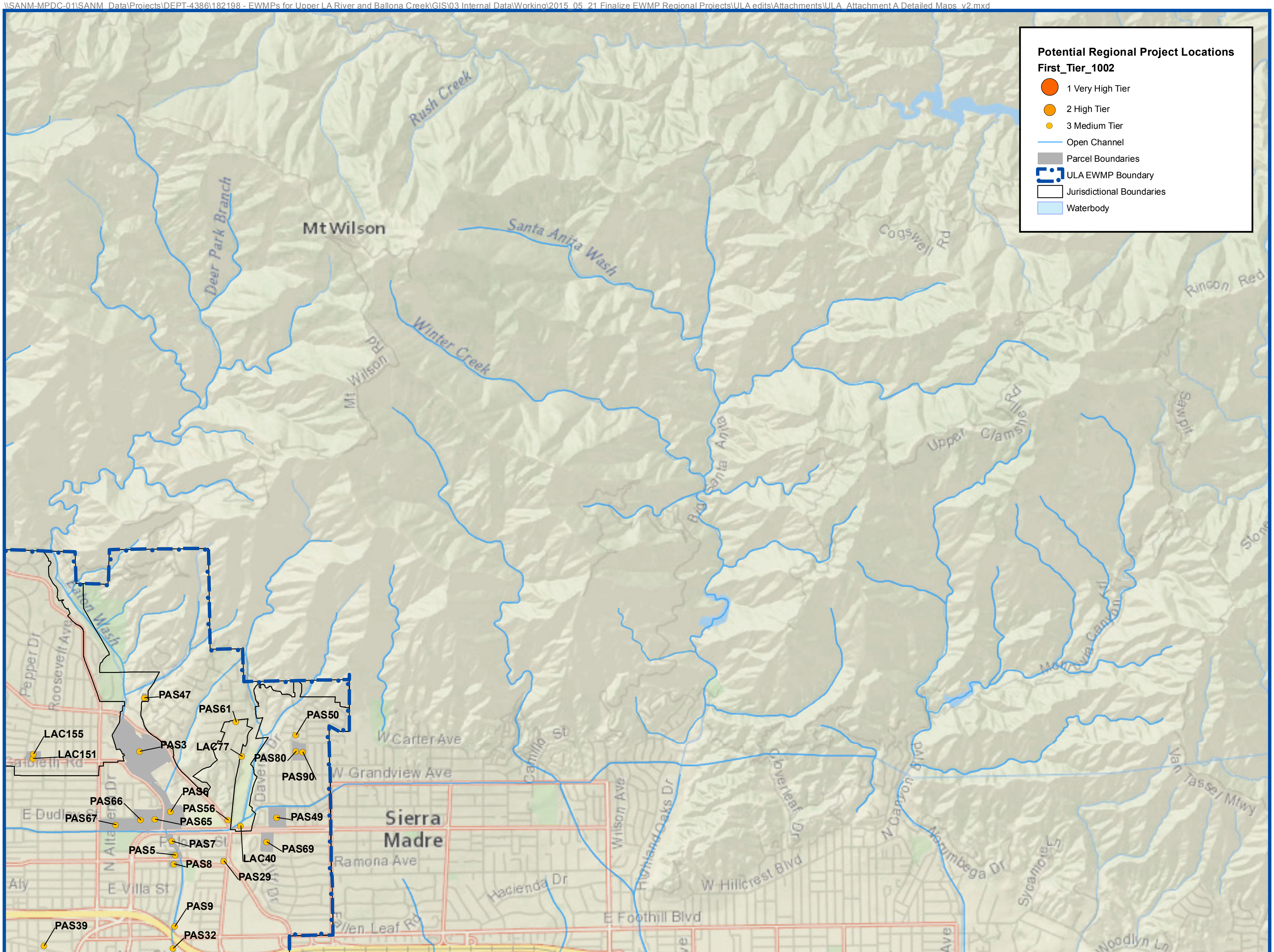
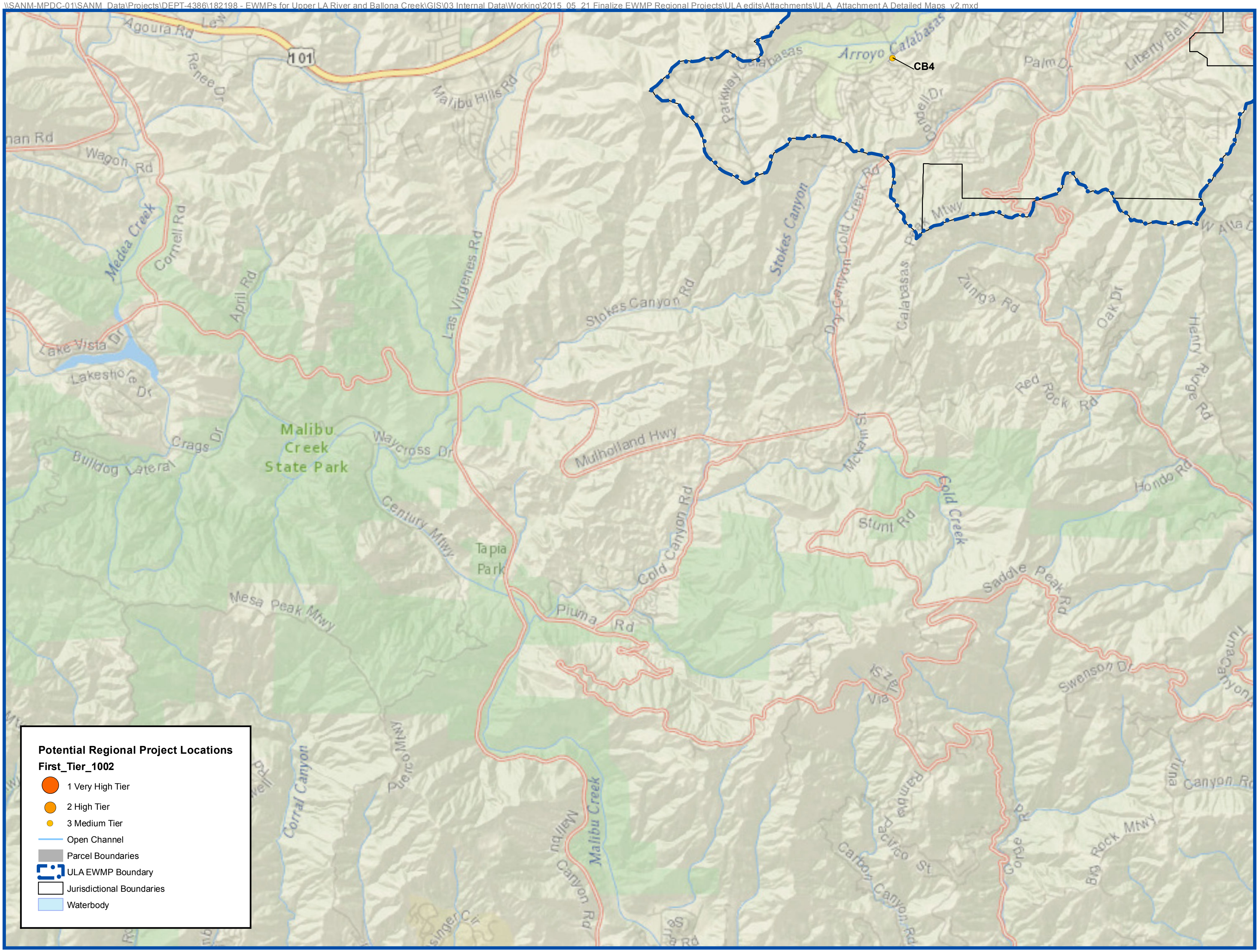
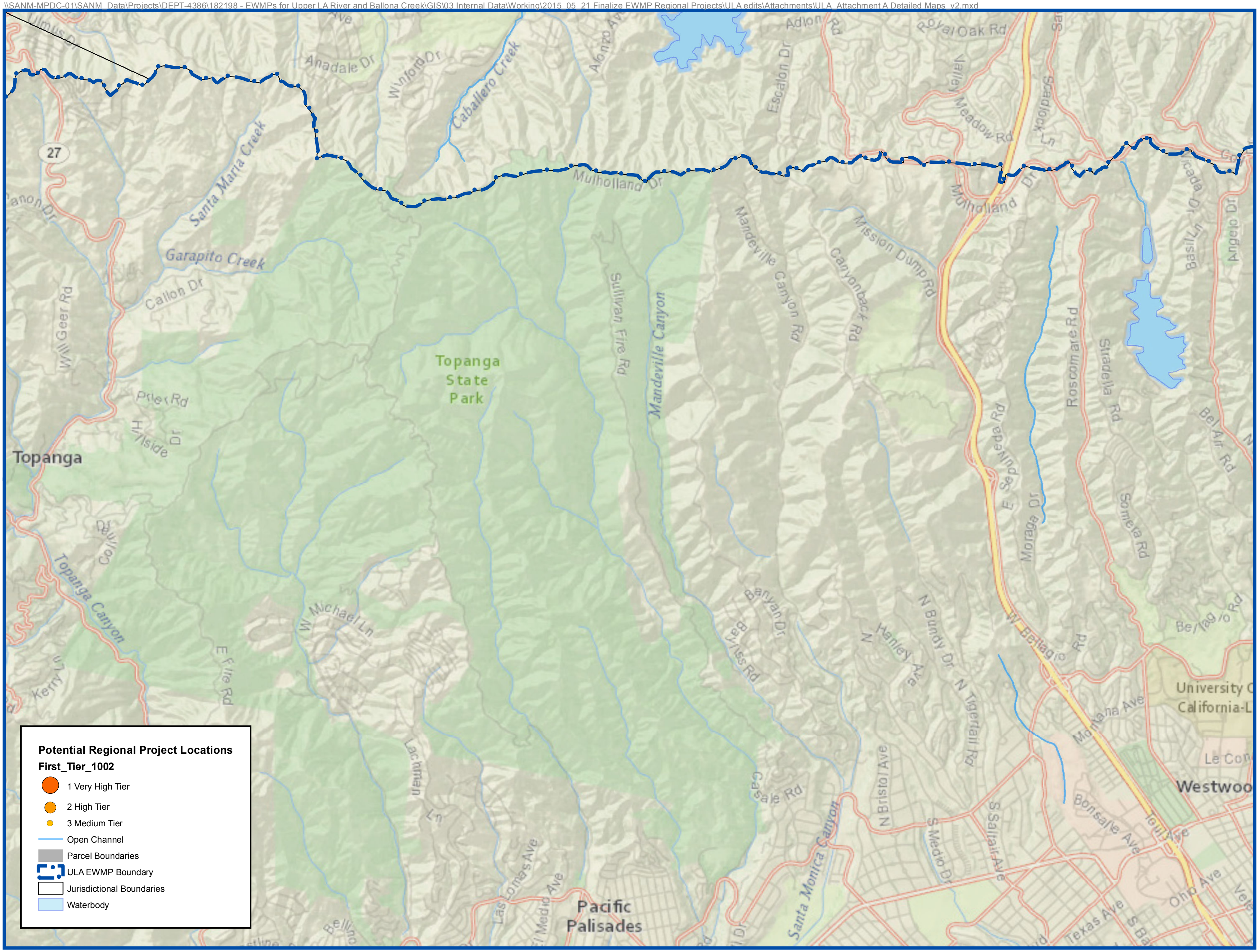
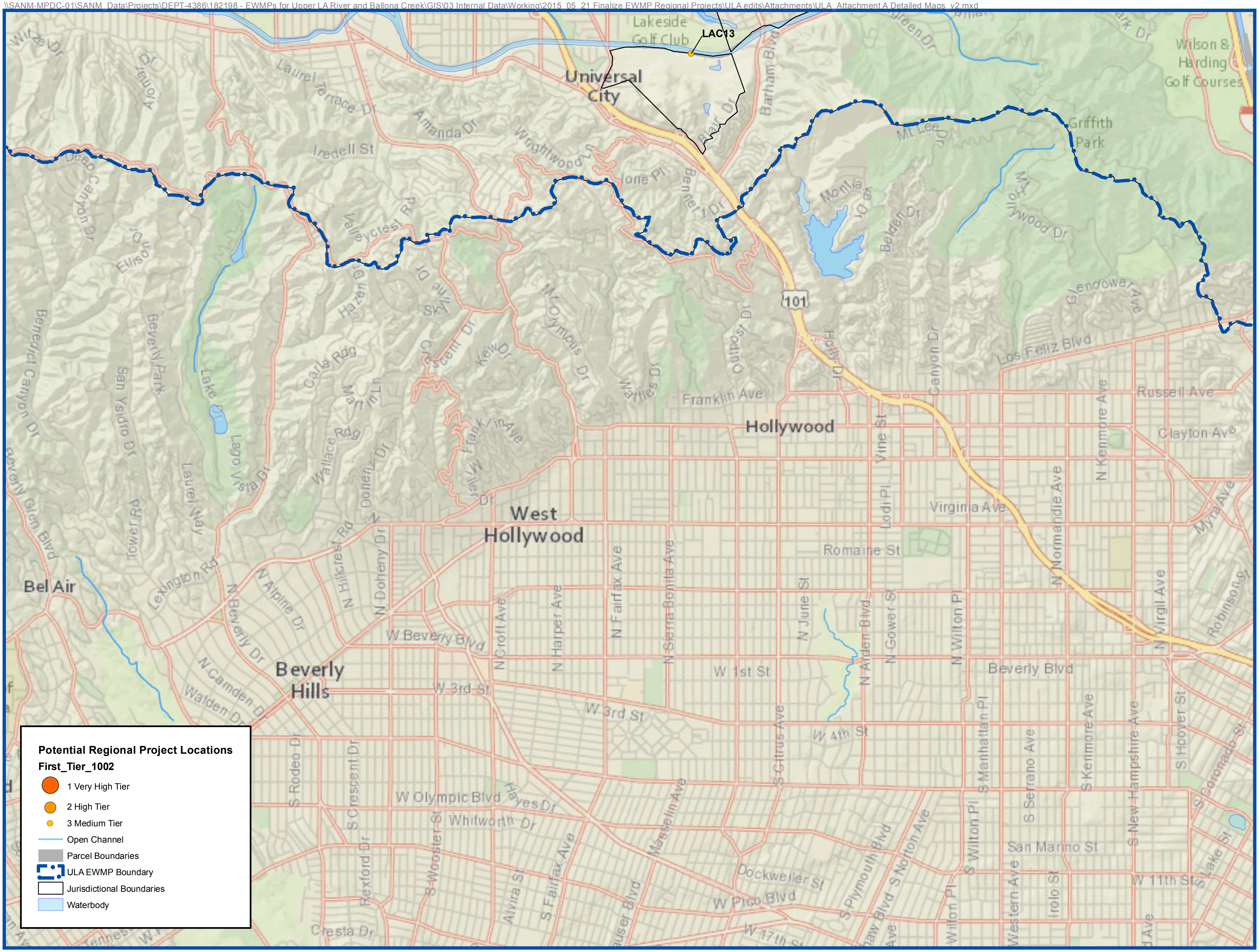


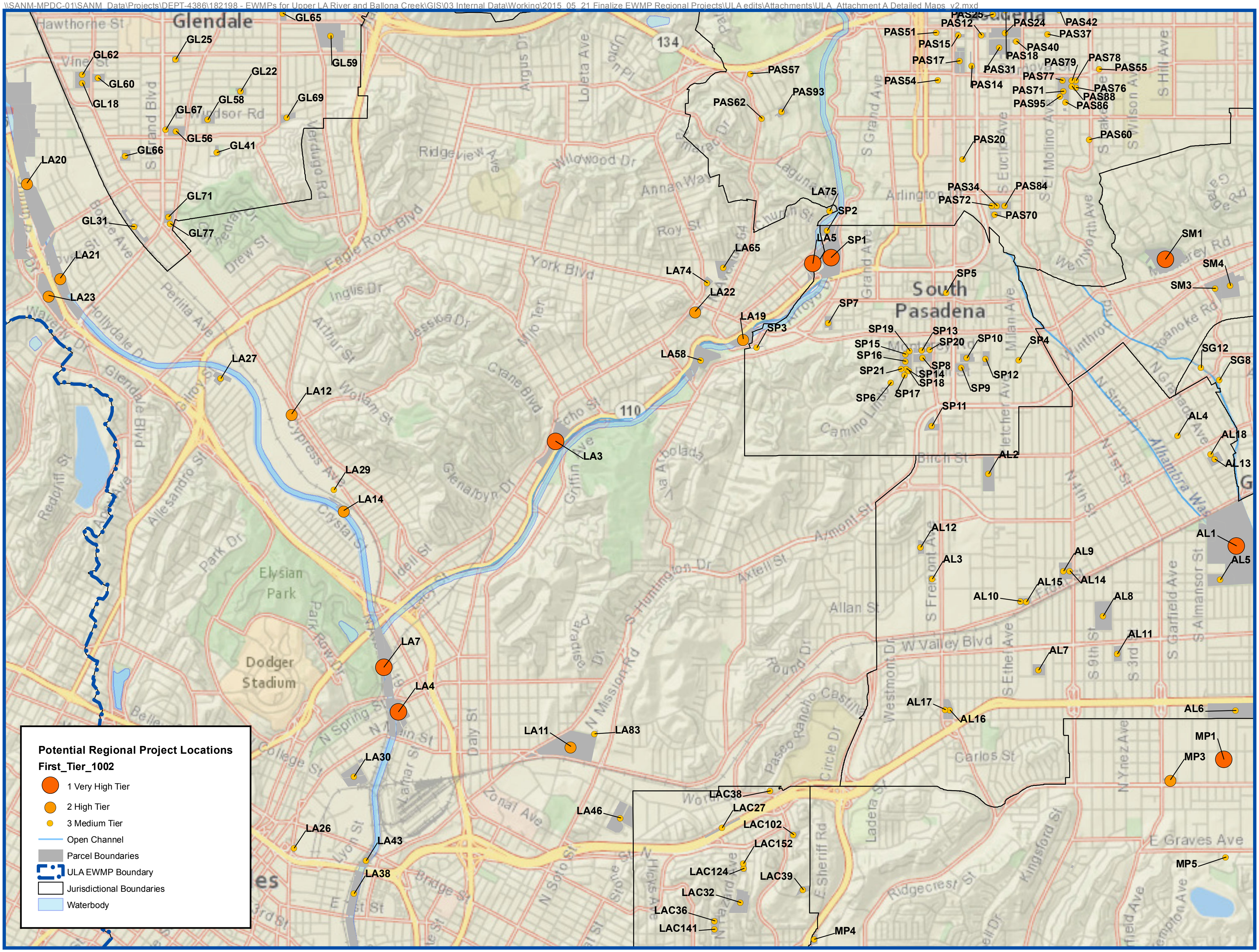

Agoura Rd
101
Renee Dr
Malibu Hills Rd
Arroyo Calabasas
CB4
Palm Dr
Liberty Bell Rd
Parkway Calabasas
Condell Dr
Wagon Rd
Medea Creek
Cornell Rd
April Rd
Las Virgenes Rd
Stokes Canyon
Stokes Canyon Rd
Cold Creek Rd
Dry Canyon Cold Creek Rd
Calabasas
Park Mtwy
Zuniga Rd
Oak Dr
Henry Ridge Rd
W Alta Dr
Lake Vista Dr
Lakeshore Dr
Red Rock Rd
Malibu Creek State Park
Waycross Dr
Mulholland Hwy
McKain St
Crags Dr
Bulldog Lateral
Cold Creek
Hondo Rd
Century Mtwy
Stunt Rd
Tapia Park
Cold Canyon Rd
Saddle Peak Rd
Mesa Peak Mtwy
Piuma Rd
Tuna Canyon
Swenson Dr
Via
Corral Canyon
Puerco Mtwy
Rambla Pacifico St
Malibu Creek
Malibu Canyon Rd
Carbon Canyon Rd
Big Rock Mtwy
Tuna Canyon Rd
Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
N
2,000
Feet


Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
Topanga State Park
Topanga
Pacific Palisades
Westwood
Mulholland Dr
Santa Marta Creek
Garapito Creek
Caballero Creek
Mandeville Canyon
Santa Monica Canyon
Topanga Canyon
27

\\SANM-MPDC-01\SANM_Data\Projects\DEPT-4386\182198 - EWMPs for Upper LA River and Ballona Creek\GIS\03 Internal Data\Working\2015_05_21 Finalize EWMP Regional Projects\ULA edits\Attachments\ULA_Attachment A Detailed Maps_v2.mxd



\\SANM-MPDC-01\SANM_Data\Projects\DEPT-4386\182198 - EWMPs for Upper LA River and Ballona Creek\GIS\03 Internal Data\Working\2015_05_21 Finalize EWMP Regional Projects\ULA edits\Attachments\ULA_Attachment A Detailed Maps_v2.mxd



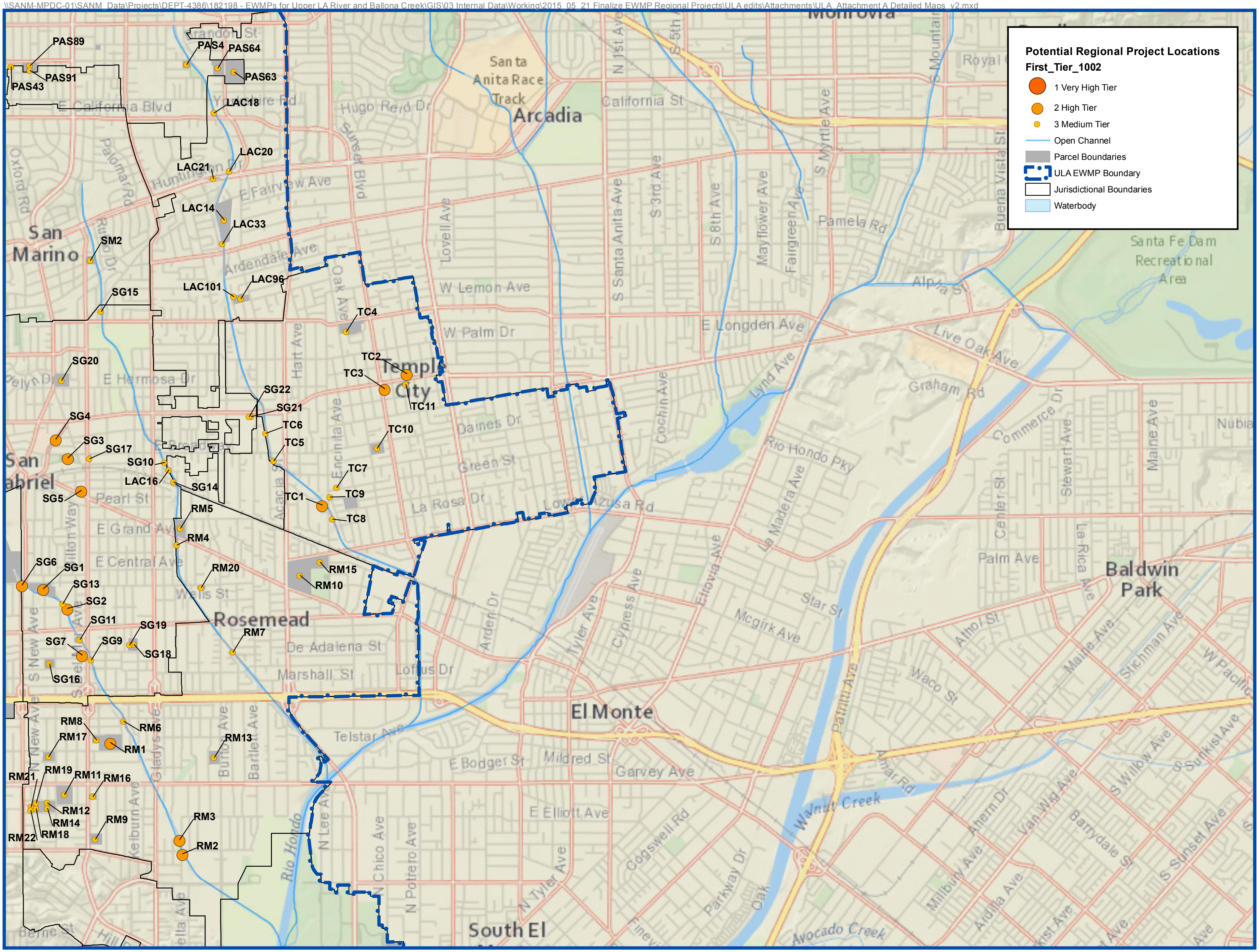
Attachment A - Regional Project Opportunities - Detailed Location Maps

BLACK & VEATCH Building a world of difference.

6/17/2015

N

2,000 Feet


Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
PAS89
PAS4
PAS64
PAS63
PAS91
PAS43
LAC18
LAC20
LAC21
LAC14
LAC33
SM2
LAC101
LAC96
SG15
TC4
TC2
TC3
TC11
SG20
SG22
SG21
TC6
TC5
TC10
SG4
SG3
SG17
SG10
LAC16
SG14
TC7
TC9
TC1
TC8
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RM5
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RM10
SG11
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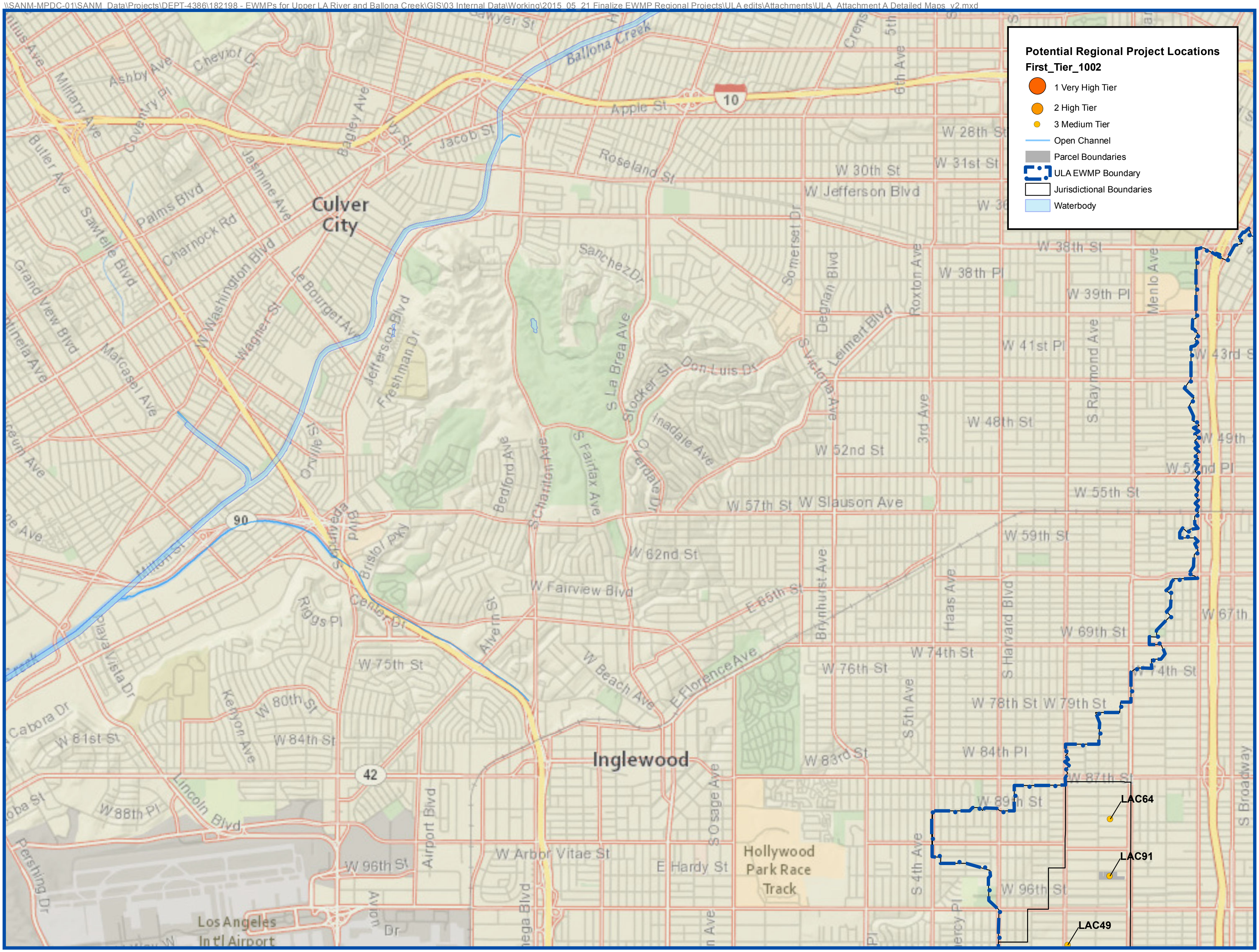
RM7
RM8
RM6
RM17
RM1
RM13
RM21
RM19
RM11
RM16
RM12
RM14
RM22
RM18
RM9
RM3
RM2
San Marino
San Gabriel
Arcadia
Santa Anita Race Track
Temple City
Rosemead
El Monte
Baldwin Park
South El
Santa Fe Dam Recreational Area
Rio Hondo
Walnut Creek
Avocado Creek

\\SANM-MPDC-01\SANM_Data\Projects\DEPT-4386\182198 - EWMPs for Upper LA River and Ballona Creek\GIS\03 Internal Data\Working\2015_05_21 Finalize EWMP Regional Projects\ULA edits\Attachments\ULA_Attachment A Detailed Maps_v2.mxd

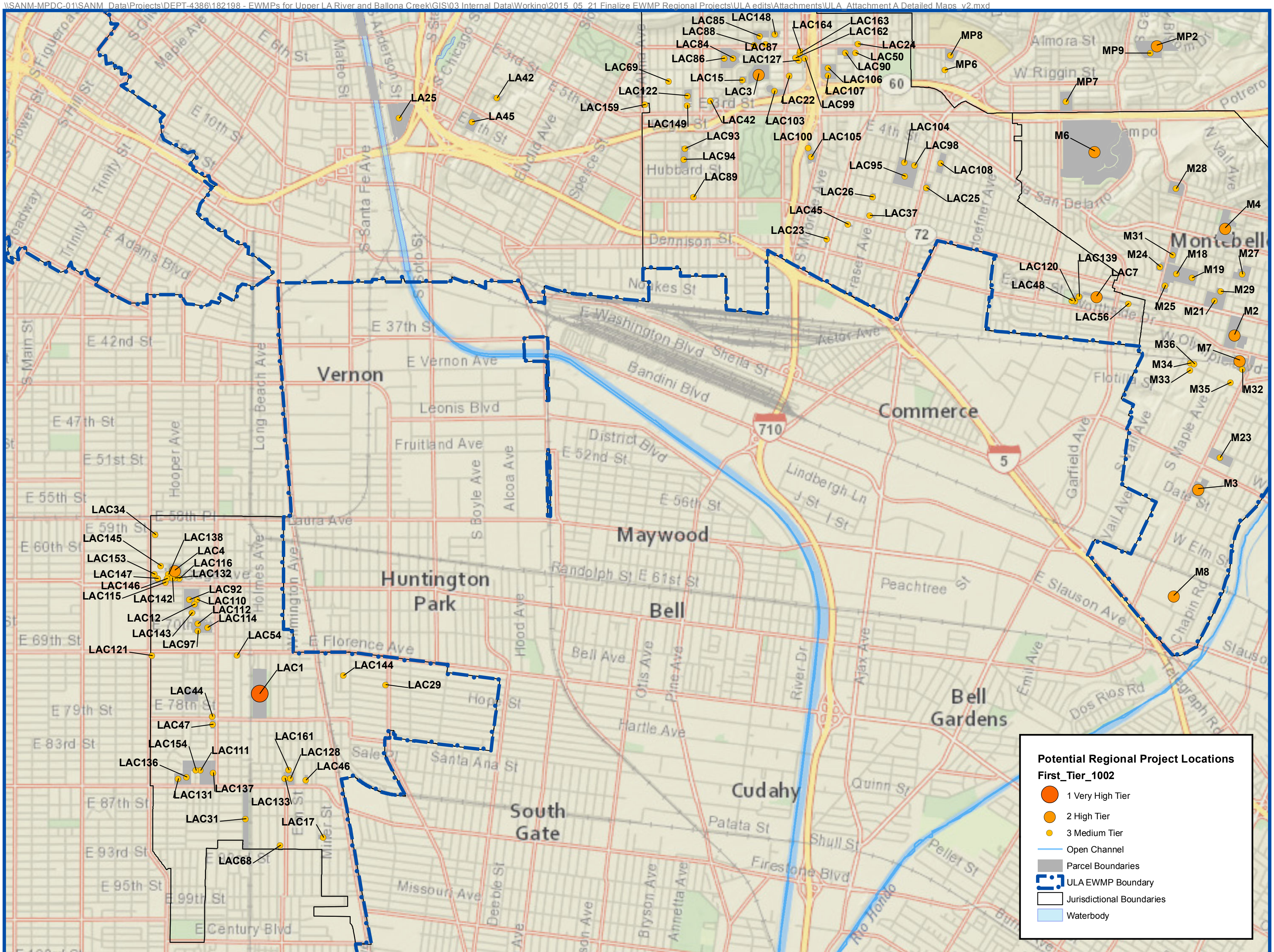


BLACK & VEATCH Building a world of difference. 6/17/2015

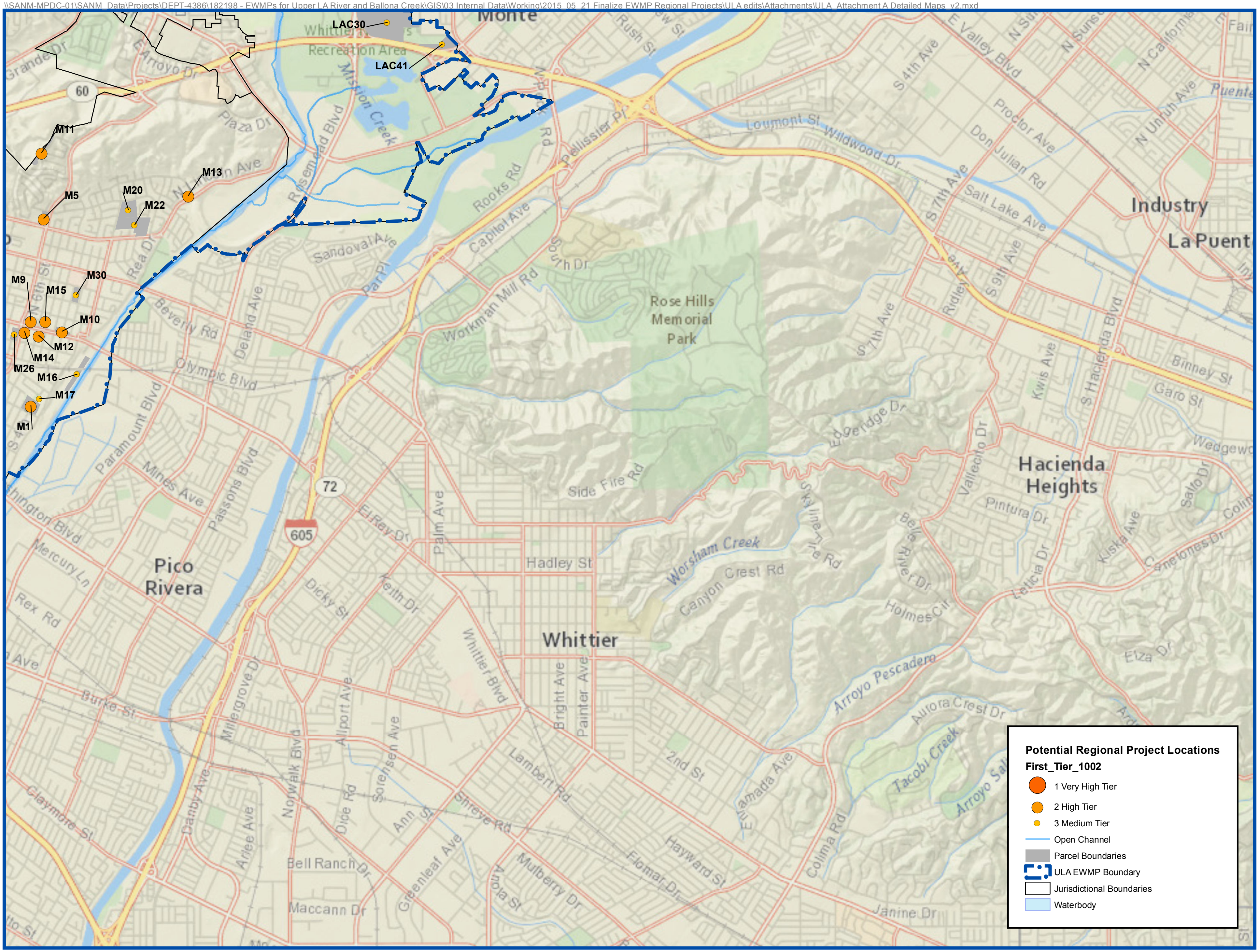
Attachment A - Regional Project Opportunities - Detailed Location Maps

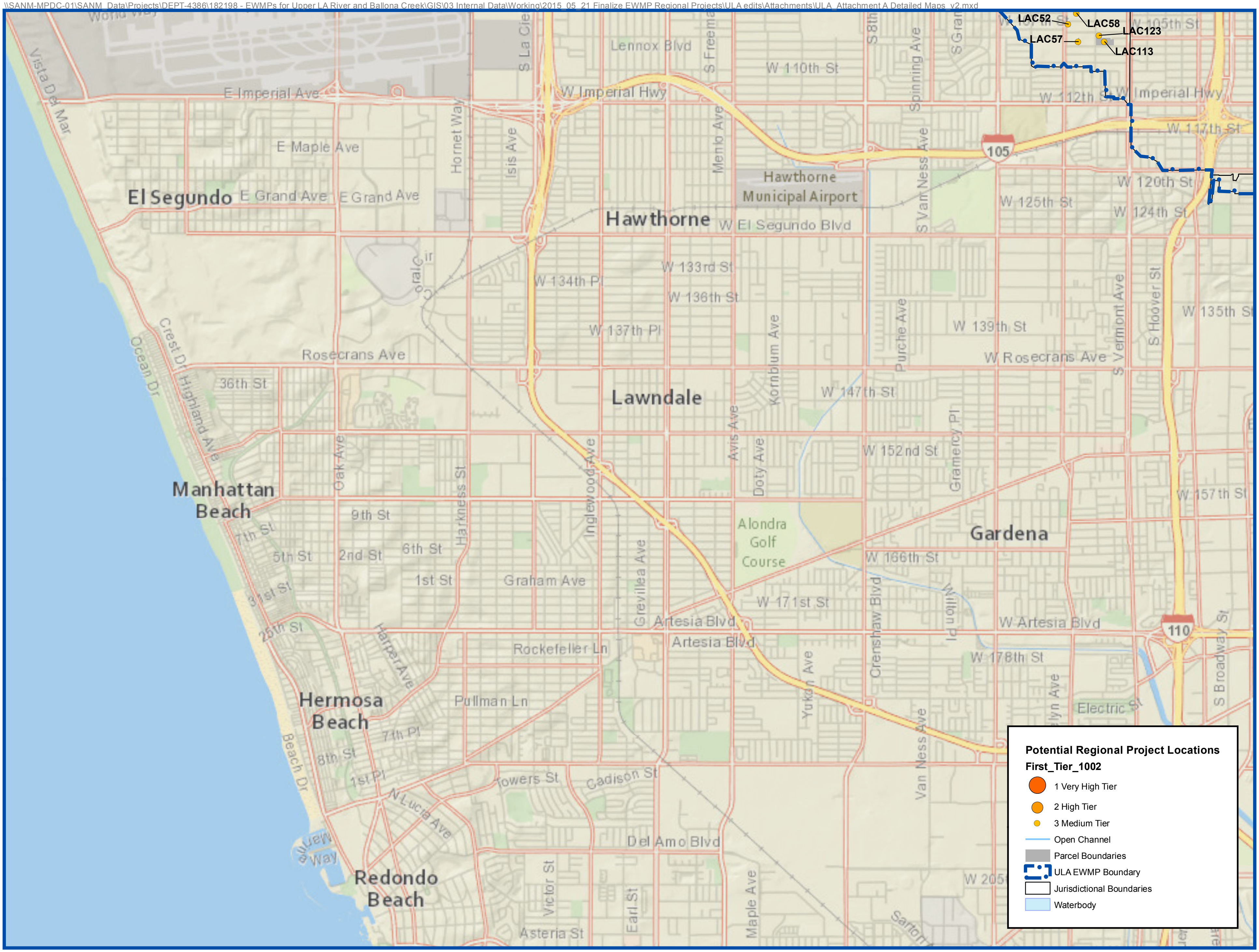
Attachment A - D3

\\SANM-MPDC-01\SANM_Data\Projects\DEPT-4386\182198 - EWMPs for Upper LA River and Ballona Creek\GIS\03 Internal Data\Working\2015_05_21 Finalize EWMP Regional Projects\ULA edits\Attachments\ULA_Attachment A Detailed Maps_v2.mxd



\\SANM-MPDC-01\SANM_Data\Projects\DEPT-4386\182198 - EWMPs for Upper LA River and Ballona Creek\GIS\03 Internal Data\Working\2015_05_21 Finalize EWMP Regional Projects\ULA edits\Attachments\ULA_Attachment A Detailed Maps_v2.mxd




LAC52
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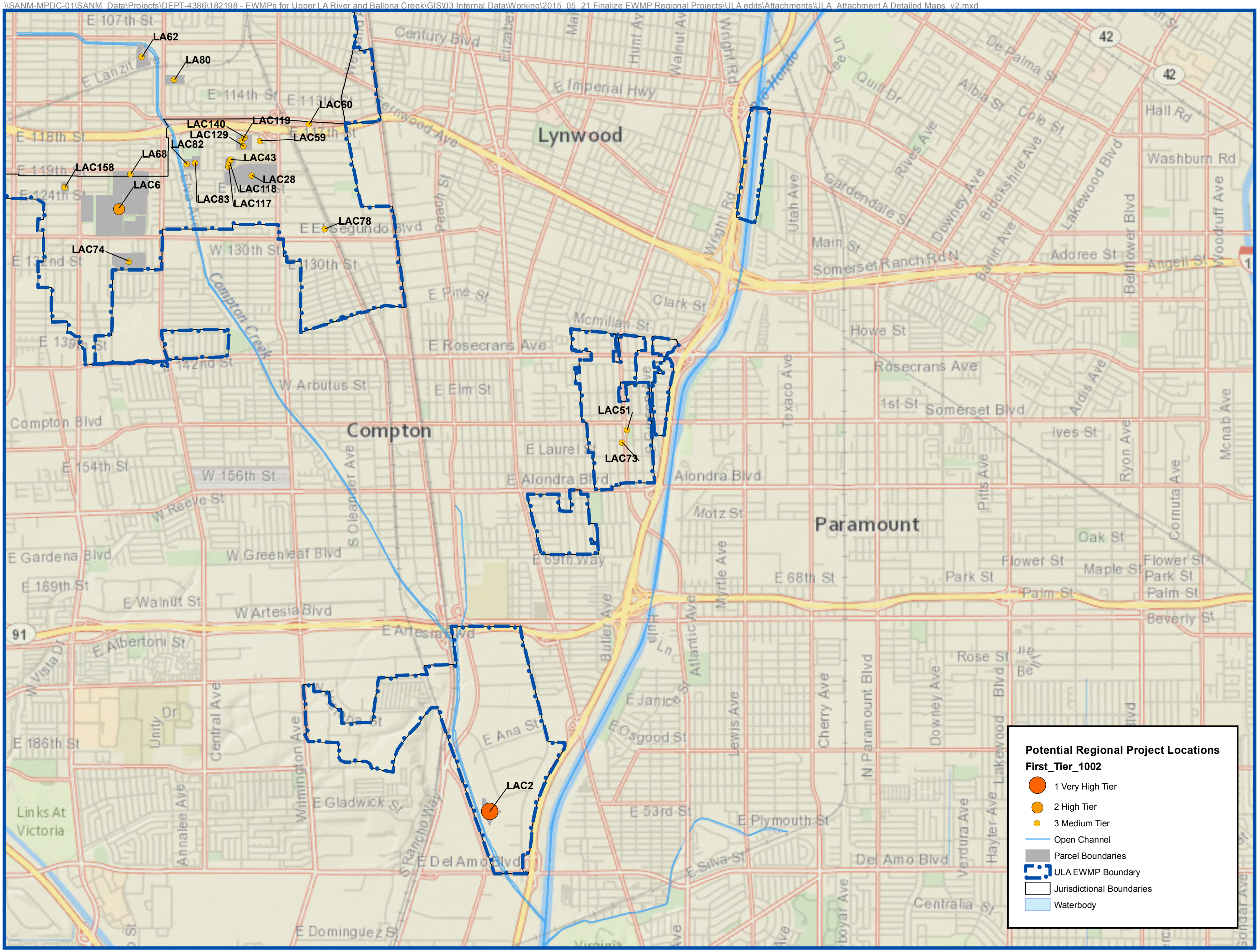
LAC123
LAC57
LAC113
El Segundo
Hawthorne
Lawndale
Manhattan Beach
Hermosa Beach
Redondo Beach
Gardena
Hawthorne Municipal Airport
Alondra Golf Course
105
110
E Imperial Ave
W Imperial Hwy
E Maple Ave
E Grand Ave
W El Segundo Blvd
Lennox Blvd
W 110th St
W 112th St
W 117th St
W 120th St
W 124th St
W 125th St
W 133rd St
W 134th Pl
W 135th St
W 136th St
W 137th Pl
W 139th St
Rosecrans Ave
W Rosecrans Ave
W 147th St
W 152nd St
W 157th St
W 166th St
W 171st St
W Artesia Blvd
Artesia Blvd
W 178th St
Electric St
Del Amo Blvd
Graham Ave
Rockefeller Ln
Pullman Ln
Towers St
Cadison St
Asteria St
Vista Del Mar
Crest Dr
Highland Ave
Ocean Dr
36th St
9th St
7th St
6th St
5th St
2nd St
1st St
31st St
25th St
7th Pl
8th St
1st Pl
Beach Dr
N Lucia Ave
Harper Ave
Oak Ave
Harkness St
Hornet Way
Isis Ave
S La Cienega
Inglewood Ave
Grevillea Ave
Menlo Ave
S Freeman
Avis Ave
Doty Ave
Kornblum Ave
Yukon Ave
Crenshaw Blvd
Purche Ave
S Van Ness Ave
Van Ness Ave
Gramercy Pl
Wilton Pl
S Vermont Ave
S Hoover St
S Broadway St
Spinning Ave
Maple Ave
Victor St
Earl St
Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
N
2,000
Feet


LA62
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LAC60
LAC119
LAC140
LAC129
LAC59
LAC82
LA68
LAC43
LAC158
LAC28
LAC6
LAC118
LAC83
LAC117
LAC78
LAC74
LAC51
LAC73
LAC2
Lynwood
Compton
Paramount
Potential Regional Project Locations
First_Tier_1002
1 Very High Tier
2 High Tier
3 Medium Tier
Open Channel
Parcel Boundaries
ULA EWMP Boundary
Jurisdictional Boundaries
Waterbody
N
2,000
Feet

Attachment B - List of Parcels in the Very High Tier

City	Cluster ID	AIN	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Alhambra	AL1	5347029907	4.25	16.73	ALHAMBRA CITY (GOLF COURSE)	700 S ALMANSOR ST	C4	34.0888	-118.113
Alhambra		5347031902	102.87	16.73	ALHAMBRA CITY		C4	34.0888	-118.113
Alhambra		5347029906	24.65	16.73	ALHAMBRA CITY	800 S ALMANSOR ST	C4	34.0888	-118.113
Alhambra		5347028905	1.87	16.73	ALHAMBRA CITY (GOLF COURSE)		C4	34.0888	-118.113
Glendale	GL1	5635006900	8.06	17.53	GLENDALE CITY	600 W HAHN AVE	B4	34.1573	-118.268
Glendale		5635006902	1.35	17.53	L A CO FLOOD CONTROL DIST		B4	34.1573	-118.268
LA County	LAC1	6025001900	24.35	9.98	L A COUNTY	760GRAHAM AVE	D4	33.9702	-118.242
LA County	LAC2	7306019901	3.68	7.04	L A COUNTY		E4	33.8534	-118.211
LA County		7306019902	4.84	7.04	L A COUNTY		E4	33.8534	-118.211
Los Angeles	LA1	2124001902	29.79	18.83	L A CITY		B2	34.1884	-118.532
Los Angeles		2124001905	11.90	18.83	L A CO FLOOD CONTROL DIST		B2	34.1884	-118.532
Los Angeles		2124001904	29.16	18.83	L A UNIFIED SCHOOL DIST	1823KITTRIDGE ST	B2	34.1884	-118.532
Los Angeles	LA2	2627019901	22.18	15.24	L A CO FLOOD CONTROL DIST		B3	34.2263	-118.415
Los Angeles		2627020902	7.10	15.24	L A CO FLOOD CONTROL DIST		B3	34.2263	-118.415
Los Angeles		2634002902	40.75	15.24	L A CITY DEPT OF WATER AND POWER		B3	34.2263	-118.415
Los Angeles		2634003904	35.84	15.24	L A CITY DEPT OF WATER AND POWER	8801 ARLETA AVE	B3	34.2263	-118.415
Los Angeles		2634016901	8.83	15.24	L A CITY DEPT OF WATER AND POWER		B3	34.2263	-118.415
Los Angeles		2634017901	20.65	15.24	L A CITY DEPT OF WATER AND POWER		B3	34.2263	-118.415
Los Angeles		2634031900	0.31	15.24	L A CITY DEPT OF WATER AND POWER		B3	34.2263	-118.415
Los Angeles	LA3	5467008901	1.25	13.63	L A CITY	4580 N FIGUEROA ST	C4	34.1002	-118.203
Los Angeles		5467011901	0.69	13.63	L A CITY		C4	34.1002	-118.203
Los Angeles		5467011900	13.72	13.63	L A CITY		C4	34.1002	-118.203
Los Angeles		5467012900	0.06	13.63	L A CITY		C4	34.1002	-118.203
Los Angeles		5467012901	0.64	13.63	L A CITY		C4	34.1002	-118.203
Los Angeles	LA4	5447027906	1.24	12.12	L A CITY	235 S AVENUE 17	C4	34.0704	-118.224
Los Angeles	LA5	5493038900	8.13	9.01	L A CITY		C4	34.1198	-118.169
Los Angeles		5493037900	1.19	9.01	L A CITY PARK		C4	34.1198	-118.169
Los Angeles	LA6	2350011908	0.89	8.41	L A CITY		B3	34.1647	-118.381
Los Angeles		2350011901	25.79	8.41	L A CITY	5211 TUJUNGA AVE	B3	34.1647	-118.381
Los Angeles		2353001903	22.45	8.41	L A CITY	1145MAGNOLIA BLVD	B3	34.1647	-118.381
Los Angeles		2353001904	2.84	8.41	L A CO FLOOD CONTROL DIST		B3	34.1647	-118.381
Los Angeles	LA7	5447032900	20.84	8.11	L A CITY		C4	34.0753	-118.226
Los Angeles		5447017901	0.50	8.11	L A CITY		C4	34.0753	-118.226
Los Angeles	LA8	2314001900	7.94	7.61	L A CO FLOOD CONTROL DIST		B3	34.2181	-118.376
Los Angeles		2314001901	38.41	7.61	L A CO FLOOD CONTROL DIST	8175 FAIR AVE	B3	34.2181	-118.376
Los Angeles		2314005900	8.76	7.61	L A CITY		B3	34.2181	-118.376
Los Angeles		2314005903	8.50	7.61	L A CITY		B3	34.2181	-118.376
Monterey Park	MP1	5258002908	1.88	8.00	MONTEREY PARK CITY		C4	34.0653	-118.115
San Fernando	SF1	2519026903	10.69	14.96	SAN FERNANDO CITY	208 PARK AVE	A3	34.2805	-118.434
San Marino	SM1	5328020900	25.57	13.86	SAN MARINO CITY PARK		C4	34.1203	-118.122
San Marino		5328020901	0.46	13.86	SAN MARINO CITY		C4	34.1203	-118.122
San Marino		5328020903	0.66	13.86	SAN MARINO CITY		C4	34.1203	-118.122
South Pasadena	SP1	5493038905	25.54	7.01	SOUTH PASADENA CITY		C4	34.1204	-118.167

*Due to the fact that many of these parcels are vacant lots, addresses may not exist. The location of each AIN can be found online at http://navigatela.lacity.org or http://maps.assessor.lacounty.gov

Attachment C - List of Parcels in the High Tier

City	Cluster ID	AIN	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Calabasas	CB1	2068005900	0.30	7.84	CALABASAS CITY	2340PARK SORRENTO	B1	34.1548	-118.639
Calabasas		2068005901	8.51	7.84	CALABASAS CITY	2340PARK SORRENTO	B1	34.1548	-118.639
Calabasas	CB2	2069007906	1.32	6.80	CALABASAS CITY		B1	34.1526	-118.653
Glendale	GL2	5636006900	0.76	14.43	GLENDALE CITY		B4	34.1596	-118.266
Glendale	GL3	5628016900	1.10	13.67	GLENDALE CITY		B3	34.1639	-118.28
Glendale	GL4	5623020900	0.32	12.41	GLENDALE CITY		B3	34.1688	-118.286
Glendale		5623020901	3.14	12.41	GLENDALE CITY		B3	34.1688	-118.286
Glendale	GL5	5652003900	2.26	11.79	L A CO FLOOD CONTROL DIST		B4	34.1743	-118.227
Glendale	GL6	5666016901	1.18	7.61	GLENDALE CITY		B4	34.1534	-118.202
Glendale	GL7	5653016901	0.54	5.58	GLENDALE CITY		B4	34.1823	-118.227
La Canada Flintridge	LCF1	5813017903	1.35	10.37	LA CANADA FLINTRIDGE CITY	442ENCINAS DR	B4	34.2046	-118.206
La Canada Flintridge	LCF2	5814002901	1.40	9.30	LA CANADA FLINTRIDGE CITY	4469 CHEVY CHASE DR	B4	34.2039	-118.202
La Canada Flintridge	LCF3	5810023900	0.94	7.43	LA CANADA FLINTRIDGE CITY		B4	34.2109	-118.216
La Canada Flintridge	LCF4	5815001900	0.75	6.67	LA CANADA FLINTRIDGE CITY		B4	34.2047	-118.198
La Canada Flintridge	LCF5	5812007900	0.35	5.79	LA CANADA FLINTRIDGE CITY	1327 FOOTHILL BLVD	B4	34.2079	-118.207
La Canada Flintridge	LCF6	5806019900	0.90	5.33	L A CO FLOOD CONTROL DIST		B4	34.2247	-118.219
La Canada Flintridge	LCF6	5864004900	0.41	5.33	LA CANADA FLINTRIDGE CITY		B4	34.2247	-118.219
LA County	LAC3	5233027921	4.23	13.62	L A COUNTY	133 N SUNOL DR	D4	34.0377	-118.177
LA County		5233026931	6.71	13.62	L A COUNTY	111 N MARIANNA AVE	D4	34.0377	-118.177
LA County	LAC4	6008014900	5.27	9.94	L A COUNTY	1244 E 61ST ST	D4	33.9836	-118.253
LA County		6008013924	0.27	9.94	LOS ANGELES UNIFIED SCHOOL DIST	1161 E 62ND ST	D4	33.9836	-118.253
LA County	LAC5	5866030901	8.19	9.03	L A COUNTY PARK	5107 ROSEMONT AVE	B4	34.2334	-118.236
LA County	LAC6	6086031914	3.02	8.04	L A COUNTY	12416 AVALON BLVD	E4	33.9196	-118.26
LA County		6086031906	37.16	8.04	L A COUNTY	905 E EL SEGUNDO BLVD	E4	33.9196	-118.26
LA County		6086031909	0.51	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086031916	20.66	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086031911	3.03	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086031915	8.99	8.04	L A COUNTY	12416 AVALON BLVD	E4	33.9196	-118.26
LA County		6086031907	0.18	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086031917	2.07	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086037906	15.00	8.04	L A COUNTY HOUSING AUTHORITY	941 E 126TH ST	E4	33.9196	-118.26
LA County		6086031908	2.18	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086037901	1.71	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086037903	6.28	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086037907	0.79	8.04	L A COUNTY HOUSING AUTHORITY	941 E 126TH ST	E4	33.9196	-118.26
LA County		6086037902	1.02	8.04	L A COUNTY		E4	33.9196	-118.26
LA County		6086037900	5.03	8.04	L A COUNTY		E4	33.9196	-118.26
LA County	LAC7	6351020900	1.21	7.99	L A COUNTY		D4	34.0136	-118.133
LA County		6351024900	1.54	7.99	L A COUNTY		D4	34.0136	-118.133
LA County	LAC8	5829006905	2.84	6.86	L A COUNTY PARK S BY S		B4	34.201	-118.157
LA County		5829006904	1.44	6.86	L A COUNTY PARK S BY S		B4	34.201	-118.157
LA County		5829006902	0.92	6.86	L A COUNTY PARK S BY S		B4	34.201	-118.157
LA County		5829006901	1.76	6.86	L A COUNTY PARK S BY S		B4	34.201	-118.157
LA County		5829006903	0.28	6.86	L A COUNTY PARK S BY S		B4	34.201	-118.157
LA County		5829006900	2.23	6.86	L A COUNTY PARK S BY S	333LINCOLN AVE	B4	34.201	-118.157
LA County	LAC9	5835013904	3.50	5.83	L A COUNTY	77 MOUNTAIN VIEW ST	B4	34.1884	-118.153
LA County		5835012908	0.25	5.83	L A COUNTY		B4	34.1884	-118.153
LA County		5835012901	0.30	5.83	L A COUNTY		B4	34.1884	-118.153
LA County		5835012904	0.29	5.83	L A COUNTY		B4	34.1884	-118.153
LA County		5835012900	0.30	5.83	L A COUNTY		B4	34.1884	-118.153
LA County		5835012906	0.57	5.83	L A COUNTY		B4	34.1884	-118.153
LA County		5835012907	0.28	5.83	L A COUNTY		B4	34.1884	-118.153
LA County	LAC10	5842020902	4.84	4.82	L A COUNTY	568 E MOUNT CURVE AVE	B4	34.2007	-118.133
LA County		5842020900	8.48	4.82	L A COUNTY	568 E MOUNT CURVE AVE	B4	34.2007	-118.133
LA County		5842020901	0.40	4.82	L A COUNTY PARK		B4	34.2007	-118.133
LA County		5842021900	0.42	4.82	L A COUNTY		B4	34.2007	-118.133
LA County		5842021901	0.61	4.82	L A COUNTY		B4	34.2007	-118.133
LA County	LAC11	5830013909	5.81	4.78	L A COUNTY	333LINCOLN AVE	B4	34.2031	-118.158
LA County		5830013925	0.15	4.78	L A COUNTY		B4	34.2031	-118.158
LA County		5830013924	0.90	4.78	L A COUNTY		B4	34.2031	-118.158
LA County		5830013908	0.51	4.78	L A COUNTY		B4	34.2031	-118.158
LA County		5830013910	1.00	4.78	L A COUNTY		B4	34.2031	-118.158
Los Angeles	LA9	2233033907	56.31	19.00	L A CITY	655ODESSA AVE	B2	34.1903	-118.489
Los Angeles	LA10	2215001912	2.95	17.56	L A CITY DEPT OF TRANSPORTATION		B2	34.2093	-118.445
Los Angeles		2215001910	32.79	17.56	L A CITY		B2	34.2093	-118.445
Los Angeles		2215001913	17.29	17.56	L A CITY DEPT OF WATER AND POWER		B2	34.2093	-118.445
Los Angeles	LA11	5211021901	42.57	17.01	L A CITY	3921 SELIG PL	C4	34.0666	-118.201
Los Angeles	LA12	5457001901	0.56	17.00	L A CITY	2110 N SAN FERNANDO RD	C4	34.1031	-118.238
Los Angeles		5457001902	0.56	17.00	L A CITY	2130 N SAN FERNANDO RD	C4	34.1031	-118.238
Los Angeles	LA13	2784001901	8.48	15.86	L A CITY	8956 VANALDEN AVE	B2	34.2326	-118.548
Los Angeles		2784001902	2.30	15.86	L A CO FLOOD CONTROL DIST		B2	34.2326	-118.548
Los Angeles	LA14	5445006901	3.23	15.83	L A CITY DEPT OF WATER AND POWER		C4	34.0925	-118.231
Los Angeles		5445004902	0.94	15.83	L A CITY		C4	34.0925	-118.231
Los Angeles	LA15	2784002903	5.88	15.38	L A CO FLOOD CONTROL DIST		B2	34.2326	-118.547
Los Angeles		2784002902	2.44	15.38	L A CITY		B2	34.2326	-118.547
Los Angeles	LA16	2770013900	12.16	14.79	L A CITY		B2	34.231	-118.542
Los Angeles		2770013901	2.24	14.79	L A CITY		B2	34.231	-118.542
Los Angeles	LA17	2653006910	2.03	14.44	L A CITY		B2	34.23	-118.458
Los Angeles		2653007900	0.57	14.44	L A CO FLOOD CONTROL DIST		B2	34.23	-118.458
Los Angeles		2653006900	8.37	14.44	L A CITY		B2	34.23	-118.458
Los Angeles		2653007904	0.26	14.44	L A CO FLOOD CONTROL DIST		B2	34.23	-118.458
Los Angeles		2653006913	0.55	14.44	L A CO FLOOD CONTROL DIST		B2	34.23	-118.458

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Attachment C - List of Parcels in the High Tier

City	Cluster ID	AIN	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Los Angeles	LA18	2024023900	8.96	13.70	L A CITY		B1	34.195	-118.62
Los Angeles		2024023901	3.37	13.70	L A CITY		B1	34.195	-118.62
Los Angeles	LA19	5311001900	8.28	13.04	L A CITY		C4	34.1115	-118.178
Los Angeles	LA20	5593018903	1.05	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles		5593002907	79.65	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles		5593018907	2.27	11.24	L A CITY S BY S		C4	34.1284	-118.273
Los Angeles		5594016900	0.40	11.24	L A CO FLOOD CONTROL DIST		C4	34.1284	-118.273
Los Angeles		5594016903	1.01	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles		5594018901	0.89	11.24	L A CO FLOOD CONTROL DIST		C4	34.1284	-118.273
Los Angeles		5594018900	1.87	11.24	L A CO FLOOD CONTROL DIST		C4	34.1284	-118.273
Los Angeles		5594016901	1.03	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles		5594016902	3.33	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles		5593030904	6.90	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles		5593002904	8.31	11.24	L A CITY		C4	34.1284	-118.273
Los Angeles	LA21	5435036900	0.33	10.97	L A CO FLOOD CONTROL DIST S BY S		C4	34.118	-118.268
Los Angeles		5435039900	5.05	10.97	L A CO FLOOD CONTROL DIST		C4	34.118	-118.268
Los Angeles		5435038902	5.66	10.97	L A CO FLOOD CONTROL DIST		C4	34.118	-118.268
Los Angeles		5435039903	5.09	10.97	L A CITY DEPT OF WATER AND POWER	2901 N GLENDALE BLVD	C4	34.118	-118.268
Los Angeles		5435038904	1.65	10.97	LOS ANGELES COUNTY FLOOD CONTROL		C4	34.118	-118.268
Los Angeles		5435037904	8.47	10.97	L A CITY		C4	34.118	-118.268
Los Angeles	LA22	5492034902	1.07	10.01	L A CITY		C4	34.1145	-118.184
Los Angeles		5492034901	2.63	10.01	L A CITY	6152 N FIGUEROA ST	C4	34.1145	-118.184
Los Angeles	LA23	5434039901	4.27	8.99	L A CITY	3201 RIVERSIDE DR	C4	34.1161	-118.27
Los Angeles		5434038901	11.97	8.99	L A CITY	3401 RIVERSIDE DR	C4	34.1161	-118.27
Montebello	M1	6349023900	7.62	14.96	MONTEBELLO CITY		D5	34.0012	-118.107
Montebello	M2	6350002900	12.93	9.75	MONTEBELLO CITY PARK	229 S TAYLOR AVE	D4	34.0094	-118.115
Montebello		6350011900	3.69	9.75	MONTEBELLO CITY	236 GEORGE HENSEL DR	D4	34.0094	-118.115
Montebello	M3	6352006901	3.17	9.14	MONTEBELLO CITY	847 CARMEL CT	D4	33.9926	-118.12
Montebello		6352005902	3.84	9.14	MONTEBELLO CITY		D4	33.9926	-118.12
Montebello	M4	5294013900	6.23	8.97	REDEVELOPMENT AGENCY OF		D4	34.021	-118.116
Montebello		5294014903	7.71	8.97	REDEVELOPMENT AGENCY OF	1600 W BEVERLY BLVD	D4	34.021	-118.116
Montebello	M5	5293013901	3.59	8.92	MONTEBELLO CITY	737 N MONTEBELLO BLVD	D5	34.0217	-118.105
Montebello	M6	5267006900	0.46	8.77	MONTEBELLO CITY		D4	34.0293	-118.133
Montebello		5267009902	1.66	8.77	MONTEBELLO CITY PARK		D4	34.0293	-118.133
Montebello		5267009900	9.48	8.77	MONTEBELLO CITY PARK		D4	34.0293	-118.133
Montebello		5267007900	1.37	8.77	MONTEBELLO CITY		D4	34.0293	-118.133
Montebello		5267007901	2.64	8.77	MONTEBELLO CITY		D4	34.0293	-118.133
Montebello		5267010904	116.47	8.77	MONTEBELLO CITY PARK	901 N VIA SAN CLEMENTE	D4	34.0293	-118.133
Montebello		5267009903	2.43	8.77	MONTEBELLO CITY PARK		D4	34.0293	-118.133
Montebello		5267009901	1.58	8.77	MONTEBELLO CITY PARK		D4	34.0293	-118.133
Montebello	M7	6350017906	3.64	8.16	MONTEBELLO CITY		D4	34.0066	-118.114
Montebello		6350016904	1.90	8.16	MONTEBELLO CITY	400 S TAYLOR AVE	D4	34.0066	-118.114
Montebello		6350018904	1.57	8.16	MONTEBELLO CITY		D4	34.0066	-118.114
Montebello	M8	6354026901	0.50	8.07	MONTEBELLO CITY		D4	33.981	-118.123
Montebello	M9	6346027901	0.65	7.79	MONTEBELLO CITY		D5	34.0105	-118.107
Montebello		6346028912	0.63	7.79	MONTEBELLO CITY		D5	34.0105	-118.107
Montebello	M10	6346022901	0.31	7.41	REDEVELOPMENT AGENCY OF	310 W WHITTIER BLVD	D5	34.0093	-118.103
Montebello		6346023900	0.96	7.41	REDEVELOPMENT AGENCY OF	310 W WHITTIER BLVD	D5	34.0093	-118.103
Montebello		6346022900	0.93	7.41	REDEVELOPMENT AGENCY OF	310 W WHITTIER BLVD	D5	34.0093	-118.103
Montebello		6346023901	0.49	7.41	REDEVELOPMENT AGENCY OF	310 W WHITTIER BLVD	D5	34.0093	-118.103
Montebello	M11	5293022900	3.52	7.11	MONTEBELLO CITY		D5	34.029	-118.106
Montebello	M12	6349005900	0.29	6.92	COMMUNITY REDEVELOPMENT AGENCY	114 S 6TH ST	D5	34.0089	-118.106
Montebello	M13	5278004901	1.75	6.86	MONTEBELLO CITY	946 N ADOBE AVE	D5	34.0243	-118.086
Montebello	M14	6349007915	0.27	6.85	MONTEBELLO CITY		D5	34.0093	-118.108
Montebello		6349007910	0.32	6.85	MONTEBELLO CITY		D5	34.0093	-118.108
Montebello	M15	6346025907	0.34	5.81	COMMUNITY REDEVELOPMENT AGENCY	125 N 5TH ST	D5	34.0105	-118.105
Monterey Park	MP2	5274011900	11.95	8.03	MONTEREY PARK CITY		D4	34.0408	-118.125
Monterey Park	MP3	5255008902	0.29	7.79	MONTEREY PARK CITY	109 N LINCOLN AVE	C4	34.0631	-118.122
Monterey Park		5255008900	1.38	7.79	MONTEREY PARK CITY		C4	34.0631	-118.122
Pasadena	PAS1	5823015902	73.78	9.45	PASADENA CITY		B4	34.1927	-118.172
Pasadena		5823004900	84.37	9.45	PASADENA WATER DEPT	1055 LA CANADA VERDUGO RD	B4	34.1927	-118.172
Pasadena		5823003907	55.71	9.45	PASADENA CITY		B4	34.1927	-118.172
Pasadena		5823003912	0.87	9.45	PASADENA CITY		B4	34.1927	-118.172
Pasadena		5823003909	4.73	9.45	PASADENA WATER DEPT		B4	34.1927	-118.172
Pasadena	PAS2	5823031900	1.57	5.10	PASADENA WATER DEPT		B4	34.1853	-118.175
Rosemead	RM1	5287020904	0.65	13.57	ROSEMEAD CITY	7933 EMERSON PL	C5	34.0672	-118.096
Rosemead		5287020900	1.34	13.57	ROSEMEAD CITY		C5	34.0672	-118.096
Rosemead		5287020903	0.95	13.57	ROSEMEAD CITY		C5	34.0672	-118.096
Rosemead		5287021900	9.65	13.57	ROSEMEAD CITY		C5	34.0672	-118.096
Rosemead	RM2	5283032903	0.31	12.79	ROSEMEAD CITY		C5	34.055	-118.087
Rosemead	RM3	5283020908	0.54	9.19	ROSEMEAD CITY	2417 ANGELUS AVE	C5	34.0565	-118.087
San Gabriel	SG1	5360010901	0.32	13.19	L A CO FLOOD CONTROL DIST S BY S		C5	34.0841	-118.105
San Gabriel		5360002900	6.39	13.19	SAN GABRIEL CITY		C5	34.0841	-118.105
San Gabriel		5360012901	0.98	13.19	SAN GABRIEL CITY	1305 PROSPECT AVE	C5	34.0841	-118.105
San Gabriel		5360011900	2.54	13.19	SAN GABRIEL CITY		C5	34.0841	-118.105
San Gabriel	SG2	5360018900	0.28	10.54	SAN GABRIEL CITY		C5	34.0819	-118.102
San Gabriel	SG3	5362018900	2.83	9.17	SAN GABRIEL CITY		C5	34.0985	-118.102
San Gabriel	SG4	5362012900	1.27	8.64	SAN GABRIEL CITY		C5	34.1005	-118.104
San Gabriel	SG5	5361002903	0.51	8.35	SAN GABRIEL CITY		C5	34.0949	-118.1
San Gabriel		5361002902	1.31	8.35	SAN GABRIEL CITY		C5	34.0949	-118.1
San Gabriel		5361002904	0.45	8.35	SAN GABRIEL CITY	135 W MISSION RD	C5	34.0949	-118.1
San Gabriel	SG6	5347031903	0.26	7.69	SAN GABRIEL CITY S BY S		C5	34.0845	-118.108

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Attachment C - List of Parcels in the High Tier

City	Cluster ID	AIN	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
San Gabriel	SG7	5360029902	0.33	5.97	SAN GABRIEL CITY		C5	34.0768	-118.1
Temple City	TC1	5388009903	1.04	8.80	TEMPLE CITY	5053 ENCINITA AVE	C5	34.0933	-118.069
Temple City		5388009902	0.44	8.80	TEMPLE CITY	9167 LA ROSA DR	C5	34.0933	-118.069
Temple City	TC2	8587025906	0.90	6.55	TEMPLE CITY	9701 LAS TUNAS DR	C5	34.1078	-118.057
Temple City		8587025903	2.00	6.55	TEMPLE CITY		C5	34.1078	-118.057
Temple City	TC3	8587018900	0.50	5.97	TEMPLE CITY	5834 TEMPLE CITY BLVD	C5	34.1061	-118.06

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Attachment D - List of Parcels in the Medium Tier / Excluding School Districts

City	Cluster ID	AIN*	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Culver City	CC02	4210025900	0.46	14.00	CULVER CITY		A5	34.0085657	-118.3999855
Culver City	CC03	4205015902	0.36	12.00	CULVER CITY S BY S		A5	34.0278955	-118.3783138
Culver City	CC04	4213006901	1.54	10.00	CULVER CITY	655 S ALVARADO ST	A5	34.0100641	-118.4124356
Culver City	CC05	4210021900	1.56	9.00	CULVER CITY		A5	34.0107766	-118.4045680
Culver City	CC06	4204013900	1.80	7.00	CULVER CITY	4861 VENICE BLVD	A5	34.0156343	-118.3782040
Culver City	CC07	4134020903	0.98	6.00	SUCCESSOR AGENCY TO THE CULVER		A5	33.9883950	-118.3908212
Los Angeles	LA60	4365009900	30.64	11.00	U S GOVT	1811 Hoover St	A1	34.0602365	-118.4589686
Los Angeles	LA61	5122014907	7.20	10.83	L A COUNTY	318 W ADAMS BLVD	A6	34.0260561	-118.2736806
Los Angeles		5122017908	0.65	10.83	L A COUNTY	2829 S GRAND AVE	A6	34.0260561	-118.2736806
Los Angeles	LA62	5134007921	1.19	10.00	L A CITY	1332 BOND ST	A6	34.0417943	-118.2723951
Los Angeles	LA63	4359014902	8.52	10.00	L A CITY		A2	34.0725719	-118.4295632
Los Angeles	LA64	5047018924	0.53	9.00	L A CITY		A5	34.0259100	-118.3711886
Los Angeles	LA65	6001016900	1.45	9.00	L A CITY DEPT OF WATER AND POWER	6219 S MANHATTAN PL	A5	33.9827759	-118.3109229
Los Angeles		6001019900	1.41	9.00	L A CITY DEPT OF WATER AND POWER		A5	33.9827759	-118.3109229
Los Angeles	LA66	6001017901	2.64	9.00	L A CITY	6000 S ST ANDREWS PL	A5	33.9845626	-118.3109155
Los Angeles	LA67	5547030900	1.37	9.00	L A CITY		A2	34.0957797	-118.3347357
Los Angeles	LA68	5533017900	0.67	8.86	L A CITY DEPT OF WATER AND POWER		A2	34.0891446	-118.3271888
Los Angeles	LA69	5024018900	1.01	8.76	L A CITY		A5	34.0055382	-118.3308023
Los Angeles		5024018901	0.26	8.76	L A CITY		A5	34.0055382	-118.3308023
Los Angeles		5024018902	1.38	8.76	L A CITY		A5	34.0055382	-118.3308023
Los Angeles		5024019900	1.14	8.76	L A CITY		A5	34.0055382	-118.3308023
Los Angeles		5024019904	0.53	8.76	LOS ANGELES CITY	4300 DEGNAN BLVD	A5	34.0055382	-118.3308023
Los Angeles	LA70	5533009900	0.79	8.74	L A CITY	6401 SANTA MONICA BLVD	A2	34.0918919	-118.3293683
Los Angeles		5533009901	2.22	8.74	L A CITY		A2	34.0918919	-118.3293683
Los Angeles	LA71	5037028909	0.40	8.66	L A CITY	3789 MENLO AVE	A5	34.0212719	-118.2919946
Los Angeles		5040030905	0.78	8.66	COMMUNITY REDEVELOPMENT AGENCY		A5	34.0212719	-118.2919946
Los Angeles	LA72	5036025910	0.48	8.29	L A CITY		A5	34.0133682	-118.3085545
Los Angeles		5036026900	0.30	8.29	L A CITY	3929 S HOBART BLVD	A5	34.0133682	-118.3085545
Los Angeles		5036026901	0.30	8.29	L A CITY	3941 S HOBART BLVD	A5	34.0133682	-118.3085545
Los Angeles		5036026902	0.81	8.29	L A CITY	Western and 39th St	A5	34.0133682	-118.3085545
Los Angeles		5036026912	0.32	8.29	L A CITY	3906 S WESTERN AVE	A5	34.0133682	-118.3085545
Los Angeles		5036026914	0.32	8.29	L A CITY	3924 S WESTERN AVE	A5	34.0133682	-118.3085545
Los Angeles		5042008902	0.25	8.29	L A CITY	3794 2ND AVE	A5	34.0133682	-118.3085545
Los Angeles	LA73	4261013900	0.28	8.00	L A CITY	1615 COLBY AVE	A1	34.0445088	-118.4527642
Los Angeles	LA74	5059003901	0.28	8.00	COMMUNITY REDEVELOPMENT AGENCY	4337 W ADAMS BLVD	A5	34.0328774	-118.3338637
Los Angeles	LA75	5426017900	0.32	8.00	L A CITY PARK		A3	34.0826607	-118.2748926
Los Angeles	LA76	5124001900	0.26	8.00	L A CITY	2301 S UNION AVE	A5	34.0347969	-118.2837688
Los Angeles	LA77	5003021900	0.26	8.00	L A CITY DEPT OF WATER AND POWER		A5	33.9917966	-118.3085787
Los Angeles	LA78	6001013906	0.85	8.00	L A CITY	5975 S ST ANDREWS PL	A5	33.9860253	-118.3119195
Los Angeles	LA79	4211022900	0.96	8.00	L A CITY	5451 S PLAYA VISTA DR	A5	33.9743362	-118.4285356
Los Angeles	LA80	4359018900	0.52	8.00	L A CITY		A2	34.0684210	-118.4253694
Los Angeles	LA81	6004002903	0.55	8.00	L A CITY	840 W SLAUSON AVE	A5	33.9888759	-118.2887582
Los Angeles	LA82	4319003900	0.87	8.00	L A CITY		A2	34.0581310	-118.4229952
Los Angeles	LA83	5054031901	0.32	8.00	L A CITY	2700 S BUDLONG AVE	A5	34.0302149	-118.2956318
Los Angeles	LA84	4261003900	0.34	8.00	L A CITY	1526 BUTLER AVE	A1	34.0461139	-118.4519660
Los Angeles	LA85	5033004901	0.74	8.00	L A CITY		A5	34.0122711	-118.3345250
Los Angeles	LA86	5046004902	0.31	8.00	COMMUNITY REDEVELOPMENT	3900 W JEFFERSON BLVD	A5	34.0252867	-118.3386692
Los Angeles	LA87	5061014900	0.27	8.00	LOS ANGELES CITY	4600 W WASHINGTON BLVD	A5	34.0395681	-118.3402158
Los Angeles	LA88	5502018902	0.36	8.00	L A CITY DEPT OF WATER AND POWER	3569 W 6TH ST	A2	34.0638038	-118.2999813
Los Angeles	LA89	5083032900	0.47	8.00	L A CITY		A2	34.0479178	-118.3340516
Los Angeles	LA90	5504008900	0.52	8.00	L A CITY	600 LORRAINE BLVD	A2	34.0632619	-118.3192313
Los Angeles		5504008901	0.52	8.00	L A CITY	605 S IRVING BLVD	A2	34.0632619	-118.3192313
Los Angeles	LA91	5042008904	0.41	8.00	L A CITY	3783 ARLINGTON AVE	A5	34.0185287	-118.3183885
Los Angeles	LA92	5536005900	0.34	8.00	L A CITY	5707 LEXINGTON AVE	A2	34.0930642	-118.3139934
Los Angeles	LA93	4205035900	0.28	8.00	L A CITY S BY S		A5	34.0287623	-118.3725937
Los Angeles	LA94	5021017902	0.30	8.00	L A CITY		A5	34.0040063	-118.3004765
Los Angeles	LA95	5050006905	0.28	7.56	L A CITY		A5	34.0328912	-118.3406306
Los Angeles		5050006909	0.22	7.56	L A CITY		A5	34.0328912	-118.3406306
Los Angeles	LA96	5546009906	0.27	7.00	COMMUNITY REDEVELOPMENT AGENCY	1601 VINE ST	A2	34.0999562	-118.3271342
Los Angeles	LA97	5032003900	0.44	7.00	COMMUNITY REDEVELOPMENT AGENCY	3700 W MARTIN LUTHER KING JR BLVD	A5	34.0120272	-118.3384877
Los Angeles		5032003901	0.36	7.00	COMMUNITY REDEVELOPMENT AGENCY	4013 MARLTON AVE	A5	34.0120272	-118.3384877
Los Angeles		5032003902	0.39	7.00	COMMUNITY REDEVELOPMENT AGENCY	3750 W MARTIN LUTHER KING JR BLVD	A5	34.0120272	-118.3384877
Los Angeles	LA98	5006009902	0.37	7.00	L A CITY		A5	33.9906435	-118.3297616
Los Angeles	LA99	5590020900	0.31	7.00	L A CITY		A2	34.1040494	-118.2910976
Los Angeles	LA100	5547016907	0.25	7.00	L A CITY	1637 WILCOX AVE	A2	34.1008154	-118.3314312
Los Angeles		5547016908	0.25	7.00	L A CITY	1633 WILCOX AVE	A2	34.1008154	-118.3314312
Los Angeles	LA101	5006007900	0.34	7.00	L A CITY		A5	33.9935838	-118.3297484
Los Angeles		5006008900	0.34	7.00	L A CITY	5407 11TH AVE	A5	33.9935838	-118.3297484
Los Angeles	LA102	4006019900	0.26	7.00	L A CITY	6537 S VICTORIA AVE	A5	33.9794442	-118.3327488
Los Angeles		4006019901	0.26	7.00	L A CITY HOUSING DEVELOPMENT		A5	33.9794442	-118.3327488
Los Angeles	LA103	4325005932	0.29	7.00	LOS ANGELES CITY	1246 GLENDON AVE	A1	34.0575028	-118.4416007
Los Angeles	LA104	5533014900	0.28	7.00	L A CITY	1037 COLE AVE	A2	34.0900833	-118.3302240
Los Angeles	LA105	5547003907	0.31	7.00	L A CITY	6671 YUCCA ST	A2	34.1033508	-118.3354516
Los Angeles		5547003908	0.31	7.00	L A CITY	1805 N CHEROKEE AVE	A2	34.1033508	-118.3354516
Los Angeles		5547009900	0.35	7.00	L A CITY	1746 N LAS PALMAS AVE	A2	34.1033508	-118.3354516
Los Angeles	LA106	5542028900	0.28	7.00	L A CITY	1171 N MADISON AVE	A2	34.0928891	-118.2897995
Los Angeles	LA107	5550025902	0.40	7.00	L A CITY		A2	34.0964432	-118.3531531
Los Angeles		5550025903	0.29	7.00	L A CITY		A2	34.0964432	-118.3531531
Los Angeles	LA108	4211011900	0.29	7.00	L A CITY DEPT OF WATER AND POWER		A5	33.9834151	-118.4001772
Los Angeles	LA109	4105016900	0.74	7.00	L A CITY DEPT OF WATER AND POWER		A5	33.9660184	-118.3849947
Los Angeles	LA110	5089003901	0.31	7.00	L A CITY		A2	34.0612927	-118.3470172
Los Angeles	LA111	4358003900	0.61	6.00	L A CITY		A2	34.0846671	-118.4347979
West Hollywood	WH04	4337017903	8.47	9.00	LACMTA		A2	34.0852162	-118.3820343

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Attachment E - List of Parcels in the Medium Tier /School Districts Only

City	Cluster ID	AIN*	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Beverly Hills	BH02	4359019900	6.36	12.00	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0679134	-118.4159797
Beverly Hills		4319001900	18.90	10.87	BEVERLY HILLS UNIFIED	241 S MORENO DR	A2	34.0617738	-118.4125748
Beverly Hills		4319001901	0.80	10.87	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0617738	-118.4125748
Beverly Hills		4319001902	5.34	10.87	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0617738	-118.4125748
Beverly Hills	BH03	4328005900	0.93	10.87	BEVERLY HILLS UNIFIED SCHOOL	5301 WILSHIRE BLVD	A2	34.0617738	-118.4125748
Beverly Hills		4331009900	0.56	9.90	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0635987	-118.3945899
Beverly Hills		4331012900	2.65	9.90	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0635987	-118.3945899
Beverly Hills	BH04	4331012901	2.65	9.90	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0635987	-118.3945899
Beverly Hills		4333017904	4.48	9.76	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0658781	-118.3833234
Beverly Hills		4333017905	0.31	9.76	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0658781	-118.3833234
Beverly Hills	BH05	4333017906	0.31	9.76	BEVERLY HILLS UNIFIED		A2	34.0658781	-118.3833234
Beverly Hills		4341029900	4.29	7.84	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0790055	-118.4040367
Beverly Hills	BH06	4341029901	0.82	7.84	BEVERLY HILLS UNIFIED SCHOOL		A2	34.0790055	-118.4040367
Culver City		4210015902	11.98	13.60	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0057369	-118.4026226
Culver City		4210016900	7.86	13.60	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0057369	-118.4026226
Culver City		4210017900	3.20	13.60	CULVER CITY UNIFIED SCHOOL DIST	1945 S HILL ST	A5	34.0057369	-118.4026226
Culver City		4210026902	4.58	13.60	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0057369	-118.4026226
Culver City	CC08	4210026903	23.70	13.60	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0057369	-118.4026226
Culver City	CC09	4205012903	1.86	13.00	CULVER CITY UNIFIED SCHOOL DIST	1413 W CONNECTICUT ST	A5	34.0288227	-118.3778553
Culver City	CC10	4208023902	3.38	10.00	CULVER CITY UNIFIED SCHOOL DIST	5301 WILSHIRE BLVD	A5	34.0136680	-118.4099582
Culver City	CC11	4203011902	6.62	10.00	CULVER CITY UNIFIED SCHOOL DIST		A5	33.9958565	-118.3915392
Culver City	CC12	4216013900	6.97	10.00	CULVER CITY UNIFIED SCHOOL DIST		A5	33.9921681	-118.4005668
Culver City		4206026906	1.94	9.64	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0224618	-118.3931573
Culver City	CC13	4206027900	3.45	9.64	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0224618	-118.3931573
Culver City	CC14	4235020901	2.11	9.00	CULVER CITY UNIFIED SCHOOL DIST	12201 WASHINGTON PL	A5	34.0006716	-118.4288485
Inglewood	IG04	4102015900	9.29	10.00	INGLEWOOD UNIFIED SCHOOL DIST		A5	33.9819650	-118.3753137
Inglewood	IG05	4001014901	6.27	10.00	INGLEWOOD UNIFIED SCHOOL DIST		A5	33.9810183	-118.3692512
Inglewood	IG06	4015013901	1.12	9.00	INGLEWOOD UNIFIED SCHOOL DIST	4861 VENICE BLVD	A5	33.9693502	-118.3515836
Inglewood	IG07	4014017900	4.61	9.00	INGLEWOOD UNIFIED SCHOOL DIST		A5	33.9776585	-118.3469100
Inglewood		4017026900	4.47	8.62	INGLEWOOD UNIFIED SCHOOL DIST	1423 W 012 ST	A5	33.9723201	-118.3624002
Inglewood		4017026901	0.46	8.62	INGLEWOOD UNIFIED SCHOOL DIST		A5	33.9723201	-118.3624002
Inglewood		4017026902	0.56	8.62	INGLEWOOD UNIFIED SCHOOL DIST	1201 S FIGUEROA ST	A5	33.9723201	-118.3624002
Inglewood	IG08	4017026903	0.36	8.62	INGLEWOOD UNIFIED SCHOOL DIST		A5	33.9723201	-118.3624002
Los Angeles	LA112	4251010902	7.75	19.00	L A UNIFIED SCHOOL DIST	11020 CLOVER AVE	A5	34.0264885	-118.4246753
Los Angeles	LA113	5014001922	25.55	18.00	L A UNIFIED SCHOOL DIST	5010 11TH AVE	A5	33.9965770	-118.3275907
Los Angeles	LA114	5051038911	4.66	18.00	L A UNIFIED SCHOOL DIST	3109 6TH AVE	A5	34.0266303	-118.3241791
Los Angeles	LA115	5509018902	4.48	18.00	L A UNIFIED SCHOOL DIST	408 S FAIRFAX AVE	A2	34.0695024	-118.3602155
Los Angeles	LA116	5024029901	12.56	17.00	L A UNIFIED SCHOOL DIST	4120 11TH AVE	A5	34.0096485	-118.3283460
Los Angeles		5014024900	3.69	16.86	L A UNIFIED SCHOOL DIST	2611 W 52ND ST	A5	33.9959257	-118.3219655
Los Angeles	LA117	5014024901	0.28	16.86	L A UNIFIED SCHOOL DIST	2611 W 52ND ST	A5	33.9959257	-118.3219655
Los Angeles		5501008908	9.31	15.27	L A UNIFIED SCHOOL DIST	152 N VERMONT AVE	A2	34.0738927	-118.2900084
Los Angeles		5501010900	0.66	15.27	L A UNIFIED SCHOOL DIST	225 N MADISON AVE	A2	34.0738927	-118.2900084
Los Angeles		5501010904	0.27	15.27	L A UNIFIED SCHOOL DISTRICT	218 N JUANITA AVE	A2	34.0738927	-118.2900084
Los Angeles		5501010907	0.29	15.27	L A UNIFIED SCHOOL DISTRICT	250 N JUANITA AVE	A2	34.0738927	-118.2900084
Los Angeles		5501010909	0.58	15.27	L A UNIFIED SCHOOL DISTRICT	206 N JUANITA AVE	A2	34.0738927	-118.2900084
Los Angeles		5501014900	0.34	15.27	L A UNIFIED SCHOOL DIST	108 BIMINI PL	A2	34.0738927	-118.2900084
Los Angeles		5501014901	0.62	15.27	L A UNIFIED SCHOOL DIST	108 BIMINI PL	A2	34.0738927	-118.2900084
Los Angeles		5518032900	0.32	15.27	L A UNIFIED SCHOOL DIST	101 N VERMONT AVE	A2	34.0738927	-118.2900084
Los Angeles	LA118	5518032906	0.48	15.27	L A UNIFIED SCHOOL DIST	151 N VERMONT AVE	A2	34.0738927	-118.2900084
Los Angeles		5501017902	0.71	14.75	L A UNIFIED SCHOOL DIST	3277 W 2ND ST	A2	34.0698134	-118.2862597
Los Angeles	LA119	5501020900	2.14	14.75	L A UNIFIED SCHOOL DIST	215 S COMMONWEALTH AVE	A2	34.0698134	-118.2862597
Los Angeles	LA120	5069031902	4.10	14.00	L A UNIFIED SCHOOL DIST	5360 SATURN ST	A2	34.0461868	-118.3564318
Los Angeles		5545016900	7.41	13.30	L A UNIFIED SCHOOL DIST	5746 W SUNSET BLVD	A2	34.0949280	-118.3154339
Los Angeles		5545017900	5.53	13.30	L A UNIFIED SCHOOL DIST	1316 N BRONSON AVE	A2	34.0949280	-118.3154339
Los Angeles		5545017902	0.69	13.30	L A UNIFIED SCHOOL DIST	1316 N BRONSON AVE	A2	34.0949280	-118.3154339
Los Angeles		5545017904	0.34	13.30	L A UNIFIED SCHOOL DIST	1316 N BRONSON AVE	A2	34.0949280	-118.3154339
Los Angeles		5545017907	2.30	13.30	L A UNIFIED SCHOOL DIST	1316 N BRONSON AVE	A2	34.0949280	-118.3154339
Los Angeles		5545019914	0.28	13.30	L A UNIFIED SCHOOL DIST	1302 N VAN NESS AVE	A2	34.0949280	-118.3154339
Los Angeles	LA121	5545019915	2.92	13.30	L A UNIFIED SCHOOL DIST	5735 FERNWOOD AVE	A2	34.0949280	-118.3154339
Los Angeles	LA122	5070013904	1.83	13.00	L A UNIFIED SCHOOL DIST		A2	34.0476485	-118.3430050
Los Angeles	LA123	4221008900	6.16	13.00	L A UNIFIED SCHOOL DIST	4711 INGLEWOOD BLVD	A5	33.9926070	-118.4159588
Los Angeles	LA124	4258016900	25.03	12.00	L A UNIFIED SCHOOL DIST	11330 GRAHAM PL	A5	34.0280842	-118.4345476
Los Angeles	LA125	4221006900	0.85	12.00	L A UNIFIED SCHOOL DIST		A5	33.9873298	-118.4185253
Los Angeles	LA126	4258005900	8.06	11.00	L A UNIFIED SCHOOL DIST	11562 RICHLAND AVE	A5	34.0275406	-118.4389872
Los Angeles	LA127	5001002908	5.77	11.00	L A UNIFIED SCHOOL DIST	816 W 51ST ST	A5	33.9958565	-118.2884285
Los Angeles	LA128	5017001905	6.10	11.00	L A UNIFIED SCHOOL DIST	4505 S RAYMOND AVE	A5	34.0029289	-118.2989999
Los Angeles	LA129	5020029902	16.39	11.00	L A UNIFIED SCHOOL DIST	4131 S VERMONT AVE	A5	34.0087698	-118.2928484
Los Angeles	LA130	5124023911	5.10	11.00	L A UNIFIED SCHOOL DISTRICT		A5	34.0313602	-118.2787782
Los Angeles	LA131	5078024910	6.11	11.00	L A UNIFIED SCHOOL DIST	1157 S BERENDO ST	A2	34.0499937	-118.2945332
Los Angeles	LA132	5430029901	10.82	11.00	L A UNIFIED SCHOOL DIST	4201 FOUNTAIN AVE	A2	34.0969851	-118.2808425
Los Angeles	LA133	5127029900	18.68	11.00	L A UNIFIED SCHOOL DIST	1915 MAPLE AVE	A6	34.0279680	-118.2638704
Los Angeles	LA134	4301018900	6.70	11.00	L A UNIFIED SCHOOL DIST	2450 S SHENANDOAH ST	A5	34.0385066	-118.3841246
Los Angeles	LA135	4308019900	5.10	11.00	L A UNIFIED SCHOOL DIST	9755 CATTARAUGUS AVE	A5	34.0383468	-118.3982404
Los Angeles	LA136	4311031901	20.74	11.00	L A UNIFIED SCHOOL DIST	2955 S ROBERTSON BLVD	A5	34.0341350	-118.3916151
Los Angeles	LA137	5066013900	14.08	11.00	L A UNIFIED SCHOOL DIST		A2	34.0448120	-118.3713921
Los Angeles		4252023900	8.04	10.93	L A UNIFIED SCHOOL DIST	10860 WOODBINE ST	A5	34.0214428	-118.4147008
Los Angeles		4254023900	6.80	10.93	L A UNIFIED SCHOOL DIST	10860 WOODBINE ST	A5	34.0214428	-118.4147008
Los Angeles	LA138	4254023901	0.33	10.93	L A UNIFIED SCHOOL DIST	10860 WOODBINE ST	A5	34.0214428	-118.4147008

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City	Cluster ID	AIN*	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Los Angeles		4262004900	0.70	10.91	L A UNIFIED SCHOOL DIST	11800 TEXAS AVE	A1	34.0450726	-118.4593446
Los Angeles		4263021904	1.01	10.91	L A UNIFIED SCHOOL DIST	11800 TEXAS AVE	A1	34.0450726	-118.4593446
Los Angeles	LA139	4263022901	24.28	10.91	L A UNIFIED SCHOOL DIST	11800 TEXAS AVE	A1	34.0450726	-118.4593446
Los Angeles		5073001900	7.77	10.87	L A UNIFIED SCHOOL DIST	1512 ARLINGTON AVE	A2	34.0457870	-118.3169926
Los Angeles	LA140	5073001901	0.53	10.87	L A UNIFIED SCHOOL DIST	1512 ARLINGTON AVE	A2	34.0457870	-118.3169926
Los Angeles		5072012917	14.83	10.86	L A UNIFIED SCHOOL DIST	1717 7TH AVE	A5	34.0417641	-118.3266685
Los Angeles		5072014901	1.37	10.86	L A UNIFIED SCHOOL DIST	1717 7TH AVE	A5	34.0417641	-118.3266685
Los Angeles	LA141	5072014902	0.51	10.86	L A UNIFIED SCHOOL DIST	1717 7TH AVE	A5	34.0417641	-118.3266685
Los Angeles		5094006902	2.36	10.72	LA UNIFIED SCHOOL DISTRICT		A2	34.0591851	-118.2969306
Los Angeles		5094006903	3.23	10.72	LA UNIFIED SCHOOL DISTRICT		A2	34.0591851	-118.2969306
Los Angeles		5094006904	17.22	10.72	LA UNIFIED SCHOOL DISTRICT		A2	34.0591851	-118.2969306
Los Angeles	LA142	5094006905	0.30	10.72	L A UNIFIED SCHOOL DIST	3131 W 8TH ST	A2	34.0591851	-118.2969306
Los Angeles		5041026900	0.46	10.71	L A UNIFIED SCHOOL DIST	3751 S HARVARD BLVD	A5	34.0191860	-118.3072839
Los Angeles		5041034900	7.38	10.71	L A UNIFIED SCHOOL DIST	3751 S HARVARD BLVD	A5	34.0191860	-118.3072839
Los Angeles	LA143	5041034901	1.29	10.71	L A UNIFIED SCHOOL DIST	3751 S HARVARD BLVD	A5	34.0191860	-118.3072839
Los Angeles		6003005908	0.97	10.69	LOS ANGELES UNIFIED SCHOOL		A5	33.9866942	-118.2950773
Los Angeles		6003006901	0.44	10.69	L A UNIFIED SCHOOL DIST	5940 S BUDLONG AVE	A5	33.9866942	-118.2950773
Los Angeles		6003013906	5.01	10.69	L A UNIFIED SCHOOL DIST	5940 S BUDLONG AVE	A5	33.9866942	-118.2950773
Los Angeles		6003013907	0.51	10.69	L A UNIFIED SCHOOL DIST	5940 S BUDLONG AVE	A5	33.9866942	-118.2950773
Los Angeles		6003013908	9.68	10.69	L A UNIFIED SCHOOL DIST	5940 S BUDLONG AVE	A5	33.9866942	-118.2950773
Los Angeles	LA144	6004006900	0.29	10.69	L A UNIFIED SCHOOL DIST	5940 S BUDLONG AVE	A5	33.9866942	-118.2950773
Los Angeles	LA145	4261018900	3.93	10.00	L A UNIFIED SCHOOL DIST	1730 CORINTH AVE	A1	34.0443425	-118.4472893
Los Angeles	LA146	6019003905	5.67	10.00	L A UNIFIED SCHOOL DIST	7511 RAYMOND AVE	A5	33.9716783	-118.2991856
Los Angeles	LA147	4249011900	5.27	10.00	L A UNIFIED SCHOOL DIST	3330 GRANVILLE AVE	A5	34.0163742	-118.4342196
Los Angeles	LA148	4314014900	3.53	10.00	L A UNIFIED SCHOOL DIST	3520 MOTOR AVE	A5	34.0260659	-118.4074695
Los Angeles	LA149	5019004903	4.04	10.00	L A UNIFIED SCHOOL DIST	4156 MENLO AVE	A5	34.0078205	-118.2888220
Los Angeles	LA150	5023027900	4.21	10.00	L A UNIFIED SCHOOL DIST	4231 4TH AVE	A5	34.0063417	-118.3220053
Los Angeles	LA151	5030015900	9.81	10.00	L A UNIFIED SCHOOL DIST	4041 HILLCREST DR	A5	34.0140118	-118.3481888
Los Angeles	LA152	5034010900	3.92	10.00	L A UNIFIED SCHOOL DIST		A5	34.0153438	-118.3229499
Los Angeles	LA153	5036027900	3.56	10.00	L A UNIFIED SCHOOL DIST	3989 S HOBART BLVD	A5	34.0119298	-118.3083317
Los Angeles	LA154	5040016908	4.90	10.00	L A UNIFIED SCHOOL DIST	1260 W 36TH PL	A5	34.0214502	-118.2963264
Los Angeles	LA155	5041013905	4.07	10.00	L A UNIFIED SCHOOL DIST	3556 W 36TH ST	A5	34.0232700	-118.3107241
Los Angeles	LA156	5045001900	5.17	10.00	L A UNIFIED SCHOOL DIST	4400 COLISEUM ST	A5	34.0177498	-118.3439483
Los Angeles	LA157	5049017901	3.83	10.00	L A UNIFIED SCHOOL DIST	5611 S ORANGE DR	A5	34.0314804	-118.3541487
Los Angeles	LA158	5050022900	3.66	10.00	L A UNIFIED SCHOOL DIST	2925 VIRGINIA RD	A5	34.0285222	-118.3399881
Los Angeles		5124020903	1.25	10.00	L A UNIFIED SCHOOL DIST	2020 OAK ST	A5	34.0350474	-118.2783125
Los Angeles	LA159	5124021906	2.79	10.00	L A UNIFIED SCHOOL DIST	2020 OAK ST	A5	34.0350474	-118.2783125
Los Angeles	LA160	6016023912	11.39	10.00	L A UNIFIED SCHOOL DIST	7001 S ST ANDREWS PL	A5	33.9765931	-118.3122591
Los Angeles	LA161	5071022900	3.73	10.00	L A UNIFIED SCHOOL DIST	1745 VINEYARD AVE	A5	34.0430141	-118.3396857
Los Angeles	LA162	5077009913	2.48	10.00	L A UNIFIED SCHOOL DIST		A2	34.0631882	-118.2906424
Los Angeles		5082007903	2.68	9.82	L A UNIFIED SCHOOL DIST	1212 QUEEN ANNE PL	A2	34.0551259	-118.3327574
Los Angeles		5082007910	0.57	9.82	L A UNIFIED SCHOOL DIST	1212 QUEEN ANNE PL	A2	34.0551259	-118.3327574
Los Angeles	LA163	5083001900	18.58	10.00	L A UNIFIED SCHOOL DISTRICT	4650 W OLYMPIC BLVD	A2	34.0551259	-118.3327574
Los Angeles	LA164	5084005905	5.23	10.00	L A UNIFIED SCHOOL DIST	5241 W OLYMPIC BLVD	A2	34.0579882	-118.3435949
Los Angeles	LA165	5092008915	1.40	10.00	L A UNIFIED SCHOOL DIST	4056 WILSHIRE BLVD	A2	34.0611835	-118.3164737
Los Angeles	LA166	5137014903	2.89	10.00	L A UNIFIED SCHOOL DIST	1000 GRATTAN ST	A3	34.0478352	-118.2733308
Los Angeles	LA167	5157018900	1.58	10.00	L A UNIFIED SCHOOL DISTRICT	123 N LAKE ST	A3	34.0682886	-118.2711763
Los Angeles	LA168	5507017900	10.54	10.00	L A UNIFIED SCHOOL DIST	600 S MCCADDEN PL	A2	34.0635422	-118.3362536
Los Angeles	LA169	5517014900	2.53	10.00	L A UNIFIED SCHOOL DIST	220 S HOBART BLVD	A2	34.0705684	-118.3049349
Los Angeles	LA170	5520014900	3.11	10.00	L A UNIFIED SCHOOL DIST	4211 OAKWOOD AVE	A2	34.0783416	-118.2988072
Los Angeles	LA171	5522023903	4.59	10.00	L A UNIFIED SCHOOL DIST	501 N VAN NESS AVE	A2	34.0806933	-118.3163718
Los Angeles	LA172	5532013900	6.39	10.00	L A UNIFIED SCHOOL DIST	929 N LAS PALMAS AVE	A2	34.0880015	-118.3371322
Los Angeles	LA173	4305003900	4.91	10.00	L A UNIFIED SCHOOL DIST	9233 AIRDROME ST	A2	34.0505979	-118.3902784
Los Angeles	LA174	4325030900	8.66	10.00	L A UNIFIED SCHOOL DIST	1650 SELBY AVE	A2	34.0540302	-118.4356898
Los Angeles		5063021901	3.88	10.00	L A UNIFIED SCHOOL DIST	2411 S MARVIN AVE	A5	34.0355929	-118.3643172
Los Angeles	LA175	5063022908	1.59	10.00	L A UNIFIED SCHOOL DIST	2411 S MARVIN AVE	A5	34.0355929	-118.3643172
Los Angeles	LA176	5068008900	3.39	10.00	L A UNIFIED SCHOOL DIST	1661 S CRESCENT HEIGHTS BLVD	A2	34.0473202	-118.3744712
Los Angeles	LA177	5088018900	3.46	10.00	L A UNIFIED SCHOOL DIST	6351 W OLYMPIC BLVD	A2	34.0595661	-118.3690574
Los Angeles	LA178	5527021900	24.15	10.00	L A UNIFIED SCHOOL DIST	7850 MELROSE AVE	A2	34.0819662	-118.3599094
Los Angeles	LA179	5528018900	3.68	10.00	L A UNIFIED SCHOOL DIST		A2	34.0810896	-118.3747389
Los Angeles	LA180	5548014900	13.30	10.00	L A UNIFIED SCHOOL DIST	1521 N HIGHLAND AVE	A2	34.0991818	-118.3400611
Los Angeles	LA181	5401015900	1.49	10.00	L A UNIFIED SCHOOL DIST	610 MICHELTORENA ST	A2	34.0793790	-118.2803448
Los Angeles		5429025900	1.81	10.00	L A UNIFIED SCHOOL DIST	1511 MICHELTORENA ST	A3	34.0894759	-118.2754310
Los Angeles	LA182	5429025901	1.78	10.00	L A UNIFIED SCHOOL DIST	1511 MICHELTORENA ST	A3	34.0894759	-118.2754310
Los Angeles	LA183	5537009910	1.75	10.00	L A UNIFIED SCHOOL DIST	5227 SANTA MONICA BLVD	A2	34.0913951	-118.3034409
Los Angeles	LA184	5540003900	2.83	10.00	L A UNIFIED SCHOOL DIST	1133 N MARIPOSA AVE	A2	34.0915668	-118.2999261
Los Angeles	LA185	5544027903	2.59	10.00	L A UNIFIED SCHOOL DIST	1530 N WILTON PL	A2	34.0996504	-118.3125298
Los Angeles	LA186	5126001900	1.47	10.00	L A UNIFIED SCHOOL DIST		A6	34.0367278	-118.2723758
Los Angeles		5128016904	3.69	10.00	L A UNIFIED SCHOOL DIST	2807 STANFORD AVE	A6	34.0189047	-118.2618093
Los Angeles	LA187	5128016910	1.37	10.00	L A UNIFIED SCHOOL DIST	2807 STANFORD AVE	A6	34.0189047	-118.2618093
Los Angeles		5134022902	1.34	10.00	L A UNIFIED SCHOOL DIST		A6	34.0350796	-118.2661377
Los Angeles	LA188	5134022903	1.34	10.00	L A UNIFIED SCHOOL DIST	240 W VENICE BLVD	A6	34.0350796	-118.2661377
Los Angeles	LA189	4218003900	7.14	10.00	L A UNIFIED SCHOOL DIST	11735 BRADDOCK DR	A5	33.9955366	-118.4133652
Los Angeles	LA190	5123008905	3.26	10.00	L A UNIFIED SCHOOL DIST		A5	34.0242659	-118.2826552
Los Angeles	LA191	4235021900	12.26	10.00	L A UNIFIED SCHOOL DIST	3960 S CENTINELA AVE	A5	34.0016199	-118.4303064
Los Angeles		5056024901	5.79	9.99	L A UNIFIED SCHOOL DISTRICT	1550 W WASHINGTON BLVD	A5	34.0390017	-118.2902797
Los Angeles		5056024903	0.47	9.99	L A UNIFIED SCHOOL DISTRICT	1944 N VERMONT AVE	A5	34.0390017	-118.2902797
Los Angeles		5056024904	0.61	9.99	L A UNIFIED SCHOOL DIST	1500 W WASHINGTON BLVD	A5	34.0390017	-118.2902797

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Attachment E - List of Parcels in the Medium Tier /School Districts Only

City	Cluster ID	AIN*	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Los Angeles		5056024905	0.82	9.99	L A UNIFIED SCHOOL DIST	1584 W WASHINGTON BLVD	A5	34.0390017	-118.2902797
Los Angeles		5056024906	0.45	9.99	L A UNIFIED SCHOOL DIST	1960 S VERMONT AVE	A5	34.0390017	-118.2902797
Los Angeles		5056025908	0.28	9.99	L A UNIFIED SCHOOL DIST	1494 W WASHINGTON BLVD	A5	34.0390017	-118.2902797
Los Angeles		5056025909	0.25	9.99	L A UNIFIED SCHOOL DIST	1910 ELLENDALE PL	A5	34.0390017	-118.2902797
Los Angeles		5056030904	0.44	9.99	L A UNIFIED SCHOOL DIST	2000 S VERMONT AVE	A5	34.0390017	-118.2902797
Los Angeles	LA192	5056030909	0.33	9.99	L A UNIFIED SCHOOL DIST	2011 MENLO AVE	A5	34.0390017	-118.2902797
Los Angeles		5122003900	3.24	9.91	L A UNIFIED SCHOOL DIST	151 W 30TH ST	A6	34.0226371	-118.2708332
Los Angeles		5122003902	2.87	9.91	L A UNIFIED SCHOOL DIST	151 W 30TH ST	A6	34.0226371	-118.2708332
Los Angeles	LA193	5122004900	0.29	9.91	L A UNIFIED SCHOOL DIST	151 W 30TH ST	A6	34.0226371	-118.2708332
Los Angeles		5054029906	4.44	9.88	L A UNIFIED SCHOOL DIST	1435 W 27TH ST	A5	34.0310642	-118.2927023
Los Angeles	LA194	5054029912	0.27	9.88	L A UNIFIED SCHOOL DISTRICT	1435 W 27TH ST	A5	34.0310642	-118.2927023
Los Angeles		5056014908	0.56	9.88	L A UNIFIED SCHOOL DIST	1715 MAGNOLIA AVE	A5	34.0437352	-118.2874399
Los Angeles	LA195	5056018912	4.06	9.88	L A UNIFIED SCHOOL DIST	1626 ORCHARD AVE	A5	34.0437352	-118.2874399
Los Angeles		5536014900	3.06	9.84	L A UNIFIED SCHOOL DIST	1070 N VAN NESS AVE	A2	34.0899166	-118.3152021
Los Angeles	LA196	5536014905	0.27	9.84	L A UNIFIED SCHOOL DIST	1000 N VAN NESS AVE	A2	34.0899166	-118.3152021
Los Angeles		5003013901	4.68	9.83	L A UNIFIED SCHOOL DIST	1724 W 53RD ST	A5	33.9937070	-118.3075348
Los Angeles	LA197	5003014920	0.98	9.83	L A UNIFIED SCHOOL DIST		A5	33.9937070	-118.3075348
Los Angeles		5157014900	2.39	9.81	L A UNIFIED SCHOOL DIST	421 ROSEMONT AVE	A3	34.0717896	-118.2703279
Los Angeles	LA198	5157015905	0.55	9.81	L A UNIFIED SCHOOL DIST	421 ROSEMONT AVE	A3	34.0717896	-118.2703279
Los Angeles		5141005901	1.79	9.75	L A UNIFID SCHOOL DIST	2401 WILSHIRE BLVD	A2	34.0603746	-118.2797403
Los Angeles	LA199	5141006904	0.59	9.75	LA UNIFIED SCHOOL DIST	611 S CARONDELET ST	A2	34.0603746	-118.2797403
Los Angeles		5092011901	0.46	9.71	L A UNIFIED SCHOOL DIST	745 S WILTON PL	A2	34.0585702	-118.3151505
Los Angeles	LA200	5092011904	2.69	9.71	L A UNIFIED SCHOOL DIST	745 S WILTON PL	A2	34.0585702	-118.3151505
Los Angeles		5529020901	1.56	9.56	L A UNIFIED SCHOOL DIST		A2	34.0879805	-118.3634705
Los Angeles	LA201	5529023901	0.44	9.56	L A UNIFIED SCHOOL DIST	925 N HAYWORTH AVE	A2	34.0879805	-118.3634705
Los Angeles		5075033900	2.03	9.48	L A UNIFIED SCHOOL DIST	1925 S BUDLONG AVE	A5	34.0391643	-118.2966134
Los Angeles		5075033901	0.69	9.48	L A UNIFIED SCHOOL DIST	1925 S BUDLONG AVE	A5	34.0391643	-118.2966134
Los Angeles		5075034906	2.24	9.48	L A UNIFIED SCHOOL DIST	1925 S BUDLONG AVE	A5	34.0391643	-118.2966134
Los Angeles		5075035900	0.38	9.48	L A UNIFIED SCHOOL DISTRICT	1733 CORDOVA ST	A5	34.0391643	-118.2966134
Los Angeles		5075035907	0.30	9.48	L A UNIFIED SCHOOL DIST	1716 W WASHINGTON BLVD	A5	34.0391643	-118.2966134
Los Angeles		5075035911	0.30	9.48	L A UNIFIED SCHOOL DIST	1744 W WASHINGTON BLVD	A5	34.0391643	-118.2966134
Los Angeles	LA202	5075035913	0.30	9.48	L A UNIFIED SCHOOL DISTRICT	1738 W WASHINGTON BLVD	A5	34.0391643	-118.2966134
Los Angeles		4006011900	0.52	9.46	L A UNIFIED SCHOOL DIST	6420 11TH AVE	A5	33.9799959	-118.3273218
Los Angeles		4006011901	0.26	9.46	L A UNIFIED SCHOOL DIST	6434 11TH AVE	A5	33.9799959	-118.3273218
Los Angeles		4006013900	3.74	9.46	L A UNIFIED SCHOOL DIST		A5	33.9799959	-118.3273218
Los Angeles	LA203	4006014900	5.86	9.46	L A UNIFIED SCHOOL DIST	6620 11TH AVE	A5	33.9799959	-118.3273218
Los Angeles		5077021900	0.59	9.41	L A UNIFIED SCHOOL DIST	2726 FRANCIS AVE	A2	34.0563473	-118.2849329
Los Angeles		5077026902	2.07	9.41	L A UNIFIED SCHOOL DIST	2726 FRANCIS AVE	A2	34.0563473	-118.2849329
Los Angeles		5077026903	0.31	9.41	L A UNIFIED SCHOOL DIST	2726 FRANCIS AVE	A2	34.0563473	-118.2849329
Los Angeles	LA204	5077027900	0.39	9.41	L A UNIFIED SCHOOL DIST	2726 FRANCIS AVE	A2	34.0563473	-118.2849329
Los Angeles		5080016907	0.57	9.18	L A UNIFIED SCHOOL DIST	980 S HOBART BLVD	A2	34.0537455	-118.3055537
Los Angeles		5080016908	0.29	9.18	L A UNIFIED SCHOOL DIST	980 S HOBART BLVD	A2	34.0537455	-118.3055537
Los Angeles		5080016910	0.43	9.18	L A UNIFIED SCHOOL DISTRICT	980 S HOBART BLVD	A2	34.0537455	-118.3055537
Los Angeles		5080023900	2.23	9.18	L A UNIFIED SCHOOL DIST	980 S HOBART BLVD	A2	34.0537455	-118.3055537
Los Angeles		5080023903	0.43	9.18	L A UNIFIED SCHOOL DIST	980 S HOBART BLVD	A2	34.0537455	-118.3055537
Los Angeles	LA205	5080023904	0.32	9.18	L A UNIFIED SCHOOL DIST	980 S HOBART BLVD	A2	34.0537455	-118.3055537
Los Angeles	LA206	5513030900	4.58	9.00	L A UNIFIED SCHOOL DIST	201 S JUNE ST	A2	34.0700057	-118.3353447
Los Angeles	LA207	5550013900	3.57	9.00	L A UNIFIED SCHOOL DIST	7450 HAWTHORN AVE	A2	34.0993101	-118.3520366
Los Angeles	LA208	4255006900	4.44	9.00	L A UNIFIED SCHOOL DIST	10650 ASHBY AVE	A5	34.0380774	-118.4206805
Los Angeles	LA209	6017012900	3.69	9.00	L A UNIFIED SCHOOL DIST	2112 W 74TH ST	A5	33.9723230	-118.3166404
Los Angeles	LA210	4106026900	5.83	9.00	L A UNIFIED SCHOOL DIST	6011 W 79TH ST	A5	33.9670293	-118.3884248
Los Angeles	LA211	4005023900	3.31	9.00	L A UNIFIED SCHOOL DIST	5939 2ND AVE	A5	33.9863811	-118.3201060
Los Angeles	LA212	4127016901	6.34	9.00	L A UNIFIED SCHOOL DIST		A5	33.9675987	-118.3778869
Los Angeles	LA213	4215005905	0.32	9.00	CULVER CITY UNIFIED SCHOOL DIST		A5	34.0021861	-118.4007288
Los Angeles	LA214	4301017904	0.97	9.00	L A UNIFIED SCHOOL DIST	2450 S SHENANDOAH ST	A5	34.0379110	-118.3850267
Los Angeles	LA215	5525010900	3.58	9.00	L A UNIFIED SCHOOL DIST	731 N DETROIT ST	A2	34.0843875	-118.3456856
Los Angeles	LA216	5542027909	1.31	9.00	L A UNIFIED SCHOOL DIST	1153 N WESTMORELAND AVE	A2	34.0927264	-118.2883572
Los Angeles	LA217	5589028900	2.58	9.00	L A UNIFIED SCHOOL DIST	1740 N NEW HAMPSHIRE AVE	A2	34.1025664	-118.2928435
Los Angeles	LA218	5126018917	0.69	9.00	L A UNIFIED SCHOOL DIST	2405 S GRAND AVE	A6	34.0282421	-118.2716535
Los Angeles	LA219	5127002908	0.74	9.00	L A UNIFIED SCHOOL DIST	1635 S SAN PEDRO ST	A6	34.0292828	-118.2581583
Los Angeles	LA220	4212001900	4.02	9.00	L A UNIFIED SCHOOL DIST	12814 MAXELLA AVE	A5	33.9900435	-118.4319862
Los Angeles	LA221	4001013900	2.24	9.00	INGLEWOOD UNIFIED SCHOOL DIST		A5	33.9818102	-118.3689911
Los Angeles	LA222	5047014901	4.87	9.00	L A UNIFIED SCHOOL DIST	5421 RODEO RD	A5	34.0225056	-118.3652955
Los Angeles	LA223	4220012900	4.58	9.00	L A UNIFIED SCHOOL DIST	12221 JUNIETTE ST	A5	33.9828739	-118.4097435
Los Angeles	LA224	5031004900	4.17	9.00	L A UNIFIED SCHOOL DIST	4000 SANTO TOMAS DR	A5	34.0086690	-118.3437345
Los Angeles	LA225	5137007911	0.58	9.00	L A UNIFIED SCHOOL DISTRICT	1333 E OLYMPIC BLVD	A3	34.0479386	-118.2705803
Los Angeles	LA226	4321015900	3.60	9.00	L A UNIFIED SCHOOL DIST	2050 SELBY AVE	A2	34.0478355	-118.4304085
Los Angeles	LA227	4360024900	3.25	9.00	L A UNIFIED SCHOOL DIST	615 HOLMBY AVE	A2	34.0695078	-118.4337231
Los Angeles	LA228	4211013900	4.09	9.00	L A UNIFIED SCHOOL DIST		A5	33.9682961	-118.4245085
Los Angeles		5517007916	0.76	9.00	L A UNIFIED SCHOOL DIST	225 S OXFORD AVE	A2	34.0702910	-118.3087312
Los Angeles		5517007917	0.62	9.00	L A UNIFIED SCHOOL DIST	218 S WESTERN AVE	A2	34.0702910	-118.3087312
Los Angeles	LA229	5517007918	0.55	9.00	L A UNIFIED SCHOOL DIST	200 S WESTERN AVE	A2	34.0702910	-118.3087312
Los Angeles	LA230	4326016900	3.14	9.00	L A UNIFIED SCHOOL DIST	1403 FAIRBURN AVE	A2	34.0587850	-118.4315714
Los Angeles		5533017901	1.02	8.86	L A UNIFIED SCHOOL DIST	955 VINE ST	A2	34.0881626	-118.3271873
Los Angeles	LA231	5533018900	3.06	8.86	L A UNIFIED SCHOOL DIST	955 VINE ST	A2	34.0881626	-118.3271873
Los Angeles		5076007900	0.88	8.73	L A UNIFIED SCHOOL DISTRICT	2481 W 11TH ST	A2	34.0510393	-118.2873628
Los Angeles	LA232	5076008900	0.33	8.73	L A UNIFIED SCHOOL DIST	2481 W 11TH ST	A2	34.0510393	-118.2873628
Los Angeles		5539005900	2.56	8.69	L A UNIFIED SCHOOL DIST	4345 LOCKWOOD AVE	A2	34.0892246	-118.2883782

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City	Cluster ID	AIN*	Acres	Cluster Score	Parcel Owner	Address	Appendix A	Latitude	Longitude
Los Angeles	LA233	5539005903	0.47	8.69	L A UNIFIED SCHOOL DIST	4345 LOCKWOOD AVE	A2	34.0892246	-118.2883782
Los Angeles		5142013906	0.35	8.54	L A UNIFIED SCHOOL DISTRICT	680 LITTLE ST	A3	34.0534351	-118.2694774
Los Angeles		5142013911	0.30	8.54	L A UNIFIED SCHOOL DIST	680 LITTLE ST	A3	34.0534351	-118.2694774
Los Angeles		5142023900	0.88	8.54	L A UNIFIED SCHOOL DIST		A3	34.0534351	-118.2694774
Los Angeles		5142026906	0.30	8.54	L A UNIFIED SCHOOL DIST	1501 W 7TH ST	A3	34.0534351	-118.2694774
Los Angeles		5142026915	0.30	8.54	L A UNIFIED SCHOOL DISTRICT	1546 WILSHIRE BLVD	A3	34.0534351	-118.2694774
Los Angeles	LA234	5142026921	0.61	8.54	L A UNIFIED SCHOOL DISTRICT	1500 WILSHIRE BLVD	A3	34.0534351	-118.2694774
Los Angeles		5539023900	0.86	8.41	L A UNIFIED SCHOOL DIST	607 N WESTMORELAND AVE	A2	34.0824757	-118.2886027
Los Angeles		5539024901	3.10	8.41	L A UNIFIED SCHOOL DIST	607 N WESTMORELAND AVE	A2	34.0824757	-118.2886027
Los Angeles		5539024902	0.34	8.41	L A UNIFIED SCHOOL DIST	607 N WESTMORELAND AVE	A2	34.0824757	-118.2886027
Los Angeles		5539025900	0.34	8.41	L A UNIFIED SCHOOL DIST	607 N WESTMORELAND AVE	A2	34.0824757	-118.2886027
Los Angeles	LA235	5539025902	0.34	8.41	L A UNIFIED SCHOOL DIST	607 N WESTMORELAND AVE	A2	34.0824757	-118.2886027
Los Angeles		5547015900	1.26	8.33	L A UNIFIED SCHOOL DIST	6611 SELMA AVE	A2	34.1005996	-118.3336903
Los Angeles		5547015901	1.11	8.33	L A UNIFIED SCHOOL DIST	6611 SELMA AVE	A2	34.1005996	-118.3336903
Los Angeles		5547015903	0.31	8.33	L A UNIFIED SCHOOL DISTRICT	6611 SELMA AVE	A2	34.1005996	-118.3336903
Los Angeles		5547015904	0.31	8.33	L A UNIFIED SCHOOL DISTRICT	6611 SELMA AVE	A2	34.1005996	-118.3336903
Los Angeles		5547015905	0.56	8.33	L A UNIFIED SCHOOL DISTRICT	6611 SELMA AVE	A2	34.1005996	-118.3336903
Los Angeles	LA236	5547015908	0.45	8.33	L A UNIFIED SCHOOL DISTRICT	6611 SELMA AVE	A2	34.1005996	-118.3336903
Los Angeles		5080012904	0.34	8.00	L A UNIFIED SCHOOL DIST	1211 S HOBART BLVD	A2	34.0479587	-118.3066308
Los Angeles		5080012905	0.39	8.00	L A UNIFIED SCHOOL DIST	1211 S HOBART BLVD	A2	34.0479587	-118.3066308
Los Angeles		5080019911	0.29	8.00	L A UNIFIED SCHOOL DIST	1211 S HOBART BLVD	A2	34.0479587	-118.3066308
Los Angeles	LA237	5080019921	0.30	8.00	L A UNIFIED SCHOOL DIST	1211 S HOBART BLVD	A2	34.0479587	-118.3066308
Los Angeles	LA238	5018003914	0.34	8.00	LOS ANGELES UNIFIED SCHOOL DIST	856 W VERNON AVE	A5	34.0034028	-118.2882158
Los Angeles	LA239	5078002905	0.30	8.00	LA UNIFIED SCHOOL DIST	2965 W OLYMPIC BLVD	A2	34.0529040	-118.2996679
Los Angeles	LA240	5016015926	0.29	8.00	L A UNIFIED SCHOOL DISTRICT	1717 W 47TH ST	A5	34.0012570	-118.3097300
Los Angeles	LA241	5045019900	0.60	8.00	L A UNIFIED SCHOOL DIST	3833 CRENSHAW BLVD	A5	34.0161026	-118.3356938
Los Angeles		5060030901	0.30	8.00	L A UNIFIED SCHOOL DIST	1908 3RD AVE	A5	34.0394933	-118.3191483
Los Angeles		5060030902	0.46	8.00	L A UNIFIED SCHOOL IDST	3200 E WASHINGTON BLVD	A5	34.0394933	-118.3191483
Los Angeles		5060030905	0.32	8.00	L A UNIFIED SCHOOL DIST	1926 3RD AVE	A5	34.0394933	-118.3191483
Los Angeles	LA242	5060031900	0.46	8.00	L A UNIFIED SCHOOL DISTRICT	2520 W WASHINGTON BLVD	A5	34.0394933	-118.3191483
Los Angeles	LA243	5078002904	0.40	8.00	LA UNIFIED SCHOOL DIST	2957 W OLYMPIC BLVD	A2	34.0529558	-118.2992471
Los Angeles	LA244	5137007913	0.42	8.00	L A CITY UNIFIED SCHOOL DIST		A3	34.0480905	-118.2698685
Los Angeles	LA245	5126018916	0.46	8.00	L A UNIFIED SCHOOL DISTRICT	2321 S GRAND AVE	A6	34.0286057	-118.2714214
Los Angeles	LA246	5123008910	0.29	8.00	L A UNIFIED SCHOOL		A5	34.0235873	-118.2827876
Los Angeles		5141016900	0.26	8.00	L A UNIFIED SCHOOL DIST	2300 W 7TH ST	A2	34.0568163	-118.2797022
Los Angeles		5141016902	0.42	8.00	L A UNIFIED SCHOOL DIST	2300 W 7TH ST	A2	34.0568163	-118.2797022
Los Angeles		5141016903	0.40	8.00	L A UNIFIED SCHOOL DIST	2300 W 7TH ST	A2	34.0568163	-118.2797022
Los Angeles	LA247	5141016905	0.37	8.00	LA UNIFIED SCHOOL DISTRICT	2323 W 8TH ST	A2	34.0568163	-118.2797022
Los Angeles	LA248	5534012909	0.37	7.00	L A UNIFIED SCHOOL DISTRICT	5951 SANTA MONICA BLVD	A2	34.0910005	-118.3193914
LA County	LC02	5010003900	5.36	10.00	L A UNIFIED SCHOOL DIST		A5	33.9960399	-118.3563302
LA County	LC03	5007011900	3.71	9.00	L A UNIFIED SCHOOL DIST	6401 SANTA MONICA BLVD	A5	33.9918871	-118.3434604
West Hollywood	WH05	5529020900	1.71	12.00	L A UNIFIED SCHOOL DIST		A2	34.0879873	-118.3630338
West Hollywood	WH06	5529009900	1.44	9.00	L A UNIFIED SCHOOL DIST		A2	34.0900388	-118.3621293
West Hollywood	WH07	4340003900	3.00	8.00	L A UNIFIED SCHOOL DIST	1201 S FIGUEROA ST	A2	34.0890595	-118.3867012

*Due to the fact that many of these parcels are vacant lots, addresses may not exist. The location of each AIN can be found online at http://navigatela.lacity.org or http://maps.assessor.lacounty.gov

Appendix 4.C
Engineering and Feasibility for Signature Regional Projects

DRAFT TECHNICAL MEMORANDUM

ENGINEERING AND ENVIRONMENTAL FEASIBILITY FOR SELECTED REGIONAL PROJECT SITES

PREPARED FOR

Upper Los Angeles River Watershed Management Group

FEBRUARY 2015

BLACK & VEATCH
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1 Background

The purpose of this technical memorandum is to describe the findings of the additional engineering and environmental feasibility reviews of the eight regional project sites selected by the Upper Los Angeles River (ULAR) Watershed Management Group (WMG). The selection of these project sites is documented in *Regional Project Section Process and Preliminary List of Projects,* October 2014. The concepts developed for these project sites will be included in the Enhanced Watershed Management Plan (EWMP) to be submitted to the Regional Water Quality Control Board (Regional Board) in June 2015.

The following sections present the methodology employed to evaluate the eight regional project locations for engineering and environmental feasibility.

2 Evaluation Methodology

The eight selected ULAR project sites underwent further evaluations to determine the engineering and environmental feasibility of constructing regional best management practice (BMP) projects at these locations. Evaluations included various desktop analyses, field investigations, hydrologic modeling, and discussions with project stakeholders. The evaluation methodology is summarized in the following sections.

2.1 COMPILE MAPPING, STORM DRAINAGE, AND WATERSHED INFORMATION

Initial evaluation efforts focused on compiling information on the surrounding storm drain system and contributing watershed area for each project site. Storm drain data was obtained from the City of Los Angeles's geographic information system (GIS) data, GIS data from Los Angeles County, as-built record drawings provided on NavigateLA, and other as-built record drawings provided by individual member agencies. NavigateLA is a web-based mapping application that delivers maps and reports based on data supplied by various City departments, Los Angeles County, and Thomas Brothers maps. Storm drain sizes and invert elevations were noted from the available data. This assessment of the surrounding storm drain network provided insight into the typical flow volumes experienced and the feasibility of intercepting the flows at the project locations. Storm drain connectivity upstream of the project sites was also reviewed in conjunction with available contour data. This analysis led to identifying the contributing watershed area, or drainage area, for each project site.

Detailed information compiled from this initial desktop evaluation, such as relevant storm drain depths and critical watershed divides, was plotted on maps suitable for review during the field investigations.

2.2 CONDUCT DESKTOP EVALUATION OF INFILTRATION POTENTIAL

A desktop evaluation of the infiltration potential of all of the sites was conducted utilizing Natural Resource Conservation Service (NRCS) soil data made available by the County of Los Angeles. The spatial dataset identified the soil class and soil type for all areas within Los Angeles County. NRCS-accepted infiltration rates were assumed for each soil type and used to calculate a single aggregate infiltration rate for each project site. This aggregate infiltration rate was calculated by multiplying the accepted infiltration rate for each soil type by the percent of total area of that soil type within the project site. The results of this soils analysis are summarized below in Table 2.2-1. Further details are provided in Appendix A.

Table 2.2-1 Infiltration Analysis Summary

Project Site ID	Site Description	Aggregate Infiltration Rate (in/hr)
AL01	Almansor Park	0.70
GL01	Fremont Park	0.30
LAC01	Roosevelt Park	0.30
MP01	Sierra Vista Park	0.30
SF01	San Fernando Regional Park	0.80
SM01	Lacy Park	0.39
SP01	Lower Arroyo Park	0.80
NHP	North Hollywood Park	0.80

2.3 CONDUCT FIELD INVESTIGATIONS TO ASSESS INITIAL OPPORTUNITY AREAS

Field investigations for the eight selected ULAR project sites were conducted over two days on January 7 and January 8, 2015. All site visits were attended by City of Los Angeles staff and engineering consulting team members from Black & Veatch. The site visit schedule was shared with WMG members prior to the visiting days. WMG members were invited to and encouraged to attend any or all site visits.

The primary objective of the field investigations was to identify the most practical project opportunity areas given each project site's existing layout and facilities. Project opportunity areas refer to a sub-area(s) within the selected project site boundary that can best accommodate the construction or implementation of the proposed BMP. In general, project opportunity areas avoided spaces posing constructability issues; established facilities such as lighted, fenced tennis courts; or environmental issues such as disturbing mature heritage trees. Findings of these field investigations for each project site are presented in the project concepts, site maps, and calculations provided in Section 3.

The project team prepared several documents that describe the findings of the field investigations, including Field Investigation Notes, Initial Study/Environmental Constraints Evaluation, and a Summary of Environmental Constraints. These documents are provided in Appendix B.

2.4 COMPILE SITE DATA AND DEVELOP BASIC BMP PARAMETERS

Findings from the field investigations were distributed to and discussed with WMG members. Follow-up discussions were conducted as necessary to continue to refine project concepts and define basic BMP parameters. These basic parameters included the type of BMP, available BMP capacity or volume, and the expected runoff volume.

The type of BMP proposed at each project site falls into one of the structural BMP subcategories based on its major function. The subcategories and example BMP types are listed below. BMP types for each project site were selected based on the findings from the desktop analyses and field investigations, and input from project stakeholders. The proposed BMP type for each site is described in Section 3.

- Infiltration BMP – surface infiltration basin, subsurface infiltration gallery
- Detention BMP – surface detention basin, subsurface detention gallery
- Constructed Wetland BMP – constructed wetlands, flow-through/linear wetland
- Treatment Facility BMP – facilities designed to treat runoff from and return it to the receiving water
- Low Flow Diversion BMP – facilities designed to divert dry weather flows to the sanitary sewer

The available BMP capacity or volume was calculated based on the estimated BMP depth and project opportunity area (or BMP footprint) at each project site. BMP depths were identified based on groundwater level and practical depth per BMP type. The City provided 10-foot groundwater contour data which was used to identify the approximate groundwater elevation within the BMP opportunity areas. A minimum of a 5-foot buffer was assumed between the groundwater elevation and bottom of BMP. The proposed opportunity area at each site was reviewed with project stakeholders and thus was carried forward in the available BMP volume calculations. The identified BMP depth was multiplied by the opportunity area to estimate a maximum practical BMP volume available for each project site. This volume will be used to retain, infiltrate, or treat stormwater runoff. BMP estimated depths, opportunity areas, and available volume calculations are presented for each project site in Section 3.

In order to determine if the available BMP volume at each project site is adequate to meet the Municipal Separate Storm Sewer System (MS4) Permit requirements, the 85th percentile runoff volume had to be determined for each project site and compared to the feasible BMP capacity. Runoff volumes were estimated using a hydrologic model and providing drainage area parameters for each site. Findings from previous desktop analyses and field investigations showed that most sites appeared to have a larger watershed area tributary to the site (by intercepting flow in a channel or larger pipe), as well as a somewhat smaller tributary watershed area (by intercepting flow in a smaller pipe). Thus, a maximum drainage area and an alternative (or minimum) drainage area were identified for all sites.

For four of the project sites, the identified maximum drainage area was situated on or near receiving waters in the ULAR watershed. Receiving waters in the ULAR watershed include Bell Creek, McCoy-Dry Canyon Creek, Brown's Canyon Wash, Los Angeles River Reach 6, Aliso Wash, Bull Creek, Tujunga Wash, Burbank Western Channel, Verdugo Wash, Arroyo Seco, Los Angeles River Reach 2, Rio Hondo, and Compton Creek. In accordance with the MS4 Permit, BMP projects should not divert receiving waters. The recommended projects in this technical memorandum avoid diverting flows from Alhambra Wash, Arcadia Wash, Eaton Wash, and Santa Anita Wash. As a result, the maximum drainage areas for the four sites situated on or near receiving waters were not considered for BMP sizing. These four project sites are: Fremont Park (GL01), San Fernando (SF01), Lower Arroyo Park (SP01), and North Hollywood Park (NHP).

The hydrologic model was run to estimate the 85th percentile runoff volume for each project site using both maximum and alternative drainage areas, if applicable. The maximum and alternative drainage areas, and associated 85th percentile runoff volumes, are presented for each site in Section

3. In many cases, the entire design storm for the maximum watershed area could be accommodated with the proposed BMP size; however, in other cases, the smaller watershed area did not fully utilize the BMP size. These results were discussed with the team and a scheme was developed to determine the optimal BMP size for each project site. This optimization process is described in the next section.

2.5 REFINE AND OPTIMIZE BMP PARAMETERS

The hydrologic modeling approach utilized in this engineering and environmental feasibility analysis to optimize BMP parameters was discussed and confirmed with the WMG members. Under this approach, the hydrologic model was used to determine the 85^{th} percentile peak flow resulting from the maximum drainage area and alternative drainage area for each project site. The model also considered a range of diversion scenarios in an effort to optimize the proposed BMP volume at each site. The hydrologic model was used to simulate the following diversion scenarios for both maximum and alternative drainage areas for each project site:

- Routing all flow through the proposed BMP
- Routing only the 85^{th} percentile 24-hour storm event through the proposed BMP
- Routing flows from a 20 cubic feet per second (cfs) diversion through the proposed BMP

Routing the various storm sizes through the model allows project stakeholders to make more informed decisions to optimize the benefits of the proposed BMPs. For instance, a BMP that can accommodate all of the flow from its drainage area may be larger than required by the MS4 Permit, but it may take advantage of economy of scale construction costs and provide greater watershed benefits. On the other hand, if sizing limitations prevent a proposed BMP from being able to receive the 85th percentile storm event as required by the MS4 Permit, it can still provide the benefits of a regional BMP project, but at a smaller scale. A 20 cfs diversion was assumed to define the lower limit of the diversion scenarios as it generally represents a maximum realistic pumped flow rate.

Based on the available volume of the proposed BMP and the runoff volume estimated for the three diversion scenarios (for both maximum and alternative drainage areas, if applicable), a maximum cost-effective BMP size was determined for each project site. Full graphical and tabular results of the optimization are presented in Appendix C. A summary of the optimization parameters and recommendations for each project site are presented in Section 3.

3 Project Concepts

Concepts for the eight regional project sites are presented in this section. The following items are included for each project site:

- A fact sheet with a summary description of the recommended BMP project; BMP parameters; and a description of potential benefits
- A figure showing a plan view of the project site, showing the identified BMP opportunity area(s) and surrounding storm drain infrastructure
- A figure showing a plan view of the maximum and alternative drainage areas delineated for the project site, if applicable

The fact sheet for each project site includes a table summarizing key design parameters for the BMP. The items presented in the summary tables are defined below.

Project Site Parameters	**Total (Maximum) Drainage Area**	The area in acres of the maximum drainage area delineated for each project site. This parameter was not considered for the four sites located on or near receiving waters. The drainage area delineation is described in Section 2.
	Alternative (Minimum) Drainage Area	The area in acres of the alternative drainage area delineated for each project site. The drainage area delineation is described in Section 2.
	Maximum Required BMP Volume	The BMP volume in acre-feet that is required to retain the 85th percentile design storm volume generated from the maximum drainage area. This parameter was not considered for the four sites located on or near receiving waters.
	Alternative Required BMP Volume	The BMP volume in acre-feet that is required to retain the 85th percentile design storm volume generated from the alternative drainage area.
	Groundwater Depth	The groundwater depth in feet from the ground surface. Groundwater depths were determined using groundwater contours and ground elevation GIS data provided by the City.
BMP Design Parameters	**BMP Opportunity Area**	The area in acres of the BMP opportunity area(s) identified during the field investigations and follow-up discussions. This process is described in Section 2.
	Recommended Maximum BMP Depth	The depth in feet of the recommended BMP project. This depth is based on groundwater depth and practical project design characteristics, as discussed in Section 2.
	Available BMP Volume	The BMP volume in acre-feet that is potentially available at the project site. This volume is based on the BMP opportunity area and recommended depth presented above, as discussed in Section 2.
	Recommended Active BMP Volume	The recommended BMP volume in acre-feet. This volume is recommended based on the hydrologic modeling and optimization results as discussed in Section 2.

3.1 ALMANSOR PARK

The Alhambra Golf Course and Almansor Park are located in the City of Alhambra in an area that drains to Alhambra Wash. The golf course is owned and operated by the City of Alhambra. Almansor Park consists of open grass fields, picnic tables with covered shelters, playgrounds, baseball fields, tennis courts, meeting/activity rooms, restrooms, and basketball court. During the site visit it was noted that the trail around the perimeter of Almansor Park is popular among residents. The potential BMP is proposed as a below-ground retention/infiltration basin situated beneath the baseball fields and open space in the southwest portions of the park.

The maximum drainage area for this project site is approximately 1,145 acres. After review of available site opportunities and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 51 acres.

After reviewing the hydrologic model results and estimated runoff volumes for the various diversion scenarios, it was determined that a retention/infiltration BMP sized to accommodate all inline flows contributed from the maximum drainage area is best suited for this project site. As a result, the recommended active volume of the BMP is 74.7 acre-feet.

Table 3.1-1 summarizes key conceptual design parameters of the BMP proposed at Almansor Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the total (maximum) and alternative (minimum) tributary drainage areas can be found in Appendix E.

Table 3.1-1 Summary of Almansor Park (AL01)

Table 3.1-1 Summary of Almansor Park (AL01)		
Project Site Parameters	Total (Maximum) Drainage Area	1,145 ac
	Alternative (Minimum) Drainage Area	51 ac
	Maximum Required BMP Volume	49.0 ac-ft
	Alternative Required BMP Volume	0.515 ac-ft
	Groundwater Depth	165 ft
BMP Design Parameters	BMP Opportunity Area	10.2 ac
	Recommended Maximum BMP Depth	25 ft
	Available BMP Volume	255 ac-ft
	Recommended Active BMP Volume	**74.7 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Water harvested can be utilized for a significant amount of on-site irrigation

3.2 FREMONT PARK

Fremont Park is located in Glendale in an area that drains to Verdugo Wash. The park is approximately 8 acres and consists of basketball courts, horseshoe courts, tennis courts, volleyball courts, playground equipment, and a wading pool. The potential BMP is proposed as a below-ground retention/infiltration basin situated beneath the open field space in the southeast corner of the park site.

No maximum drainage area was identified for this site since it is located adjacent to a receiving waterbody, Verdugo Wash. After review of available site opportunities and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 206 acres. A considerable part of this alternative watershed area is comprised of CalTrans right-of-way for the CA-134 Freeway.

After reviewing the hydrologic model results and estimated runoff volumes for the various diversion scenarios, it was determined that this site is not suited for accommodating the 85th percentile design storm runoff volume contributed from the smaller drainage area. As a result, a BMP implemented at this site will provide important water quality benefits; however, it will not qualify as a regional project. As such, the recommended active volume of the BMP is 8.0 acre-feet.

Table 3.2-1 summarizes key conceptual design parameters of the BMP proposed at Fremont Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the alternative (minimum) tributary drainage area can be found in Appendix E.

Table 3.2-1 Summary of Fremont Park (GL01)

Table 3.2-1 Summary of Fremont Park (GL01)		
Project Site Parameters	Total (Maximum) Drainage Area	N/A
	Alternative (Minimum) Drainage Area	206 ac
	Maximum Required BMP Volume	N/A
	Alternative Required BMP Volume	16.0 ac-ft
	Groundwater Depth	50 ft
BMP Design Parameters	BMP Opportunity Area	0.4 ac
	Recommended Maximum BMP Depth	20 ft
	Available BMP Volume	8 ac-ft
	Recommended Active BMP Volume	**8.0 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Water harvested can be utilized on-site irrigation
- Collaboration and potential cost sharing with CalTrans

3.3 ROOSEVELT PARK

Roosevelt Park is located in unincorporated Los Angeles County. The park is a large facility that includes basketball courts, picnic facilities with barbecue grills, playground equipment, a senior center, community room, computer center, fitness zone, and gym. The County investigated several BMP options including an infiltration basin near the north end of the park and dry wells to the east and west of the park.

The maximum drainage area for this project site is approximately 2,250 acres. After review of the available site information and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 169 acres.

After reviewing the hydrologic model results and estimated runoff volumes for the various diversion scenarios, it was determined that this site is suitable for a BMP sized to accommodate more than the 85th percentile design storm runoff volume contributed from the maximum drainage area. As a result, the recommended active volume of the BMP is 8.4 acre feet.

Table 3.3-1 summarizes key conceptual design parameters of the BMP proposed at Roosevelt Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the total (maximum) and alternative (minimum) tributary drainage areas can be found in Appendix E.

Table 3.3-1 Summary of Roosevelt Park (LAC01)

Table 3.3-1 Summary of Roosevelt Park (LAC01)		
Project Site Parameters	Total (Maximum) Drainage Area	2,250 ac
	Alternative (Minimum) Drainage Area	169 ac
	Maximum Required BMP Volume	82.4 ac-ft
	Alternative Required BMP Volume	2.2 ac-ft
	Groundwater Depth	80 ft
BMP Design Parameters	BMP Opportunity Area	10 ac
	Recommended Maximum BMP Depth	20 ft
	Available BMP Volume	200 ac-ft
	Recommended Active BMP Volume	**8.4 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Surface water can be utilized for aesthetic and other community benefits
- Water harvested can be utilized for a significant amount of on-site irrigation

3.4 SIERRA VISTA PARK

Sierra Vista Park is located within the City of Monterey Park. The park includes a senior/community center, baseball diamond, basketball court, picnic shelters, tennis courts, restrooms, and playground equipment. The potential BMP type is proposed as a below-ground retention/infiltration basin situated beneath the baseball diamond in the southwest corner of the site.

The maximum drainage area for this project site is 2,928 acres. After review of available site information and surround infrastructure data, a smaller (alternative) drainage area was delineated, encompassing approximately 800 acres.

After reviewing the hydrologic model results and estimated runoff volumes for the various diversion scenarios, it was determined that this site cannot accommodate the 85th percentile design storm flows from the smaller drainage area. Thus, it is recommended that the BMP be sized for retention/infiltration of approximately 10 ac-ft of runoff, which will be conveyed to the BMP via a 20 cfs pumped diversion. 20 cfs is viewed as a maximum realistic peak pumped flowrate, as discussed in Section 2.

Table 3.4-1 summarizes key conceptual design parameters of the BMP proposed at Sierra Vista Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the total (maximum) and alternative (minimum) tributary drainage areas can be found in Appendix E.

Table 3.4-1 Summary of Sierra Vista Park (MP01)

Table 3.4-1 Summary of Sierra Vista Park (MP01)		
Project Site Parameters	Total (Maximum) Drainage Area	2,928 ac
	Alternative (Minimum) Drainage Area	800 ac
	Maximum Required BMP Volume	178.6 ac-ft
	Alternative Required BMP Volume	48.6 ac-ft
	Groundwater Depth	80 ft
BMP Design Parameters	BMP Opportunity Area	0.7 ac
	Recommended Maximum BMP Depth	20 ft
	Available BMP Volume	14 ac-ft
	Recommended Active BMP Volume	**10.0 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Surfaced water can be utilized for aesthetic and other community benefits
- Water harvested can be utilized for a significant amount of on-site irrigation

3.5 SAN FERNANDO REGIONAL PARK

The park representing the San Fernando Regional Park is located within the City of San Fernando. The park includes open field space, baseball diamonds, community center, and pool facilities. The potential BMP type is proposed as a below-ground retention/infiltration basin situated beneath the open fields and baseball diamond at the southwest end of the park.

No maximum drainage area was identified for this site since it is located adjacent to a receiving waterbody, Pacoima Wash. After review of available site opportunities and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 423 acres.

After reviewing the hydrologic model results and estimated runoff volumes for the various diversion scenarios, it was determined that this site is suitable for an underground retention/infiltration BMP sized to accommodate more than the 85th percentile design storm runoff volume contributed from the smaller drainage area. As a result, the recommended active volume of the BMP is 22.6 acre-feet.

Table 3.5-1 summarizes key conceptual design parameters of the BMP proposed at San Fernando Regional Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the alternative (minimum) tributary drainage area can be found in Appendix E.

Table 3.5-1 Summary of San Fernando Regional Park (SF01)

Table 3.5-1 Summary of San Fernando Regional Park (SF01)		
Project Site Parameters	Total (Maximum) Drainage Area	N/A
	Alternative (Minimum) Drainage Area	423 ac
	Maximum Required BMP Volume	N/A
	Alternative Required BMP Volume	11.3 ac-ft
	Groundwater Depth	50 ft
BMP Design Parameters	BMP Opportunity Area	2.7 ac
	Recommended Maximum BMP Depth	20 ft
	Available BMP Volume	54 ac-ft
	Recommended Active BMP Volume	**22.6 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Water harvested can be utilized for on-site irrigation

3.6 LACY PARK

Lacy Park is a public park located within the City of San Marino in an area that drains to the Upper Los Angeles River. Park features include a picnic area heavily used by residents, open green space, two walking trails, and tennis courts. The potential BMP type proposed is a below-ground retention/infiltration basin situated in the center of the park beneath a depressed area of land that used to be a natural lake.

The maximum drainage area for this project site is approximately 1,067 acres. After review of available site information and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 928 acres.

After reviewing the hydrologic model results and estimated runoff resulting from the various diversion scenarios, it was determined that this is suitable for an underground retention/infiltration BMP sized to accommodate the 85th percentile design storm runoff volume contributed from the maximum drainage area. As a result, the recommended active volume of the BMP is 46.4 acre-feet.

Table 3.6-1 summarizes key conceptual design parameters of the BMP proposed at the Lacy Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the total (maximum) and alternative (minimum) tributary drainage areas can be found in Appendix E.

Table 3.6-1 Summary of Lacy Park (SM01)

Table 3.6-1 Summary of Lacy Park (SM01)		
Project Site Parameters	Total (Maximum) Drainage Area	928 ac
	Alternative (Minimum) Drainage Area	1,067 ac
	Maximum Required BMP Volume	46.6 ac-ft
	Alternative Required BMP Volume	40.0 ac-ft
	Groundwater Depth	145 ft
BMP Design Parameters	BMP Opportunity Area	2.4 ac
	Recommended Maximum BMP Depth	20 ft
	Available BMP Volume	48 ac-ft
	Recommended Active BMP Volume	**46.4 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Water harvested can be utilized for a significant amount of on-site irrigation

3.7 LOWER ARROYO PARK

Lower Arroyo Park is located within the City of South Pasadena in an area that drains to Aroyo Seco. A channelized portion of Arroyo Seco runs through the center of the proposed site parcel. Park facilities include two baseball diamonds, open field space, and playground equipment. The potential BMP type is proposed as a below-ground retention/infiltration basin situated beneath the baseball diamonds and other open field space in the southwest corner and northern portions of the park.

No maximum drainage area was identified for this site since it is located adjacent to a receiving waterbody, Arroyo Seco. After review of available site opportunities and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 145 acres.

After reviewing the hydrologic model results and estimated runoff volume for the various diversion scenarios, it was determined that this project site was suitable for a retention/infiltration BMP sized to accommodate more than the 85th percentile design storm flows contributed from the smaller alternative drainage area. As a result, the recommended active volume of the BMP is 3.7 acre feet.

Table 3.7-1 summarizes key conceptual design parameters of the BMP proposed at Lower Arroyo Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the alternative (minimum) tributary drainage area can be found in Appendix E.

Table 3.7-1 Summary of Lower Arroyo Park (SP01)

Table 3.7-1 Summary of Lower Arroyo Park (SP01)		
Project Site Parameters	Total (Maximum) Drainage Area	N/A
	Alternative (Minimum) Drainage Area	145 ac
	Maximum Required BMP Volume	N/A
	Alternative Required BMP Volume	0.06 ac-ft
	Groundwater Depth	25 ft
BMP Design Parameters	BMP Opportunity Area	10.6 ac
	Recommended Maximum BMP Depth	25 ft
	Available BMP Volume	265 ac-ft
	Recommended Active BMP Volume	**3.7 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Water harvested can be utilized for a significant amount of on-site irrigation

3.8 NORTH HOLLYWOOD PARK

North Hollywood Park is located within the City of Los Angeles in an area that drains to Tujunga Wash. Park facilities include an auditorium, baseball diamonds, basketball courts, playground, indoor gym, picnic tables, seasonal pool, and tennis courts. The potential BMP type is proposed as a below-ground retention/infiltration basin situated beneath open field space in the south and central areas of the park.

No maximum drainage area was identified for this site since it is located adjacent to a receiving waterbody, Tujunga Wash. After review of available site opportunities and surrounding infrastructure, a smaller (alternative) drainage area was delineated, encompassing approximately 5,122 acres.

After reviewing the hydrologic model results and estimated runoff volume for the various diversion scenarios, it was determined that this project site was suitable for a retention/infiltration BMP sized to accommodate the 85th percentile design storm flows contributed from the smaller alternative drainage area. As a result, the recommended active volume of the BMP is 38 acre feet.

Table 3.8-1 summarizes key conceptual design parameters of the BMP proposed at North Hollywood Park. A map of the project site including key infrastructure and highlighted BMP opportunity areas is provided in Appendix D. A map of the alternative (minimum) tributary drainage area can be found in Appendix E.

Table 3.8-1 Summary of North Hollywood Park (NHP)

Table 3.8-1 Summary of North Hollywood Park (NHP)		
Project Site Parameters	Total (Maximum) Drainage Area	N/A
	Alternative (Minimum) Drainage Area	5,122 ac
	Maximum Required BMP Volume	N/A
	Alternative Required BMP Volume	38.0 ac-ft
	Groundwater Depth	65 ft
BMP Design Parameters	BMP Opportunity Area	7.8 ac
	Recommended Maximum BMP Depth	20 ft
	Available BMP Volume	156 ac-ft
	Recommended Active BMP Volume	**38.0 ac-ft**

In addition to the volumetric features summarized above, it is envisioned that this site would feature the following potential benefits:

- Drains an urbanized area
- Stormwater capture and some infiltration
- Stormwater quality improvement via pre-treatment, retention, and infiltration
- Water harvested can be utilized for a significant amount of on-site irrigation

4 Estimated Costs

Comparative costs (derived from WMMS's comparative costs) are presented in Table 4-1. These comparative costs were developed based on unit costs for individual construction components including planning, design, and mobilization that were collected from the Los Angeles County Department of Public Works Bid History and local vendors that serve the Los Angeles area as part of the Phase II Report: Development of the Framework for Watershed-Scale Optimization Modeling, June 2011. These comparative costs include the estimated capital cost of the facility plus 20 years of estimated operation and maintenance costs. More detailed cost opinions (commensurate with a conceptual level of design completion) will be developed for each of the eight regional project sites, after feedback is received on this draft report.

Table 4-1 Estimated Cost Summary

Cluster ID	Site Description	Active Volume (AF)	Comparative Cost ($M)
AL01	Almansor Park	74.7	27.9
GL01	Fremont Park	8.0	1.5
LAC01	Roosevelt Park	8.4	33.0
MP01	Sierra Vista Park	10.0	2.3
SF01	San Fernando	22.6	7.5
SM01	Lacy Park	46.4	9.3
SP01	Lower Arroyo Park	3.7	21.4
NHP	North Hollywood Park	38.0	19.6

5 Next Steps

The following presents recommended next steps in the development of this memo:

- WMG Reviews Draft Memo and provides feedback on project type and size
- With this feedback the team will:
  - develop final cost opinions
  - incorporate feedback into final memo
  - and include projects in final RAA run, and the EWMP

6 References

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LACDPW. GIS Feature Class Name: NRCS_SOIL; Reference Date: 2004. LA County GIS Data Portal: http://egis3.lacounty.gov/dataportal/2011/01/27/soil-types/

Minnesota Pollution Control Agency. *Minnesota Stormwater Manual: Design Infiltration Rates.* http://stormwater.pca.state.mn.us/index.php/Design_infiltration_rates

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APPENDIX A

DESKTOP GEOTECHNICAL ANALYSIS

				Chino Silt Loam		Hanford Fine Sandy Loam		Hanford Gravelly Sandy Loam		Ramona Loam		Ramona Sandy Loam		Tujunga Fine Sandy Loam		Yolo Loam	
Cluster ID	Site Name	Total Area (ac)	Aggregate Infiltration Rate (in/hr)	Soil Area (ac)	% of Site Total	Soil Area (ac)	% of Site Total	Soil Area (ac)	% of Site Total	Soil Area (ac)	% of Site Total	Soil Area (ac)	% of Site Total	Soil Area (ac)	% of Site Total	Soil Area (ac)	% of Site Total
AL01	Almansor Park	133.6	0.70	0.0	0%	0.0	0%	0.0	0%	27.6	21%	92.8	69%	13.3	10%	0.0	0%
GL01	Fremont Park	9.4	0.30	0.0	0%	9.4	100%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
LAC01	Roosevelt Park	24.3	0.30	17.3	71%	7.1	29%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
MP01	Sierra Vista Park	2.5	0.30	0.0	0%	0.0	0%	0.0	0%	0.1	5%	0.0	0%	0.0	0%	2.3	95%
NHP	North Hollywood Park San	22.5	0.80	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	22.5	100%	0.0	0%
SF01	Fernando Regional Park	10.7	0.80	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	10.7	100%	0.0	0%
SM01	Lacy Park	26.7	0.39	0.0	0%	0.0	0%	0.0	0%	21.9	82%	4.8	18%	0.0	0%	0.0	0%
SP01	Lower Arroyo Park	25.5	0.80	0.0	0%	0.0	0%	25.5	100%	0.0	0%	0.0	0%	0.0	0%	0.0	0%

Hydrologic Soil Group	Infiltration Rate (in/hr)	Soil Textures	Corresponding Unified Soil Classification	
			Symbol	Description
A	1.63	gravel	GW	well-graded gravels, sandy gravels
	1.63	sandy gravel	GP	gap-graded or uniform gravels, sandy gravels
	1.63	silty gravels	GM	silty gravels, silty sandy gravels
	1.63		SW	well-graded gravelly sands
	0.8	sandy gravel	SP	gap-graded or uniform sands, gravelly sands
	0.8	loamy sand		
	0.8	sandy loam		
B	0.45		SM	silty sands, silty gravelly sands
	0.3	loam, silt loam	MH	micaceous silts, diatomaceous silts, volcanic ash
C	0.2	sandy clay loam	ML	silts, very fine sands, silty or clayey fine sands
D	0.06	clay loam	GC	clayey gracels, clayey sandy gravels
	0.06	silty clay loam	SC	clayey sands, clayey gravelly sands
	0.06	sandy clay	CL	low plasticity clays, sandy or silty clays
	0.06	silty clay	OL	organic silts and clays of low plasticity
	0.06	clay	CH	highly plastic clays and sandy clays
	0.06		OH	organic silts and clays of high plasticity

APPENDIX B

FIELD INVESTIGATION FINDINGS

ULAR Site Tour Summary by Black & Veatch

SP01: Lower Arroyo Park

Day 1 Stop # 1, 8:30 AM

General:

- Mikki Klee, a consultant representing the City of South Pasadena, met us onsite and attended the site walk.
- No underground network shows up on GIS or Navigate LA. Based on surface grates, there appears to be SD piping within the park site, South Pasadena will review.
- Park appears to be graded to generally slope to the east towards the open channel
- Soil data unknown but permeable soils are not likely present.
- Park contains two baseball fields and a playground. Construction phasing may take one baseball field out of commission at any given time to minimize disruptions.
- Natural vegetated swale west of San Ramon Drive drains to a pooled area that acts as a natural basin (may be able to repurpose in some way, possibly with small hydraulic modifications) 9
- City is open to surface BMPs if necessary, but not in areas such as ball fields or parking lots.
- It appears that the residential area to the east drains towards the park .

Channelized portion of the Arroyo Seco running through center of parcel area

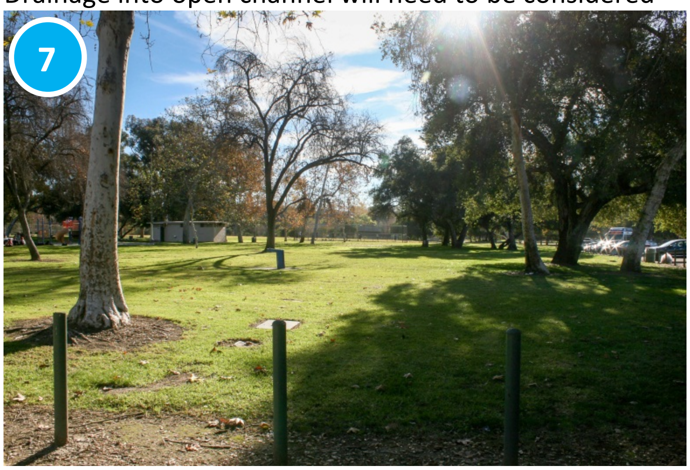
Parking lot south on San Ramon Drive

Playground in southeastern corner of parcel area

Baseball field in southwestern corner of parcel area

Drainage grate and connecting system will need to be considered

Drainage into open channel will need to be considered



San Pascual Ave & Comet St where SD enters park area

Catch basin on San Pascual Ave

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

9 This area may include an existing swale/biofilter.

SM01: Lacy Park

Day 1 Stop # 2, 10:00 AM

- Ron Serven with the City of San Marino met us onsite and attended the site walk.
- Large diameter storm drain runs through the center of the park (immediate drainage from park & surrounding areas including the Huntington Library and the Yard). This storm drain was installed to drain a natural lake used to exist in the center of the park. It was discussed that this location could be used for a buried tank at the low point with spread infiltration.
- Wooded areas will need to be avoided.
- A project that will allow for infiltration of drainage off of the road interloop is in the works.
- Men's pick up soccer league and other team utilize the field, must maintain surface use.

Depression in center of park where natural lake used to exist

Trees along north side

Playground on western side of park

Park heavily used by surrounding community for sports/walking/playing/gatherings

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

AL01: Almansor Park

Day 1 Stop # 3, 11:00 AM

- David Dolphin, with the City of Alhambra Public Works Department, met us onsite and attended the site walk.
- Generally, the City is amenable to use of Almansor Park for buried solutions. The Golf Course and Pond area are not considered opportunity areas.
- Catch basins and storm drain along Adams Ave are county-owned & feed into Alhambra Wash near intersection of Adams Ave and New Ave.
- May be able to divert drainage from Alhambra Wash if a large watershed is treatable here.
- Walking trail around Almansor park heavily used by local residents.

Alhambra Wash runs along the east side of the Golf Course

Dry-weather flow in Alhambra Wash

Adams Ave looking west towards Granada Ave

Lower parking lot appears to have deep storm drain below

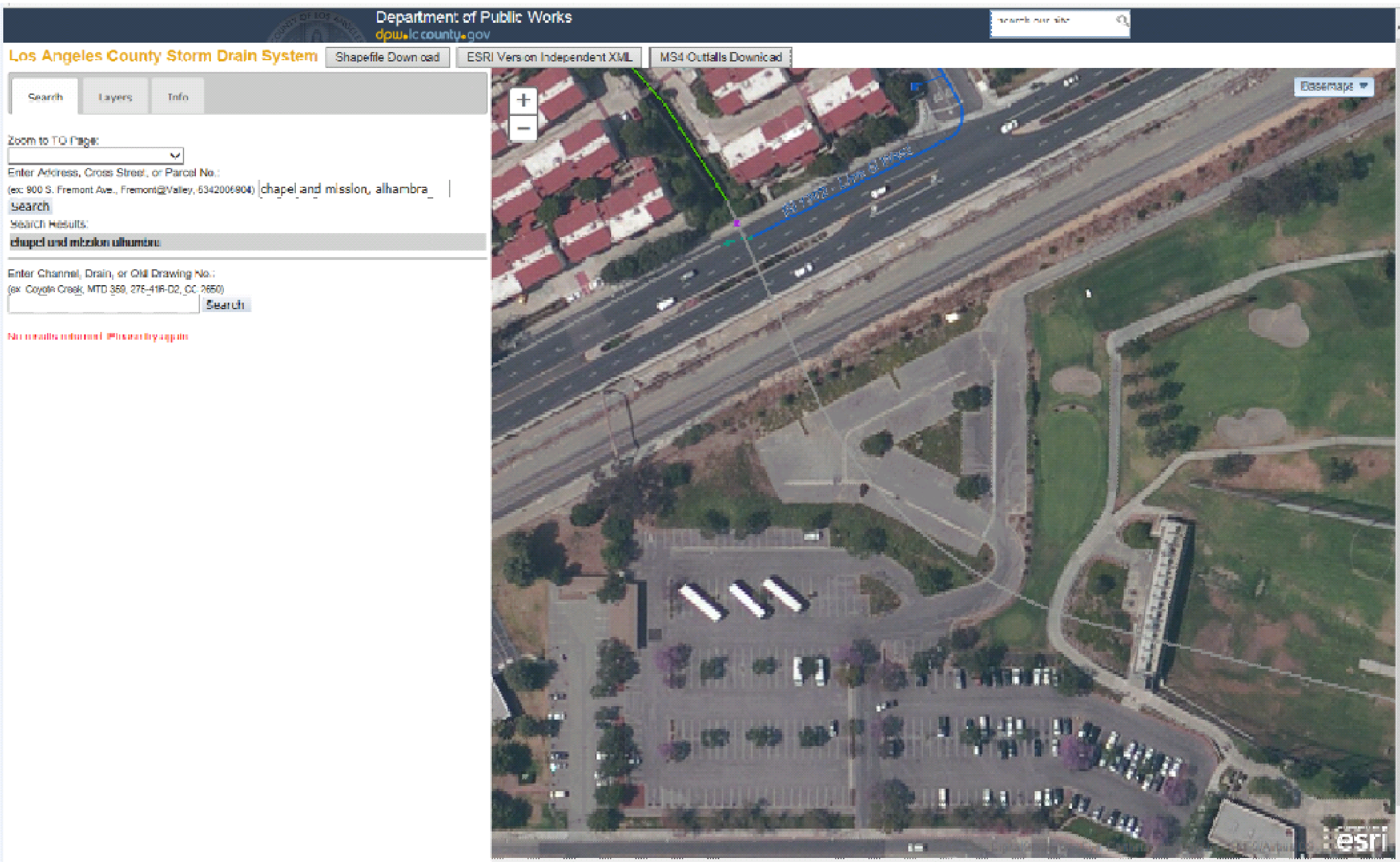
Baseball field on west side of parcel area

Railroad tracks along northwestern side of parcel area

The Public works yard, although situated on the wash, is not viewed as an opportunity area by the City

Lake area is not viewed as an opportunity area by the City

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.



Storm drain layout in lower parking lot area of Golf Course. Storm drain appears to discharge into 24-inch line connected to San Pasqual Wash, which runs underground through the Golf Course.

MP01: Monterey Park

Day 1 Stop # 4, 2:00 PM

- Mikki Klee, a consultant representing the City of Monterey Park, and Chris Arriola, with the City of Monterey Park met us onsite and attended the site walk.
- They City considers the baseball field to be the opportunity area for underground detention. Construction impacts may be a concern.
- Both the park itself and parking lot appears to be highly used by local residents.
- Park set a few feet above grade of surrounding streets.
- Storm drains on Atlantic & Garvey are likely very deep, but City will confirm or obtain drawings.

Playground in northwestern corner of park

Northeastern corner of park on Emerson Ave & Rural Dr

Intersection of Rural Dr & Garve Ave looking towards Sierra Vista Park (very flat from park to intersection where strom drain is located)

Catch basin on Rural Dr near Garvey Ave

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

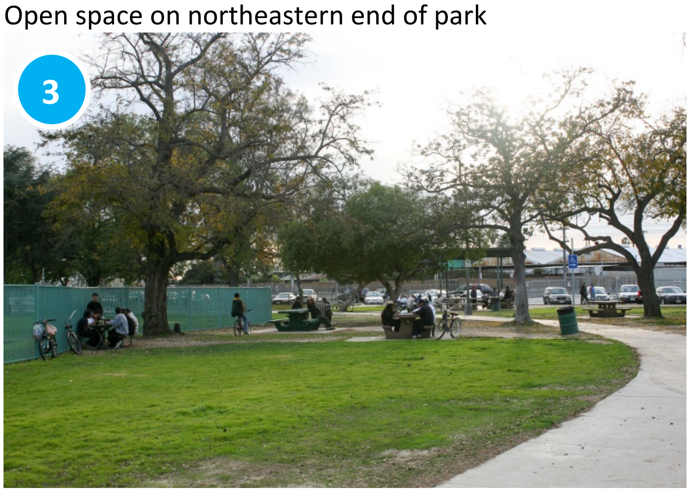
LAC01: Roosevelt Park

Day 1 Stop # 5, 3:30 PM

- Aaron Chiang, with the County of Los Angeles Department of Public Works, met us onsite and attended the site walk.
- County has already investigated multiple BMP options:
  - Infiltration basin on north end of park
  - Dry wells to the east and west of the park
- Aaron noted that they have found the upper 15’ to be clay, layers below that have much higher infiltration rates.
- Entire park appears to be heavily utilized (typ.) for recreational activities including basketball courts, skate park, children’s play area, and sitting area.
- Preliminary calculations done by County show 6 af for 85th percentile.

Open space on northeastern end of park

Open space on northeastern end of park



Park heavily used by local residents

Baseball field on southern end of park

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

SF01: San Fernando

Day 2 Stop # 1, 9:00 AM

- Joe Bellomo, a consultant representing the City of San Fernando, met us onsite and attended the site walk.
- According to Joe, approximately ¾ of the City's drainage is captured in two parallel SDs surrounding the park. He added that the City has 8 outlets, SD near park captures ~2/3 of the City's drainage.
- Based on soils observed in nearby rail embankment/channel, reasonable infiltration rates may be found here.
- Joe mentioned new park was built last year off of 8th St to capture surface runoff.

Baseball field on southern end of park

Baseball field on southern end of park

1st St where major storm drain runs beside park

Railroad tracks on west side of 1st St

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

NHP: North Hollywood Park

Day 2 Stop # 2, 10:15 AM

- Jane Parathara and Bing Neris representing the City of Los Angeles attended this and all 8 site visits.
- Park is heavily used (walkers, people walking dogs)
- Great number of mature trees all over north end of park
- Middle and south end of park contains less mature trees
- Could potentially pipe storm drains from north end of park to center of park where less mature trees are located and could be removed
- Park does not include many large open spaces, but more smaller pockets dispersed throughout park between a large number of trees
- Jane acknowledged that the City may have a concept developed for this site. She will review with Deborah Deets who may know of the concept.

Channelized portion of the Central Branch of the Tunjunga Wash bordering west side of park

Dry-weather flow in open channel

Mature trees on north end of park

Less mature trees in center of park area

9/11/2001 Memorial

Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

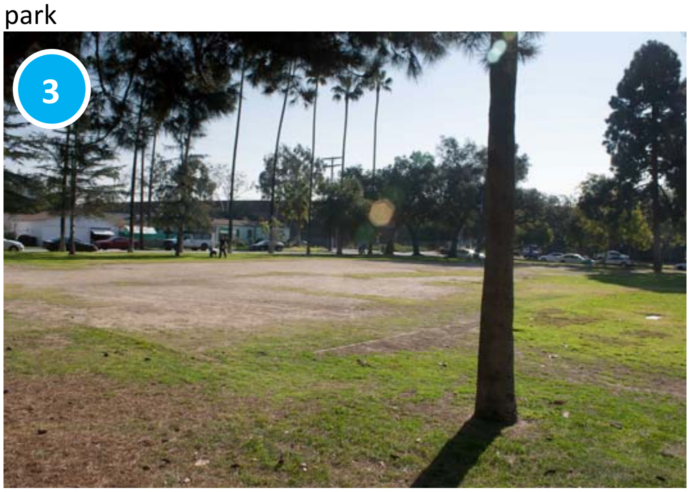
GL01: Fremont Park

Day 2 Stop # 3, 11:30 AM

- Michael Lundsford from the City of Glendale and Mikki Klee, a consultant representing the City, met us onsite and attended the site walk.
- Could potentially capture drainage from piped storm drain on east side of park and pipe to open area on east side of park. Storm drain outlet into channel is approximately 30’ deep, which could be challenging and may require pumping.
- Approximately half of the 200ac watershed in storm drain is in Caltrans right of way (drainage off of 134 freeway).

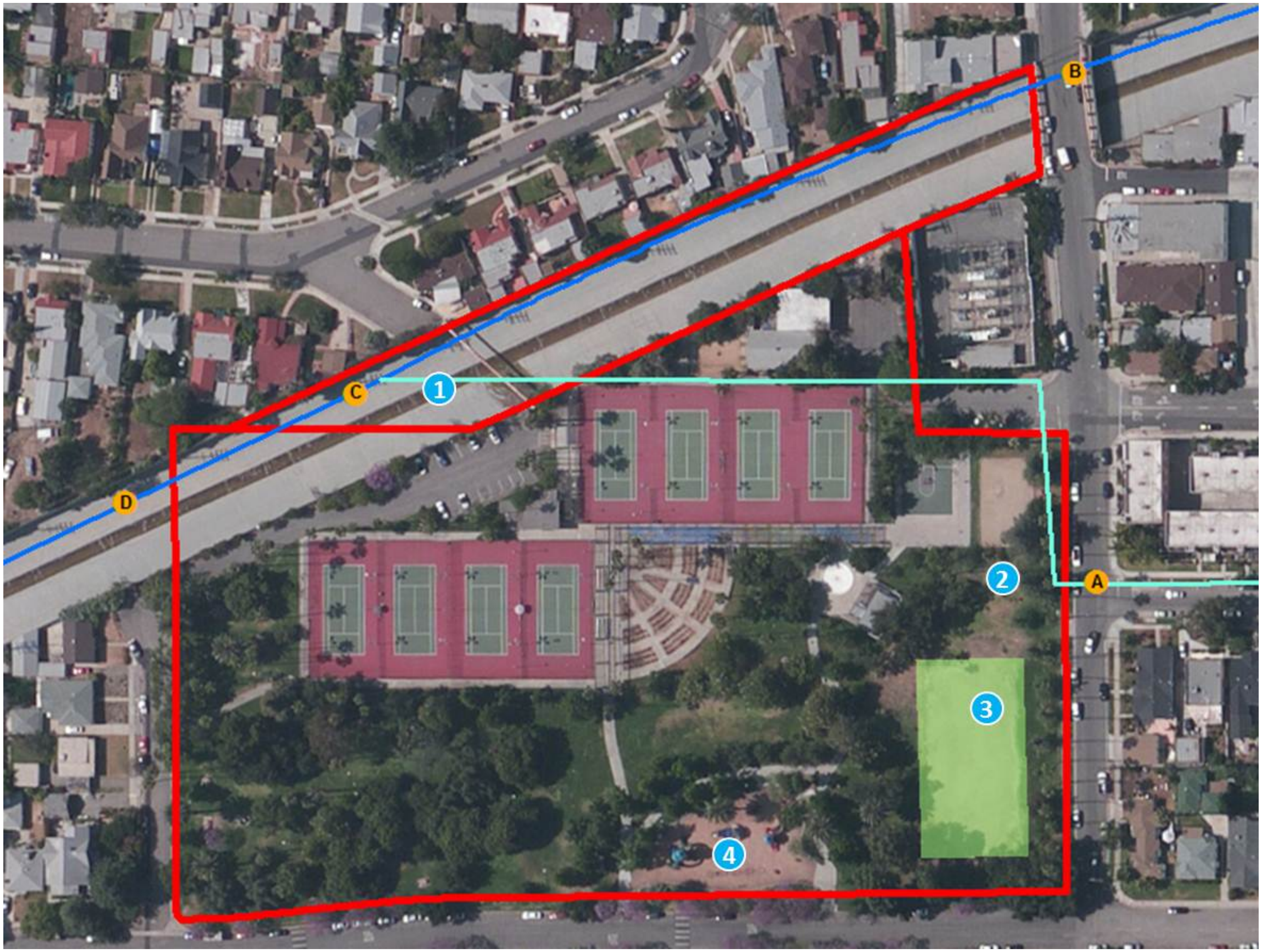
Channelized portion of Verdugo Wash on north side of park

Heavily used tables on eastern side of park



Open area on east side of park. Currently utilized for parking periodically.

Playground in southwestern area of park



Opportunity Areas (highlighted in green) would likely include subsurface BMPs.

Summary Environmental Constraints: Upper Los Angeles River Watershed Regional Projects

SF01 – Recreation Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **HAZ:** Potential contamination (lead) site identified 350 feet east of Recreation Park. Additional due diligence may be required to determine is contamination has migrated; may increase time for site-specific CEQA compliance.
- **WQ:** Remote possibility that contamination has migrated to site, and for infiltration to occur in or above the contamination (if present); may increase time for project design and site-specific CEQA compliance.
- **NOI:** Potential for construction to generate noise in excess of City limit (at property line) of 70 dBA; may increase time for site-specific CEQA compliance.
- **REC:** Temporary loss of recreational areas of Recreation Park is likely to require close coordination between the City of San Fernando, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. Increased site-specific CEQA compliance time.

NHP – North Hollywood Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could destroy protected trees; may increase time for site-specific CEQA compliance.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **NOI:** City LA has construction noise thresholds that may increase the length of time required for individual project approvals and CEQA compliance.
- **REC:** Temporary closure of a large portion of North Hollywood Park during construction is likely to require close coordination between the City of Los Angeles, local residents, and community stakeholders to develop suitable mitigation options for addressing impacts to passive recreational uses of the park. Increased site-specific CEQA compliance time.

GL01 – Fremont Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could destroy protected trees; may increase time for site-specific CEQA compliance.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **REC:** Temporary closure of a portion of Fremont Park during construction will likely to require close coordination between the City of Glendale, local residents, and community stakeholders to develop suitable mitigation options for addressing impacts to Fremont Park. Increased site-specific CEQA compliance time.

SP01 – Arroyo Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could destroy protected trees; may increase time for site-specific CEQA compliance.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **REC:** Temporary closure of the recreational uses within Arroyo Park is likely to require close coordination between the City of South Pasadena, City of Los Angeles (a small section of the park west of the Arroyo Seco appears to be located within the City of Los Angeles), local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. Increased site-specific CEQA compliance time.

SM01 – Lacy Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal will require City approval; may increase time for site-specific CEQA compliance.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **REC:** Temporary closure of the central portion of Lacy Park is likely to require close coordination between the City of San Marino, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary closure. Increased site-specific CEQA compliance time.

AL01 – Almansor Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal will require City approval.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **NOI:** Although construction at Almansor Park will not conflict with City noise regulations, several schools located nearby (Martha Baldwin Elementary School and Emmaus Lutheran Preschool), and implementation of noise reducing measures may be prudent during construction.
- **REC:** Temporary closure of the recreational uses within Almansor Park is likely to require close coordination between the City of Alhambra, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. Increased site-specific CEQA compliance time.

MP01 – Sierra Vista Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal will require city approval.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **REC:** Temporary closure of the recreational uses within Sierra Vista Park is likely to require close coordination between the City of Monterey Park, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. Increased site-specific CEQA compliance time.

LAC01 – Franklin D. Roosevelt Park

- **AQ:** Construction emissions in excess of thresholds; may increase time for site-specific CEQA compliance.
- **AQ:** Cumulative AQ impacts may increase time for site-specific CEQA compliance.
- **AQ:** Air pollutant concentrations from construction may increase time for site-specific CEQA compliance.
- **BIO:** Tree removal could disturb active nests (violation of Migratory Bird Treaty Act); may increase time for site-specific CEQA compliance.
- **CUL:** Archeological resources may be present; should be addressed during site specific CEQA compliance.
- **CUL:** Paleontological resources may be present; should be addressed during site specific CEQA compliance.
- **NOI:** Although construction at Franklin D. Roosevelt Park will not conflict with County noise regulations, a Head Start preschool is located onsite, and implementation of noise reducing measures may be prudent during construction.
- **REC:** Temporary closure of large portions of Franklin D. Roosevelt Park will require close coordination between the County of Los Angeles, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational areas. Increased site-specific CEQA compliance time.

Initial Study/
Environmental Constraints Evaluation

For

the Eight Recommended Regional Projects
within the Upper Los Angeles River Watershed

February 2015

City of Los Angeles

Bureau of Engineering
Watershed Protection Division

1.0 INTRODUCTION

National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit (MS4 Permit) Order No. R4-2012-0175 establishes the waste discharge requirements for stormwater and non-stormwater discharges within the watersheds of Los Angeles County. This MS4 Permit was adopted by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), on November 8, 2012, and became effective on December 28, 2012.

The MS4 Permit includes provisions that allow permittees the flexibility to customize their stormwater programs to achieve compliance with certain receiving water limitations and water quality based effluent limits over time. Specifically, permittees may voluntarily choose to develop and implement an Enhanced Watershed Management Program (Program). The Program includes prioritization of water-quality issues, identification of implementation strategies, control measures, and Best Management Practices (BMPs) sufficient to meet pertinent standards, integrated water-quality monitoring, and opportunity for stakeholder input. Through the Program, permittees will implement projects to improve water quality, and also have incentives to evaluate and, where feasible, implement regional projects that retain all non-stormwater runoff and all stormwater runoff from the 85th percentile, 24-hour storm event for the drainage area tributary to those projects.

Municipalities, non-governmental organizations and community stakeholders throughout the County of Los Angeles are working collaboratively to develop Enhanced Watershed Management Plans for each of LA's five watersheds - Ballona Creek, Dominguez Channel, Marina Del Rey, Santa Monica Bay and Upper Los Angeles River. The objectives of the Enhanced Watershed Management Plans (or EWMPs) are to comply with water quality mandates, improve the quality of our rivers, creeks and beaches, and address current and future regional water supply issues.

Each of the five watersheds has a Watershed Management Group that meets on a regular basis. The goal of each Watershed Management Group is to develop an EWMP for their specific watershed. Each EWMP will identify current and future multi-benefit projects that will improve water quality, promote water conservation, enhance recreational opportunities, manage flood risk, improve local aesthetics, and support public education opportunities. Each EWMP will include water quality priorities, watershed control measures, reasonable assurance analysis, the scheduling of projects and the monitoring, assessment and adaptive management of projects. The Upper Los Angeles River Watershed Management Group has developed a list of eight very high priority Regional Projects for implementation, which has been submitted to the Regional Water Quality Control Board for approval.

The Los Angeles County Flood Control District is in the process of preparing a Program EIR (Program EIR) to address the environmental impacts associated with implementing EWMPs within 12 watersheds in the MS4 permit coverage area. One of these watersheds is the Upper Los Angeles River Watershed. The Program EIR will focus on potential effects that could result from implementation of the projects and management actions identified in each EWMP, and would assess the physical changes to the environment that would likely result from the construction and operation of EWMP projects, including direct, indirect, and cumulative impacts.

The purpose of this environmental constraints evaluation is to identify potential site-specific environmental constraints associated with each of the recommended eight structural Regional Projects within the Upper Los Angeles River Watershed, including increased time requirements to address issues, obtain project approvals (including CEQA compliance).

2.0 PROJECT DESCRIPTION

2.1 Project Location

2.1.1 Regional Setting

The Upper Los Angeles River Watershed is located on the Los Angeles Coastal Plain south of the San Gabriel Mountains. The watershed encompasses large portions of the San Fernando Valley; east into Pasadena, South Pasadena, San Marino, Alhambra, Monterey Park; south into Los Angeles and south Los Angeles (see Figure 1). The Upper Los Angeles River Watershed is largely urbanized.

2.1.2 Project Setting

Eight structural Regional Projects are recommended for implementation, and the general settings at each location, are as follows:

- SF01 - Recreation Park in the City of San Fernando. The site includes a multi-purpose center, indoor gymnasium, an active recreational field (softball), outdoor basketball courts, playgrounds, fitness area, and picnic areas. The San Fernando Regional Pool facility is located on the northern portion of the site. Mature trees are located along the periphery and some interior areas around the active field. Surrounding land uses include single and multi-family residential units to the west, commercial/industrial uses to the east, the Pacoima Wash to the southeast, and railroad right-of-way to the southwest. The operating hours for the park are sunrise to 9 p.m. daily.
- NHP – North Hollywood Park in the City of Los Angeles. The southern part of North Hollywood Park (located south of Magnolia Boulevard is a landscaped area that includes mature trees, and walking paths. The trees are interspersed throughout the open space. A September 11, 2001 memorial is located bear the west border in approximately the middle of the park. Commercial and multi-family uses are located to the east across Tujunga Avenue, and the Tujunga Wash and Hollywood Freeway to the west.
- GL01 - Fremont Park in the City of Glendale. The site includes tennis courts, a basketball court, playgrounds, horseshoe pits, picnic areas with barbecues, and wading pool. A field is also located along the eastern portion of the park. Mature trees are present at the site and along the periphery. Surrounding land uses include single and multi-family residential units to the west, south and east of the park, and the Verdugo Wash to the north of the park. The operating hours for the park are sunrise to sunset daily.
- SP01 - Arroyo Park in the City of South Pasadena. Arroyo Park is bisected by the Arroyo Seco. the site east of the Arroyo Seco includes multiple lighted athletic fields (baseball, softball and soccer), playground equipment, picnic areas, small amphitheater, .and hiking trails. The park located west of the Arroyo Seco includes a baseball field and open space. Both sites include mature trees. Surrounding land uses are primarily single family residences (in the vicinity of the west site. The San Pascual Stables are located to the north of the park and San Pascual Avenue. The park does not have designated operating hours. (South Pasadena, 2015c).
- SM01 – Lacy Park in the City of San Marino. The site includes a central landscaped green space with an inner and outer walkway around the perimeter. The perimeter of the green space is has been planted with trees of varying species, and most are mature. Site uses include tennis courts, picnic areas, playground, and small field. Surrounding land uses are primarily single-family homes. The operating hours for the park is Monday - Friday: 6:30 a.m. to Sunset, and Saturday -

Sunday: 8:00 a.m. to 8:00 p.m. (March 13–November 5) or 8:00 a.m. to 6:00 p.m. (November 6–March 12).

- AL01 – Almansor Park in the City of Alhambra. The site includes open space areas, picnic tables with covered shelters, playground equipment, barbecues, restrooms, ball fields, tennis courts, horseshoe pits, exercise par course, meeting room, activity room, gymnasium, outdoor basketball court, a small lake, and a jogging course. Mature trees are located along the periphery. Surrounding land uses include single-family residences to the south and west, Alhambra Golf Course to the immediate east, and the Alhambra Fire Training Facility and Alhambra Wash farther to the east. In addition, the Martha Baldwin Elementary School, Emmaus Lutheran School, and Emmaus Lutheran Church are contiguous to the park. The operating hours for the park are 5:00 a.m. to 10:30 p.m. daily. .
- MP01 - Sierra Vista Park in the City of Monterey Park. The site includes a softball field, outdoor basketball and paddle tennis court, children's play area, picnic area, and community center. Mature trees are located along the periphery. Surrounding land uses include single- and multi-family residences. The operating hours for the park are 6:00a.m. - 10:00 p.m. daily.
- LAC01 – Franklin D. Roosevelt Park in the County of Los Angeles. The site includes basketball courts, children's play areas, soccer fields, ball fields, a community center, computer center, fitness zone, gymnasium, skate park, picnic areas with barbecue grills, and senior center. In addition, a Head Start preschool operated by the Mexican American Opportunity Foundation is located at the park. The operating hours for the park are sunrise to sunset, daily. Surrounding land uses include single-family residences to the north and east of the park, commercial and residential to the south, and railroad right-of-way to the west.

2.2 Goals and Objectives

The purpose of the Regional Projects is to improve water quality and help the Cities and County comply with the MS4 permit discharge requirements for stormwater and non-stormwater discharges within the Upper Los Angeles River Watershed.

2.3 Description of Proposed Project

The Regional Projects are defined by the MS4 Permit as multi-benefit regional projects that, wherever feasible, retain all non-stormwater runoff and all stormwater runoff from the 85th percentile, 24-hour storm event for the contributing drainage area, while also achieving other benefits such as flood control and/or water supply. The proposed eight Regional Project sites within the Upper Los Angeles River Watershed would include one or more of the following at each site:

- Infiltration Projects, that could include surface infiltration devices (infiltration basins, infiltration trenches, infiltration galleries, and bio-retention approaches.
- Multi-Directional Infiltration Projects that could include devices such as dry wells, and/or hybrid bio-retention and dry wells.
- Detention Basins that promote settling out of larger particles.
- Capture and Use Projects such as underground cisterns, storage facilities to make captured water available for uses such as irrigation.

The Regional Projects would install and operate infiltrations structures, detention basins, and/or capture and use structures at eight locations (eight parks) within the Upper Los Angeles River Watershed, as described above. The infiltrations structures, detention basins, and/or capture and use structures would likely be located underground at each of the park sites, with possible bio-retention approaches in select areas.

The water quality improvements proposed at each of the Regional Project sites within the Upper Los Angeles River Watershed are as follows:

- SF01-Recreation Park: Buried Infiltration structure, capture and use facility, or detention basin.
- NHP-North Hollywood Park: Buried Infiltration structure, capture and use facility, or detention basin.
- GL01-Fremont Park: Buried Infiltration structure, capture and use facility, or detention basin.
- SP01-Arroyo Park: Buried Infiltration structure, capture and use facility, or detention basin, with possible bio-retention in suitable areas.
- SM01-Lacy Park: Buried Infiltration structure, capture and use facility, or detention basin.
- AL01 – Almansor Park: Buried Infiltration structure, capture and use facility, or detention basin.
- MP01 – Sierra Vista Park: Buried Infiltration structure, capture and use facility, or detention basin.
- LAC01-Franklin D. Roosevelt Park: Buried Infiltration structure, capture and use facility, or detention basin.

In addition, accessory improvements would be required at each Regional Project site to make connections with nearby storm drains, as well as other improvement such as wells, pump stations, and electrical connections and controls.

2.4 Regional Project Construction

Construction of each of the Regional Projects is expected to take between 12-18 months, and would involve mobilization (of materials and equipment), excavation and shoring, haul away of soils, construction of the infiltration, detention, or capture and use structure (likely to be cast-in-place concrete), accessory improvements such as storm drain connections, equipment installation, backfilling, and surface restoration. Because the project sites are all park areas, the construction areas would have to be physically separated from the remaining park areas and screened. Due to the large quantities of runoff that would be infiltrated, detained, or captured, the subsurface structures would likely occupy substantial subsurface portions of the identified sites. Following construction of the facilities, surface features at each location would be restored to existing conditions or better.

2.5 Regional Project Operations

Once the Regional Projects are completed and commissioned, they would operate automatically, although their operation would be monitored and adjustments made on an as-needed basis, including during wet weather. The majority of the Regional Project would have subsurface components and their operation would not be detectible or apparent at the site surface. Small above-ground structures that house control equipment may be required.

Regional Projects that utilize approaches at the site surfaces (such as bio-retention) could periodically fill with retained runoff, and preclude other uses of those areas until percolation has been completed and the areas dry enough to support other uses.

2.6 Anticipated Permits and Approvals

Approvals or permits from the following agencies are expected to be required:

- City of Alhambra
- City of Glendale
- City of Los Angeles
- City of Monterey Park
- City of San Marino

- City of South Pasadena
- City of San Fernando
- County of Los Angeles
- State and Regional Water Quality Control Boards
- Others?

3.0 Initial Study Checklist

Potential environmental constraints associated with the Regional Projects are addressed in the Initial Study Checklist and detailed discussions are provided below.

Environmental Checklist Form

1. Project Title:	Upper Los Angeles River Regional Projects
2. Lead Agency Name and Address:	Varies depending on jurisdiction of each Regional Project (City of Alhambra, City of Glendale, City of Los Angeles, City of Monterey Park, City of San Marino, City of South Pasadena, City of San Fernando, and County of Los Angeles)
3. Contact Person and Phone Number:	Jim Rasmus, Black and Veatch (858) 945-8675
4. Project Location:	City of Alhambra, City of Glendale, City of Los Angeles, City of Monterey Park, City of San Marino, City of South Pasadena, City of San Fernando, and County of Los Angeles
5. Project Sponsor's Name and Address:	Bureau of Sanitation Watershed Protection Division1149 S. Broadway, 10th Floor Los Angeles, CA 90015
6. General Plan Designations:	Varies (Open Space)
7. Zoning:	Varies (includes OS, OS-1XL, SR – special recreation)
8. Description of Project:	The proposed Project consists of installation and operation of runoff infiltration and/or capture and use facilities at eight (8) locations within the Upper Los Angeles River Watershed. Facility options include underground stormwater and runoff detention facilities, underground infiltration facilities, and surface treatment features. Ancillary improvements, including connector pipelines to nearby storm drains, and/or pump stations or wet wells would be included.

Environmental Factors Potentially Affected:

The environmental factors checked below would potentially be affected by the Regional Projects (i.e., the proposed Project would involve environmental constraints, as indicated by the checklist on the following pages).

	Aesthetics		Agriculture and Forest Resources	X	Air Quality
X	Biological Resources	X	Cultural Resources		Geology/Soils
	Greenhouse Gas Emissions	X	Hazards and Hazardous Materials	X	Hydrology/Water Quality
	Land Use/Planning		Mineral Resources	X	Noise
	Population/Housing		Public Services	X	Recreation
	Transportation/Traffic		Utilities/Service Systems	X	Mandatory Findings of Significance

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
I.	**AESTHETICS.** Would the project:				
a.	Have a substantial adverse effect on a scenic vista?			X	
b.	Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings along a scenic highway?			X	
c.	Substantially degrade the existing visual character or quality of the site and its surroundings?			X	
d.	Create a new source of substantial light or glare that would adversely affect daytime or nighttime views in the area?			X	

Discussion:

a. Would the project have a substantial adverse effect on a scenic vista?

A scenic vista generally provides focal views of objects, settings, or features of visual interest; or panoramic views of large geographic areas of scenic quality, primarily from a given vantage point. Substantial constraints occur if the Regional Projects introduce incompatible visual elements within a field of view containing a scenic vista or substantially alters a view of a scenic vista.

No Environmental Constraints.

- SF01 - Recreation Park. Recreation Park is located in an urbanized portion of the City of San Fernando and is not located within a Scenic Vista. Further, the improvements at this site would likely be buried features with the park surface restored to the same or better condition than currently exists.

- NHP – North Hollywood Park. North Hollywood Park is located in the City of Los Angeles' North Hollywood Community in an urbanized area, and is not located within a Scenic Vista. The improvements at this site would occur underground, and the park surface restored to the same or better condition than currently exists.

- GL01 – Fremont Park. Fremont Park, located in the City of Glendale just north of SR134 and south of the Verdugo Wash, is not located within a Scenic Vista. The improvements would place subsurface structures at this site, with the park surface restored to the same or better condition than currently exists.

- SP01 – Arroyo Park. Arroyo Park is located in South Pasadena along the Arroyo Seco north of the Pasadena Freeway. Although a ridgeline is present along the east side of Arroyo Park, the future improvements at this site would likely be buried and surface features restored to the same or better condition than currently exists. A small area of surface bio-treatment features could be added between the wash and San Ramon Drive. None of the proposed improvements would block views of the surrounding hillside, and no scenic vistas would be adversely affected.
- SM01 – Lacy Park. Lacy Park is located within a residential neighborhood in the City of San Marino. There are no designated scenic vistas in Lacy Park. The improvements would place subsurface structures at this site, with the park surface restored to the same or better condition than currently exists.
- AL01 – Almansor Park. Almansor Park is located adjacent to a single-family residential area and the Alhambra Golf Course in the City of Alhambra. This park is not located within a Scenic Vista. The improvements at this site would likely be buried and surface features would be restored to the same or better condition than currently exists.
- MP01 – Sierra Vista Park. Sierra Vista Park is located in a mixed residential area in the City of Monterey Park. This park is not located within a Scenic Vista. The improvements at this site would likely be buried and surface features would restored to the same or better condition than currently exists.
- LAC01 – Franklin D. Roosevelt Park. Franklin D. Roosevelt Park is located in a mixed residential and urbanized area in the southern portion of the County of Los Angeles. This park is not located within a Scenic Vista. The improvements at this site would likely be buried and surface features would be restored to the same or better condition than currently exists.

b./c. Would the project substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?

Would the project substantially degrade the existing visual character or quality of the site and its surroundings?

No Environmental Constraints. The Regional Project improvements would not have the potential to damage scenic resources within a state scenic highway because none of the activities would be located near an eligible or designated state scenic highway. The California Department of Transportation (Caltrans) is responsible for the official nomination and designation of eligible scenic highways. The nearest officially designated state scenic highway (State Highway 2, from approximately three miles north of Interstate [I]-210 in La Cañada to the San Bernardino County Line) (California Department of Transportation, 2013) is located approximately 6 miles northeast of the nearest Regional Project (GL01 – Fremont Park).

The nearest eligible state scenic highway (State Highway 1, from State Highway 19 near Long Beach to I-5 south of San Juan Capistrano) (California Department of Transportation, 2013) is approximately 14 miles southeast of the nearest Regional Project (LAC01 – Franklin D. Roosevelt Park). None of the Regional Projects are visible from either of these State Scenic Highways; therefore, the Regional Projects would not adversely affect the quality of the scenic views from these locations.

In addition, the following summarizes specific details regarding scenic resources at each Regional Project site:

- SF01 - Recreation Park. Recreation Park is located between industrial development to the east and residential structures along to the west. The buried water quality improvement structures Recreation Park would not be visible, and the surface would be restored to the same or better condition than currently exists following construction. As such, the improvements at Recreation Park are not expected to result in adverse effects to scenic resources or result in significant adverse impacts to visual character of the area.

- NHP – North Hollywood Park. The area of North Hollywood Park proposed for the water quality improvement facilities is a well-used landscaped open space with various mature and less mature trees. The water quality improvements at this site would likely be subsurface facilities that would not be visible. Further, the park surface would be restored to the same or better condition than currently exists following construction. As such, the improvements at North Hollywood Park are not expected to result in adverse effects to scenic resources or result in significant adverse impacts to visual character of the area.

- GL01 – Fremont Park. Fremont Park is landscaped and includes various active and passive recreational uses. There are no designated scenic highways in the City of Glendale. The Open Space and Conservation Element of the General Plan identify several "urban hikeways" in an effort to provide opportunities for citizens and visitors to discover Glendale's unique urban form. Three self-guided routes cross through downtown Glendale, highlighting the Financial/Fremont Park District, the Brand Shopping District, and the Civic Center District. Although Fremont Park is located along one of the hikeways, the water quality improvements at this site would likely be subsurface facilities that would not be visible, once completed. Further, the park surface would be restored to the same or better condition than currently exists following construction. As such, the improvements at Fremont Park are not expected to result in adverse effects to scenic resources or result in significant adverse impacts to visual character of the area.

- SP01 – Arroyo Park. Arroyo Park is landscaped, and contains active and passive recreational uses. Trees are located throughout the park. This park is not located along a locally designated scenic highway; however, as stated in the City's Open Space and Resource Conservation element of the General Plan, it is considered a valued resource by the City of South Pasadena. The subsurface water quality improvements at this site would not be visible. There is the potential for surface bio retention improvements to be added between the wash and Stoney Drive; however, these improvements are expected to be consistent with the open space setting of the park and would not introduce incompatible structures. Further, the park surfaces would be restored to the same or better condition than currently exists following construction. As such, the improvements at Arroyo Park are not expected to result in adverse effects to scenic resources or result in significant adverse impacts to visual character of the area.

- SM01 – Lacy Park. Lacy Park is located within a residential neighborhood in the City of San Marino. The center of Lacy Park serves as an open expanse which is highlighted as a resource in the City's General Plan. The proposed improvements would be located beneath the ground surface in the central area of lacy park; however, because the improvements would be subsurface and the park surfaces restored to existing conditions or better, the improvements are not expected to adversely affect the central area as a scenic resource.

- AL01 – Almansor Park. Almansor Park is located adjacent to a single-family residential area and the Alhambra Golf Course in the City of Alhambra. The improvements at this site would likely be buried and surface features would restored to the same or better condition than currently exists, and are not anticipated to result in significant impacts to scenic resources or the visual character of the project area.
- MP01 – Sierra Vista Park. Sierra Vista Park is located in a mixed residential area in the City of Monterey Park. Because the improvements at this site would likely be buried and surface features would restored to the same or better condition than currently exists, significant impacts to scenic resources or visual character of the project area are not anticipated.
- LAC01 – Franklin D. Roosevelt Park. Franklin D. Roosevelt Park is located in a mixed residential and urbanized area in the southern portion of the County of Los Angeles. The improvements at this site would likely be buried and surface features would restored to the same or better condition than currently exists, and are not anticipated to result in significant impacts to scenic resources or the visual character of the project area.

d. affect day or nighttime views in the area?

No Environmental Constraints. The Regional Projects would involve the placement of buried infiltration or storage structures, with surface features restored. Exterior lighting of such structures are not anticipated. Water quality improvements such as bio-retention of runoff and stormwater could be place at ground level in one area of Arroyo Park in South Pasadena; however, lighting, if any, is not expected to be substantial. Some low intensity security lighting could be included; however, such lighting would not be intrusive and would not represent a substantial source of new lighting. As a consequence, adverse impacts related to new lighting sources are not anticipated.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
II.	**AGRICULTURE AND FOREST RESOURCES.** In determining whether impacts on agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest Range Assessment Project and the Forest Legacy Assessment Project; and the forest carbon measurement methodology provided in the Forest Protocols adopted by the California Air Resources Board. Would the project:				
a.	Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X
b.	Conflict with existing zoning for agricultural use or conflict with a Williamson Act contract?				X
c.	Conflict with existing zoning for, or cause rezoning of, forest land (as defined in PRC Section 12220(g)) or timberland (as defined in PRC Section 4526)?				X
d.	Result in the loss of forest land or conversion of forest land to non-forest use?				X

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
e.	Involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?				X

Discussion:

a. Would the project convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?

No Environmental Constraints. The California Department of Conservation, as part of its Farmland Mapping and Monitoring Program (FMMP), develops maps and statistical data to be used for analyzing impacts on California's agricultural resources. The FMMP categorizes agricultural land according to soil quality and irrigation status; the best quality agricultural land is identified as Prime Farmland. According to the FMMP, the proposed Regional Project sites are located in areas designated as Urban and Built-Up Land, which is described as land occupied by structures that has a variety of uses including industrial, commercial, institutional facilities, railroad or other transportation yards (California Department of Conservation, 2010 and 2011b). There is no Prime Farmland, Unique Farmland, Farmland of Statewide Importance, or Farmland of Local Importance in the vicinity of the Regional Project sites. Therefore, there would be no impact to designated farmland.

b. Would the project conflict with existing zoning for agricultural use or a Williamson Act contract?

No Environmental Constraints. The Regional Project sites are zoned for open space or developed as existing parks, and there are no agricultural zoning designations or agricultural uses within the Project limits or adjacent areas. The Williamson Act applies to parcels consisting of at least 20 acres of Prime Farmland or at least 40 acres of land not designated as Prime Farmland. None of the Regional Project sites are located within a Prime Farmland designation, or on areas consisting of more than 40 acres of farmland (California Department of Conservation, 2010 and 2011b). No Williamson Act contracts apply to the Regional Project sites. Therefore, the Regional Projects would not have an impact on agricultural zoning or a Williamson Act contract.

c. Would the project conflict with existing zoning for, or cause rezoning of, forest land (as defined in PRC Section 12220(g)) or timberland (as defined in PRC Section 4526)?

No Environmental Constraints. The Regional Project sites are zoned for open space or used for parks, and therefore would not conflict with existing zoning for, or require rezoning of forest land or timberland. Therefore, the Regional Projects would have no impact on land zoned for forest land.

d. Would the project result in the loss of forest land or conversion of forest land to non-forest use?

No Environmental Constraints. The Regional Projects would occur at existing park sites, which are not designated as forest lands. The Regional Projects would not result in the loss of forest land or conversion of forest land to non-forest use.

e. Would the project involve other changes in the existing environment that, due to their location or nature, could individually or cumulatively result in loss of Farmland to non-agricultural use or conversion of forest land to non-forest use?

No Environmental Constraints. As discussed above, no farmland or forest land is located on the Regional Project sites. Therefore, the Regional Projects would not involve the disruption or damage of the existing environment that would result in the loss of farmland to non-agricultural use or conversion of forest land to non-forest use.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
III.	**AIR QUALITY.** When available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a.	Conflict with or obstruct implementation of the applicable air quality plan?			X	
b.	Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	X			
c.	Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is a non-attainment area for an applicable federal or state ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors)?	X			
d.	Expose sensitive receptors to substantial pollutant concentrations?	X			
e.	Create objectionable odors affecting a substantial number of people?			X	

Discussion:

a. Would the project conflict with or obstruct implementation of the applicable air quality plans?

No Environmental Constraints. The Regional Project sites are located within the South Coast Air Basin (SCAB), which is under the jurisdiction of the South Coast Air Quality Management District (SCAQMD). The SCAQMD is responsible for administering the Air Quality Management Plan (AQMP) for the Basin, which is a comprehensive air pollution control program for attaining state and federal ambient air quality standards. The Cities in which the Regional Project sites would occur have each adopted an Air Quality Element as part of their General Plan. The Air Quality Elements contains policies and goals for attaining state and federal air quality standards, while continuing economic growth, and includes implementation strategies for local programs contained in the AQMP. A significant impact could occur if the proposed project is inconsistent with the AQMP or the applicable General Plan.

The Regional Projects would place water quality improvements below each of the sites or at their surface, and would not require permanent changes in uses of the parks (or median). Rather, the Regional projects are deemed to be consistent with the planned and existing uses at each site and with the applicable general plan. Therefore, the Regional Projects are not expected to conflict with or obstruct implementation of the applicable air quality plan and no impact is anticipated.

b. Would the project violate any air quality standard or contribute substantially to an existing or projected air quality violation?

Some Environmental Constraints. Construction of the Regional Projects would require excavation of portions of each site for either the placement of subsurface storage and infiltration structures, or surface improvements. In addition, construction would be required to make connections with existing storm drains, and could require construction of accessory facilities such as subsurface pump stations or wet wells. The South Coast Air Quality Management District (SCAQMD) has established thresholds of significance for criteria pollutants generated during construction and operation, and a significant impact would occur if the Regional Projects result in construction or operational emissions that exceed the thresholds. Construction is likely to require heavy equipment such as loaders, and excavators, and substantial amounts of soil would require export from the sites. As a consequence, there is a possibility for construction emissions to exceed the SCAQMD significance thresholds, even with mitigation, depending on the construction phasing and schedule. Although such exceedances would not represent a substantial environmental constraint to the project, they would likely have the effect of increasing the length of time required for individual project approvals by requiring Mitigated Negative Declarations or Environmental Impact Reports for CEQA compliance. There is also the potential for the applicable decision-making body to determine that the benefits of an individual Regional Project do not override any associated significant impacts (including impacts to air quality), and therefore do not approve the project. However, this potential is considered to be minimal given the need for the Regional Projects in order to comply with the MS4 permit requirements.

Operation of the proposed Project would occur either passively, or if pumping is required, would not likely utilize a substantial amount of energy or require more than nominal operational activities, and therefore, are not likely to result in emission in excess of the SCAQMD significance thresholds for operation. Therefore, operation of the Regional Projects would not likely pose environmental constraints.

c. Would the project result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?

Some Environmental Constraints. Construction of the Regional projects could result in emissions that exceed SCAQMD significance thresholds, and pose constraints related to individual Regional Project approval, as discussed above. Construction of the Regional Projects, in conjunction with construction of other water quality and related improvements, could result in cumulative air quality impacts. Cumulative impacts would be addressed as part of the County's Program EIR or in site specific environmental compliance documentation (under the California Quality Act) and would pose the same environmental constraint as described above under Checklist Item III.b.

d. Would the project expose sensitive receptors to substantial pollutant concentrations?

Some Environmental Constraints. As discussed above, construction of the Regional projects could result in emissions that exceeds SCAQMD significance thresholds. Many of the Regional Projects are located in close proximity to residences, which are considered to be sensitive receptors. The SCAQMD has established localized significance thresholds (LST) to address the impacts that pollutant concentrations could have on nearby receptors. There is a potential for construction to result in emissions in excess of the applicable LSTs, which would have the effect of increasing the length of time required for individual project approvals for CEQA compliance.

e. Would the project create objectionable odors affecting a substantial number of people?

No Environmental Constraints. Construction of the Regional Projects would result in some odors associated with diesel emissions from construction equipment. Diesel odors are common in urbanized environments, and during project construction, would be temporary and localized, and not expected to result in substantial odor impacts.

Air emissions, including odors, during operation are anticipated to be absent or minimal, as surface water would not be stagnant, and storage and infiltration units would be located underground. Therefore, operation of the Regional Projects are not expected to result in substantial odors.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
IV.	**BIOLOGICAL RESOURCES.** Would the project:				
a.	Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?			X	
b.	Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?				X
c.	Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marshes, vernal pools, coastal wetlands, etc.) through direct removal, filling, hydrological interruption, or other means?				X
d.	Interfere substantially with the movement of any native resident or migratory fish or wildlife species, or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?		X		
e.	Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?		X		
f.	Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan?				X

Discussion:

a. **Would the project have a substantial adverse impact, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service?**

No Environmental Constraints. No candidate, sensitive, or special-status species are known to occur on the Regional Project sites. Sites SF01 is located within the USGS San Fernando quadrangle; NHP within the Van Nuys quadrangle; GL01 within the Burbank quadrangle; SP01 within the Los Angeles quadrangle; SM01, AL01, and MP01 within the El Monte quadrangle; and LAC01 within the South Gate quadrangle. Federal and state listed threatened and endangered species have been found in each of the quadrangles in the past (CNDDB, 2015); however it is very unlikely that such habitat existing at any of the Regional Project sites, as those sites are all developed and actively used urban recreational areas. In addition, there are no Significant Ecological Areas (SEAs) in the vicinity of the Regional Project sites (LA County, 2014).

b. **Would the project have a substantial adverse impact on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service?**

No Environmental Constraints. There is no riparian habitat or wetlands located at any of the Regional Project sites or the immediate vicinity, as all of the sites are developed are recreational areas. Open drainage channels that are concrete lined are located adjacent to NHP (Tujunga Wash), GL01 (Verdugo Wash), and SP01 (Arroyo Seco); however, these drainages are devoid of riparian habitat and are not expected to be physically modified. Each Regional Project site is designated in its respective general plan as recreation, open space, or other public use. In addition, no SEAs are located in the vicinity of the Regional Project sites.

c. **Would the project have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marshes, vernal pools, coastal wetlands, etc.) through direct removal, filling, hydrological interruption, or other means?**

No Environmental Constraints. There is no riparian habitat or wetlands located at any of the Regional Project sites or the immediate vicinity, as all of the sites are developed are recreational areas (see discussion above for Checklist Item IV.b.), and adjacent washes are lined with concrete.

d. **Would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species, or with established native resident or migratory wildlife corridors, or impede the use of wildlife nursery sites?**

Some Environmental Constraints. There are no known terrestrial migration corridors within the vicinities of the Regional Project sites. The sites are located in urban areas, and are not connected with other open space areas via undeveloped or natural corridors. Although wildlife may visit the Regional Project sites, introduction of subsurface facilities at the Regional Project sites would not otherwise impede migration. None of the Regional Project sites have water courses that can be used by migratory fish. Therefore, the Regional Projects would not interfere with wildlife migration.

The Regional Project sites include landscaped open space areas, which include trees that could be used as nesting sites. Impacts to migratory birds and active nests are prohibited under the Federal Migratory Bird Treaty Act (MBTA), 50 C.F.R. Part 10, and Sections 3500 through 3705 of the California Fish and Game Code protect most migratory bird species and active nests from harm or destruction. Nearly all native North American bird species are on the MBTA list. The nesting season varies according to species, but is generally February 15th through August 15th for most birds and January 31st through September 1st for raptors. If tree and vegetation removal would occur during nesting months at any Regional Project site, a confirmation bird survey at each of the sites should be performed to prevent disturbance of active nests. Such surveys are standard mitigation applied during site specific environmental documentation. The requirements for bird surveys are not expected to result in substantial environmental constraints, but could result in additional time requirements for CEQA compliance.

e. Would the project conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?

Some Environmental Constraints. The Regional Projects would be located in the City of San Fernando (SF01), City of Los Angeles (NHP), City of Glendale (GL01), City of South Pasadena (SP01), City of San Marino (SM01), City of Alhambra (AL01), City of Monterey Park (MP01), and the County of Los Angeles LAC01).

The City of San Fernando does not currently have any locally-designated tree species, and existing vegetation is limited to introduced species used for landscaping (i.e. lawn area, bushes, and trees) (City of San Fernando, 2008).

The City of San Marino has established an Oak Tree Preservation Program that assists property owners on the proper care of oak trees. San Marino has established tree removal regulations for private property, which would not apply to Lacy Park. The City however does prohibit tree removal in Lacy Park unless authorized by the City Manager.

The City of Alhambra has established tree removal requirements and allows trees to be removed at city-owned facilities only after a review by the department head having jurisdiction. Any removed trees must be replaced as soon as practicable.

The City of Monterey Park allows the removal of trees from public property provided the owner of adjacent private property receives approval from the recreation and parks director. It is assumed that the director would also have to approve any tree removals from Sierra Vista Park or public areas, if required for the water quality improvements.

The County of Los Angeles protects oak trees and requires a permit prior to any oak tree removals.

Other municipalities have established various requirements for tree protection.

The City of Los Angeles protects the following trees within its jurisdiction:

- Oak tree including valley oak
- California Live Oak
- Southern California Black Walnut
- Western Sycamore

- Any other oak genus indigenous to California but excluding the scrub oak,
- California Bay

The City of Glendale protects the following trees, regardless of their location (public or private property):

- Coast Live Oak
- Mesa Oak
- Valley Oak
- Scrub Oak
- California Sycamore
- California Bay

The City of South Pasadena has established regulations governing tree removals within its jurisdiction. A permit is required for trimming or removing the following tree types:

- Oak trees of all varieties
- Coast Redwood
- Dawn Redwood
- Sycamore
- Blue Elderberry
- Heritage trees
- Giant Redwood
- California Walnut
- Christmas Berry
- Mexican Elderberry

There is a potential for the Regional Projects to result in some tree removal, depending on the specific locations and parameters of the water quality improvements, which would require permits or other approvals from the respective jurisdiction. The jurisdictions could apply conditions of approval, including tree replacements, or other measure that mitigate the removals. There tree removals would likely have the effect of increasing the length of time required for individual project approvals and CEQA compliance.

f. Would the project conflict with the provisions of an adopted habitat conservation plan, natural communities conservation plan, or any other approved local, regional, or state habitat conservation plan?

No Environmental Constraint. The Regional Project sites are located within urbanized areas and are developed as parks and recreational facilities. The sites are not located within an adopted Natural Communities Conservation Plan (NCCP) or Habitat Conservation Plan (HCP). In addition, the sites are not located in or near any SEA.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
V.	**CULTURAL RESOURCES.** Would the project:				
a.	Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5?			X	
b.	Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?		X		
c.	Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?		X		
d.	Disturb any human remains, including those interred outside of formal cemeteries?			X	

Discussion:

a. Would the project cause a substantial adverse change in the significance of a historical resource as defined in State CEQA Guidelines §15064.5?

No Environmental Constraints. The Regional Projects would be located at community parks, or on a center median. None of the locations where water quality improvements would occur at the Regional Project sites are developed with structures over the age of 50-years that would be directly affected, and therefore, none of the Regional Projects would result in demolition or relocation of any historic structure. However, there is one historic resource north of GL01, Fremont Park, and one historic structure located at the east end of Lacy Park (SM01) in San Marino.

<u>SM01 – Lacy Park.</u> Lacy Park was originally Wilson Lake in 1875, and the land was purchased by the city in 1925 and dedicated as a park. Many of the tree species, planted nearly 100 years ago, are the result of the designer, Mr. William Hertrich and its first Park Superintendent, Mr. Armin Thurnher. The City considers the Thurnher house, located at the east end of the Park, to be a historic resource. In addition, the San Marino War Memorial is located at the east end of the Park. The water quality improvements would be subsurface and confined to center area of the Park and are not expected to not result in physical changes to the Thurnher house or the War memorial.

<u>GL01 – Fremont Park.</u> Fremont Park is bounded by Kenilworth Avenue on its east boundary. Approximately 200 feet to the north of the northern boundary of Fremont Park, the Kenilworth Avenue Bridge crosses over the Verdugo Wash. This bridge is listed as a historic resource in the City of Glendale’s Register of Historic Resources. The water quality improvements would be confined to Fremont Park and would not result in physical changes to the bridge, or its context.

b. Would the project cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines §15064.5?

Some Environmental Constraints. The Regional Project site would be constructed within the boundaries of community parks and recreation sites. The surfaces of these sites are developed for active recreational uses (fields and courts) and passive recreational uses (picnic areas, etc.), and are not intensively developed. Because the development history of these sites is unknown and the onsite development is low intensity, there could be undisturbed soils below the sites which contain archaeological resources. Based on this, site-specific cultural resource investigations, including a cultural resources records search and field survey by a qualified archaeologist) should be conducted, either prior to or as part of the site-specific environmental documentation for each Regional Project. Mitigation that may be applied in the site-specific environmental document may include monitoring of excavation work by a qualified archaeologist with the authority to halt construction, and the subsequent evaluation and curation of any discovered resources. This potential constraint could have the effect of increasing the length of time required for individual project approvals and CEQA compliance.

c. Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

Some Environmental Constraints. Similar to the discussion under archaeological resources, the development history of the Regional Project sites is unknown and the onsite development is low intensity. There could be undisturbed subsurface geological units suitable for containing paleontological resources. A site-specific paleontological records search should be conducted by the County's Natural History Museum to determine whether paleontological resources can be present at the depths that would occur at each site, either prior to or as part of the site-specific environmental documentation for each Regional Project. Mitigation that may be applied in the site-specific environmental document may include monitoring of excavation work by a qualified paleontologist with the authority to halt construction, and the subsequent evaluation and curation of any discovered resources. This potential constraint could have the effect of increasing the length of time required for individual project approvals and CEQA compliance.

d. Disturb any human remains, including those interred outside of formal cemeteries?

No Environmental Constraint. No cemeteries or burial sites are known to have occurred at the Regional Project site; however, it is still possible that human remains exist in the subsurface. California Health and Safety Code Section 7050.5 requires that in the event of the discovery of human remains outside of a dedicated cemetery, all ground disturbances must cease and the county coroner must be notified. Section 7052 establishes a felony penalty for mutilating, disinterring, or otherwise disturbing human remains, except by relatives. Sections 5097.94 and 5097.98 of the Public Resources Code specify a protocol to be followed when the Native American Heritage Commission receives notification of a discovery of Native American human remains from a county coroner. Compliance with existing laws regarding the handling of human remains discovered outside of formal cemeteries are expected to address any issues associated with the unanticipated discovery of human remains during project construction, and no environmental constraints are anticipated.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VI.	**GEOLOGY AND SOILS.** Would the project:				
a.	Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
	i.) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the state geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.			X	
	ii.) Strong seismic ground shaking?			X	
	iii.) Seismic-related ground failure, including liquefaction?			X	
	iv.) Landslides?				X
b.	Result in substantial soil erosion or the loss of topsoil?				X
c.	Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project and potentially result in an on-site or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?			X	
d.	Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?			X	
e.	Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems in areas where sewers are not available for the disposal of wastewater?				X

Discussion:

a. **Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:**

(i.) **Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the state geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.**

No Environmental Constraints. Southern California is one of the most seismically active areas in the U.S. Numerous active faults and fault zones are located within the general region, including the Whittier, Hollywood-Raymond, and Newport Inglewood faults. The Regional Projects would include subsurface storage basins and structures, and potentially some surface improvements. As a standard practice during the design process for any structure or facility, a geotechnical study is performed of each site that evaluates and identifies faults and fault zones that could affect the project, and that would make recommendations regarding project design based on the geotechnical considerations. Because geotechnical considerations are addressed during the design phase, the Regional Projects would not result in exposure of people or structures to substantial geotechnical hazards.

(ii.) **Strong seismic ground shaking?**

No Environmental Constraints. As discussed above, the Los Angeles Basin is an area of known seismic activity. The risk of seismic hazards such as ground shaking cannot be avoided. Similar to the earthquake fault hazards described above, geotechnical evaluations would be performed as a standard practice as part of the design phase, and the recommendations would be incorporated into project design to keep the Regional Projects from resulting in exposure of people or structures to substantial geotechnical hazards, including to ground shaking.

(iii.) **Seismic-related ground failure, including liquefaction?**

No Environmental Constraints. Similar to the earthquake hazards described above, a geotechnical study for each Regional Project would be prepared as a standard practice to address geotechnical considerations, including liquefaction, during the Project design phase, which would keep the Regional projects from resulting in exposure of people or structures to geotechnical hazards related to liquefaction.

(iv.) **Landslides?**

No Environmental Constraints. The Regional Projects would be constructed and operated on various community park sites and a center median. The project sites are relatively flat with no substantial natural or graded slopes. The Regional Projects are not located near any landslide hazard areas; therefore, there would be no environmental constraints.

b. **Would the project result in substantial soil erosion or the loss of topsoil?**

No Environmental Constraints. The majority of Regional Projects would involve storage structures beneath community recreation areas, and would not result in erosion. The

Regional Projects at Arroyo Park (SM01) could place bio-retention features at the ground surface; however, these improvements would be engineered and constructed in a manner that infiltrates captured stormwater, rather than conveys it offsite. These design features would limit the potential for erosion, and would not represent an environmental constraint.

c. Is the project located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-site or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse?

No Environmental Constraints. Although no unstable geologic conditions are known to occur at the Regional Project sites, a geotechnical study for each Regional Project would be prepared as a standard practice to address geotechnical considerations during the Project design phase. Recommendations would be incorporated into the project design, which would keep the Regional Projects from resulting in substantive geotechnical hazards or risk exposure.

d. Is the project located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?

No Environmental Constraints Expansive soils generally result from specific clay minerals that expand when saturated and shrink when dry. Expansive clay minerals are common in the geologic deposits throughout the Southern California region, and there is the potential that expansive sols could be present that the Regional Project sites. As discussed above, a geotechnical study for each Regional Project would be prepared to address geotechnical considerations (including expansive soils) as a standard practice during the Project design phase, and recommendations would be incorporated into Project designs to keep the Regional Projects from resulting in substantial risks to life or property.

e. Would the project have soils that are incapable of supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

No Environmental Constraints. The Regional Projects are water quality improvement projects that do not generate wastewater. Therefore, the Regional Projects would not result in environmental constraints related to alternative wastewater disposal methods.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VII.	**GREENHOUSE GAS EMISSIONS.** Would the project:				
a.	Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?			X	
b.	Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the emissions of greenhouse gases?			X	

Discussion;

a. Would the project generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

No Environmental Constraints. The Regional Projects would generate criteria pollutant emissions during construction, including CO2 and equivalents. Construction emissions are amortized over 30-years, and are not likely to result in substantive annual greenhouse gas emissions. In addition, operation of the Regional Projects would consist of the pumping of stormwater to the treatment devices, and are not expected to generate substantial levels of greenhouse gasses.

b. Would the project conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of greenhouse gases?

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not generate substantial greenhouse gas emissions. Because of this, the Regional Projects are not expected to not conflict with any applicable plans, policies, or regulations adopted by the state and local jurisdictions for the purposes of reducing GHG emissions.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VIII.	**HAZARDS AND HAZARDOUS MATERIALS.** Would the project:				
a.	Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?			X	
b.	Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?		X		
c.	Emit hazardous emissions or involve handling hazardous or acutely hazardous materials, substances, or waste within 0.25-mile of an existing or proposed school?				X
d.	Be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e.	Be located within an airport land use plan area or, where such a plan has not been adopted, be within 2 miles of a public airport or public use airport, and result in a safety hazard for people residing or working in the project area?				X
f.	Be located within the vicinity of a private airstrip and result in a safety hazard for people residing or working in the project area?				X
g.	Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?			X	
h.	Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				X

Discussion:

a. **Would the project create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?**

No Environmental Constraint. Construction activities associated with the Regional Projects are not likely to involve the use of substantial quantities of hazardous materials and the most likely source of hazardous materials would be from vehicles and construction equipment at the site. However, there could be small amounts of hazardous materials, including solvents and lubricants used to maintain construction equipment. These materials would be confined and located at the applicable staging areas. Federal and state regulations that govern the storage of hazardous materials in containers (i.e., the types of materials and the size of packages containing hazardous materials), secondary confinement requirements, and the separation of containers holding hazardous materials, would limit the potential adverse impacts of contamination to a relatively small area. In compliance with the State General Permit for Storm Water Discharges Associated with Construction Activity and a Project-specific SWPPP, standard BMPs would be used during construction activities to minimize runoff of contaminants and clean-up any spills. Applicable BMPs include, but are not limited to controls for: vehicle and equipment fueling and maintenance; material delivery, storage, and use; spill prevention and control; and waste management. Therefore, implementation of construction standards would minimize the potential for an accidental release of petroleum products, hazardous materials, and/or explosion during construction activities at the Project site. As a consequence, construction would not create an environmental constraint related to potential hazards to the public or the environmental through the routine transport, use, or disposal of hazardous materials.

Operation of the Regional Projects would be automated (with minimal electrical consumption for pumping) and would not require hazardous materials. The infiltration units would filter incoming stormwater to remove oil, grease, metals, and trash; however, the filters would be routinely replaced, and disposed of in accordance with applicable laws and regulations. Based on the above, the Regional project s are not expected to create a substantial hazard to the public or the environmental through the routine transport, use, or disposal of hazardous materials.

b. **Would the project create a significant hazard to the public or the environment through the reasonably foreseeable upset and accident conditions involving the likely release of hazardous materials into the environment?**

Some Environmental Constraints. The Regional Projects would be located on or beneath community parks within in residential or mixed commercial residential areas, Various hazardous materials and contamination databases were reviewed (Geotracker and Envirostor), and several sites were identified near two Regional Project sites (SF01 and AL01) that have indications of past contamination.

None of the other Regional Project sites were documented to have been subject to past contamination, leaks, or remediation efforts. Based on this, Regional Projects NHP, GL01, SP01, SM01, MP01, and LAC01 are not expected to create a hazard to the public or environment during construction.

- <u>SF01 – Recreation Park.</u> The water quality improvement are within Recreation Park is located about 350 feet west of a site (located just east of Parkside Drive) potentially contaminated with lead. The Envirostor database identifies this site as "San Fernando Playground" and as in need of evaluation. Because this site is in need of evaluation, the extent of contamination present is unknown, and due to its proximity to SF01, further due diligence may be required during the Project planning and design phase. This potential constraint could also have the effect of increasing the length of time required for individual project approvals and CEQA compliance.

AL01 – Almansor Park. Geotracker identifies a leaking underground fuel tank located at 900 New Avenue that is owned by the City of Alhambra. Although Geotracker displayed the site location at the intersection of New Avenue and East Adams Avenue, the actual location of the tank may be at the City's Fire Training Facility approximately 900 feet east of the area of Almansor Park where the water quality improvements would occur. Due to the distance of the leaking underground fuel tank from this Regional Project site and given that the tank location is at a lower elevation than Almansor Park, it is unlikely that leaked fuel has traveled to the Project site. In addition, Geotracker has identified several reported leaks from auto repair facilities (in 2000). Geotracker shows these sites located at the north end of Almansor Street (extended) and the railroad right-of-way; however, Geotracker appears to be displaying these locations incorrectly, and the actual locations of these facilities are north of the railroad right-of-way and west of the project site. Because of this, these facilities are not likely to have contaminated the project site or potential storm drain tie-in locations near the railroad right-of-way.

Based on the above, there appears to be a low potential for contaminated soils or groundwater to be present beneath the Project site, and no additional constraints related to hazardous materials are anticipated.

c. Would the project emit hazardous emissions or handle hazardous materials or acutely hazardous materials, substances, or waste within 0.25-mile of an existing or proposed school?

No Environmental Constraint. None of the Regional Projects would utilize processes that could emit hazardous emissions or otherwise release hazardous substances or wastes. Infiltration devices would contain filtration systems designed to remove oils, metals, and other pollutants from storm water; however, the filters would be removed and disposed of in accordance with manufacturers' recommendations and would not be released to the environment. Because of this, no environmental constraint associated with the Regional Projects are expected.

d. Is the project located on a site that is included on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?

No Environmental Constraint. The provisions in Government Code Section 65962.5 are commonly referred to as the "Cortese List" (after the Legislator who authored the legislation that enacted it). Because this statute was enacted over twenty years ago, some of the provisions refer to agency activities that were conducted many years ago and are no longer being implemented and, in some cases, the information to be included in the Cortese List does not exist. While Government Code Section 65962.5 makes reference to the preparation of a "list," many changes have occurred related to web-based information access since 1992 and this information is now largely available on the Internet sites of the responsible organizations (CalEPA, 2015). The California Environmental Protection Agency (CalEPA) has identified the data resources that provide information regarding the facilities or sites identified as meeting the "Cortese List" requirements (Cal EPA, 2014b), which are as follows:

- List of Hazardous Waste and Substances sites from Department of Toxic Substances Control (DTSC) EnviroStor database,
- List of Leaking Underground Storage Tank Sites by County and Fiscal Year from State Water Board GeoTracker database,
- List of solid waste disposal sites identified by the State Water Board with waste constituents above hazardous waste levels outside the waste management unit,
- List of "active" Cease and Desist Orders (CDO) and Cleanup and Abatement Order (CAO) from the State Water Board[1], and
- List of hazardous waste facilities subject to corrective action pursuant to Section 25187.5 of the Health and Safety Code, identified by DTSC.

The Hazardous Waste and Substance Site List maintained by the DTSC Information was downloaded from the DTSC EnviroStor website (DTSC, 2015), and reviewed. The Regional Project sites are not listed in the Hazardous Waste and Substance Site.

The Leaking Underground Storage Tank (LUST) Cleanup Sites contained in the State Water Resources Control Board (SWRCB) GeoTracker database was queried (February, 2015), and the Regional Project sites are not contained in the LUST Cleanup Site list.

The list of solid waste disposal sites identified by the SWRCB with waste constituents above hazardous waste levels outside the waste management unit (CalEPA, 2015c) was reviewed, and the Project site was not contained in the list.

The list of "active" CDOs and CAOs from the SWRCB (SWRCB, 2015b) was downloaded in February, 2015 and reviewed (sorted and searched). The Regional Project sites are not contained in the list of "active" CDO and CAO.

The DTSC list of hazardous waste facilities subject to corrective action pursuant to Section 25187.5 of the Health and Safety Code (DTSC, 2015b) was reviewed and the Regional Project sites are not included in this list.

Based on the reviews of the specific lists that currently comprise the Cortese List, none of the Regional Project sites are contained on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5.

e. For a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?

No Environmental Constraints. The Regional Project site that is closest to a public airport is SF01, which is located approximately 1.4 miles northwest of the Whiteman Airport runway. None of the other Regional Project are located within 2 miles of a public use airport. Although SF01 is located within 2 miles of an airport, neither it nor the other Regional Project sites are located within an airport land use plan; therefore, there would be no environmental constraints.

[1] This list contains many CDOs and CAOs that do NOT concern the discharge of wastes that are hazardous materials. Many of the listed orders concern, as examples, discharges of domestic sewage, food processing wastes, or sediment that do not contain hazardous materials, but the State Water Boards' database does not distinguish between these types of orders.

f. **For a project located within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?**

No Environmental Constraints. There are numerous private airports throughout Los Angeles County, which include heliports. The proximity of the heliports to any of the Regional Projects would not result in a safety hazard for people working in the Project area, as the Regional Project would have no effect on air transport activities or their flight paths. The Regional Projects would therefore not result in any safety hazards for people in the vicinity of the sites.

g. **Would the project impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?**

No Environmental Constraint. The Regional Project sites are currently used for recreational activities (active and passive). Although the Regional Projects would place water quality improvement infrastructure within the park and recreational sites, additional construction would be required at each site to connect with the existing storm drain system, which are located within the streets surrounding each site. The storm drain connections would involve excavations into the streets to make the tie-ins with the storm drains, and would require the temporary closure of one or more lanes while street work is occurring. However, street work would occur under permit from the applicable City or County, and appropriate notifications would be made to local emergency providers so that alternative routes can be planned for in the event of an emergency. As a standard practice, street work would be subject to the requirements of a Traffic Control Plan approved by the local transportation agency, or would comply with applicable work area traffic control requirements. In addition, contractors would have steel plating available in the event excavations need to be quickly spanned. Aside from the temporary street work, no other disruptions to the local transportation system would occur, and substantial interruptions to emergency access are not anticipated.

h. **Would the project expose people or structures to the risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?**

No Environmental Constraint. The Regional Project sites are developed as community parks and recreations areas, or landscaped center median, and no wildlands are present at the Regional Project sites. The areas immediately surrounding the Regional Project sites are urbanized, and no increased wildland fire hazard is expected as a result of the water quality improvements at each site.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
IX.	**HYDROLOGY AND WATER QUALITY.** Would the project:				
a.	Violate any water quality standards or waste discharge requirements?		X		
b.	Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, resulting in a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)?				X
c.	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 that would result in substantial erosion or siltation on site or off site?				X
d.	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 that would result in flooding on site or off site?			X	
e.	Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?			X	
f.	Otherwise substantially degrade water quality?				X
g.	Place housing within a 100-year flood hazard area, as mapped on a federal Flood Hazard Boundary, Flood Insurance Rate Map or other flood hazard delineation map?				X
h.	Place within a 100-year flood hazard area structures that would impede or redirect flood flows?				X

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
i.	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?			X	
j.	Contribute to inundation by seiche, tsunami, or mudflow?			X	

Discussion:

a. Would the project violate any water quality standards or waste discharge requirements?

Some Environmental Constraints. The Regional Projects would install and operate water quality improvement facilities at eight parks Upper Los Angeles River watershed, which would divert, treat, and infiltrate stormwater in order to meet the requirements of the MS4 permits. The Regional Projects would generally result in beneficial impacts to water quality.

However, for SF01, there is a remote potential for subsurface contamination to be present at portions of SF01 if contamination from the sites west of Parkside Drive (see Checklist Item VIII.b. above) has migrated westward. If such subsurface contamination is present and infiltration would occur in areas where the contamination is present, then there is a potential for adverse water quality impacts to groundwater. This potential environmental constraint is considered remote but could result in increased time for the planning and design of these three Regional Projects, and could also have the effect of increasing the length of time required for individual project approvals, design and CEQA compliance.

b. Would the project 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 (i.e., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)?

No Environmental Constraints. The Regional Projects would not be located in areas used for groundwater recharge and therefore would not interfere with groundwater recharge. The Regional Projects would divert runoff and stormwater from the storm drain system in the Upper Los Angeles River watershed, and treat and infiltrate some of the diverted stormwater. As a consequence, the Regional Projects are considered to provide beneficial effects to groundwater by increasing infiltration above baseline conditions.

c. Would the project 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 that would result in substantial erosion or siltation on site or off site?

No Environmental Constraints. The Regional Projects would be located within community parks or a center median, and would not result in physical changes to a stream or river. All Regional Project sites would be restored following construction. Infiltration would occur subsurface and would not result in erosion. Bio-retention features would be designed to properly manage the diverted runoff and storm water, and would not result in erosion.

d. Would the project 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 that would result in flooding on site or off site?

No Environmental Constraints. The Regional Projects would divert and store or divert and treat/infiltrate a portion of the stormwater generated within the Upper Los Angeles River watershed, and would have the effect of decreasing the amount and slowing runoff generated in the watershed, which are considered to be beneficial effects. In addition, the stormwater diversions would decrease the potential for flooding downstream.

e. Would the project create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?

No Environmental Constraints. The Regional Projects would divert and store or treat/infiltrate a portion of the stormwater generated within the Upper Los Angeles River watershed, and would have the effect of improving runoff quality and decreasing the potential for flooding downstream.

f. Would the project otherwise substantially degrade water quality?

No Environmental Constraints. No constraints regarding water quality are anticipated beyond those discussed under Checklist Item IX.a. above.

g. Would the project place housing within a 100-year floodplain, as mapped on a federal Flood Hazard Boundary, Flood Insurance Rate Map or other flood hazard delineation map?

No Environmental Constraints. No housing is proposed under any of the Regional Projects.

h. Would the project place within a 100-year floodplain structures that would impede or redirect flood flows?

No Environmental Constraints. The water quality improvements under the Regional Projects would be either buried infiltration or storage units, or surface bio-retention features, neither of which would impede site runoff or flood flows.

i. Would the project 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?

No Environmental Constraints. Based on a review of the safety elements of the general plans of the Cities of Glendale, Los Angeles, Monterey Park, Pasadena, and South Pasadena, Regional Project sites SF01, NHP, SP01, and LAC01 appear to be within potential inundation or flood areas, including areas subject to flooding in the event of a dam failure. However, the Regional Projects would not house people or otherwise increase the risk of exposure to risks related to potential flooding. In addition, the Regional

Projects are stormwater management projects that are expected to result in beneficial effects to downstream conveyance capacity in the event of a flood.

j. Would the project contribute to inundation by seiche, tsunami, or mudflow?

No Environmental Constraints. The Regional Project sites are not located within a tsunami hazard zone, or near inland water bodies that could be subject to a seiche. In addition, the sites are relatively flat and are not subject to mudflows.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
X.	**LAND USE AND PLANNING.** Would the project:				
a.	Physically divide an established community?				X
b.	Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to, a general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c.	Conflict with any applicable habitat conservation plan or natural community conservation plan?				X

Discussion:

a. Would the project physically divide an established community?

No Environmental Constraints. The Regional Projects would be located within existing community parks, and would not physically divide the surrounding communities.

b. Would the project conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to, the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?

No Environmental Constraints. The Regional Projects would be placed within community parks that are designated as open space or public facilities, and are considered to be consistent with planned and existing uses. It should be noted that for the water quality improvements under SP01, part of the site located west of Arroyo Seco appears to fall within the City of Los Angeles, and another portion within the City of South Pasadena. Regardless, the improvements at SP01 are not expected to conflict with either jurisdiction's applicable land use plan.

c. Would the project conflict with any applicable habitat conservation plan or natural communities conservation plan?

No Environmental Constraints. The Regional Project sites do not fall within or near an area covered by a habitat conservation plan or natural communities conservation plan. In addition, there are no Significant Ecological Areas in the vicinity of the Regional Projects.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XI.	**MINERAL RESOURCES.** Would the project:				
a.	Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b.	Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?				X

Discussion:

a. Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?

No Environmental Constraints. The Regional Projects would be located within existing community parks or a center median, and none of the sites are designated as containing important mineral resources.

b. Would the project result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?

No Environmental Constraints. The Regional Project sites are designated in the applicable general plan as open space or parks. Therefore, the Regional Projects would not result in the loss of availability of mineral resources.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XII.	**NOISE.** Would the project:				
a.	Expose persons to or generate noise levels in excess of standards established in a local general plan or noise ordinance or applicable standards of other agencies?		X		
b.	Expose persons to or generate excessive groundborne vibration or groundborne noise levels?			X	
c.	Result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
d.	Result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?		X		
e.	Be located within an airport land use plan area, or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport and expose people residing or working in the project area to excessive noise levels?				X
f.	Be located in the vicinity of a private airstrip and expose people residing or working in the project area to excessive noise levels?				X

Discussion:

a. Would the project result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance or applicable standards of other agencies?

No Environmental Constraints. The Regional Projects would be located beneath the surface as the eight respective sites and the surface restored such that existing activities could resume following completion of construction. Operation of the water quality improvements would be automated and pump systems required to convey stormwater to the buried facilities would either be subsurface or placed in small housing units. Noise from operations is not expected to be noticeable, and would not result in elevations in ambient noise levels at the Regional Project sites or vicinities. The water quality improvements would require periodic maintenance; however, maintenance activities would not result in substantial elevation in ambient noise.

Construction of the water quality improvement facilities would result in noise associated with construction equipment and haul trip activities. Constriction noise is typically governed by ordinance in each jurisdiction, and the following summarizes the construction noise regulations (the City of San Fernando construction noise regulations are discussed below).

- City of Los Angeles Noise Regulations. The City of Los Angeles (municipal Code, Chapter IV, Article 1, Section 41.40) allows construction Monday through Friday between 7:00 a.m. to 9:00 p.m., Saturdays and National Holidays between 8:00 a.m. to 6:00 p.m., and prohibits construction on Sundays (except for residents). The noise regulations also prohibit night construction if related noise can disturb persons occupying sleeping quarters in any dwelling, hotel, or residence. Major public works projects conducted by the City are exempt from this weekend and holiday restriction.

- City of Glendale Construction Noise Regulations. The City of Glendale (Municipal Code section 8.36.080) prohibits construction for projects within 500 feet of a residential zone between the hours of 7:00 p.m. one day and 7:00 a.m. the next day; 7:00 p.m. Saturday to 7:00 a.m. Monday; and from 7:00 p.m. preceding a holiday to 7:00 a.m. following such holiday.

- City of South Pasadena Noise Regulations. The City of South Pasadena (Municipal Code 19A.13) prohibits construction within or within 500 feet of a residential before 8:00 a.m. and after 7:00 p.m. on Monday through Friday, on Saturday before 9:00 a.m. and after 7:00 p.m., and Sunday before 10 a.m. and after 6:00 p.m.

- City of San Marino Noise Regulations. The City of San Marino (Municipal Code Section 25.01.02) prohibits construction between the hours of 6:00 p.m. and 7:00 a.m. Monday through Friday, on Saturdays, before 9:00 a.m. and after 4:00 p.m., and on Sunday and National holidays. City of Alhambra. The City of Alhambra regulates noise sources in its jurisdiction (Municipal Code Chapter 18.02), but exempts construction on public property or by public entities or their authorized representatives from the noise regulations.

- City of Monterey Park. The City of Monterey Park regulate noise sources in its jurisdiction (Municipal Code 9.53.010 - 9.53.070), but exempts construction conducted between the hours of 7:00 a.m. and 7:00 p.m. on weekdays and the hours of 9:00 a.m. and 6:00 p.m. on Saturdays, Sundays and holidays.

- County of Los Angeles. The County of Los Angeles regulates noise within its jurisdiction (Code section 12.08.440) and prohibits construction activities between the hours of 7:00 p.m. and 7:00 a.m. and on Sundays and national holidays. The Code also establishes specific noise level limits at residential receptors for different categories of construction (mobile equipment operated for short durations, and stationary equipment operated for longer durations); however, the construction noise levels of the proposed project are exempt from the noise limits of the County Noise Control Ordinance as specified in the County Noise Control Ordinance Part 5 Exemptions, H: 5, which includes all transportation, flood control, and utility company maintenance and construction operations at any time on public right of way, and those situations, which may occur on private real property deemed necessary to serve the best interest of the public and to protect the public's health and well-being (County, 2012).

Construction of the Regional Projects would occur within the hours allowed for in the applicable noise regulations, or would be exempt from the noise regulations. It should be noted that several schools (Martha Baldwin Elementary School and Emmaus Lutheran Preschool) are located close to Almansor Park, and a Head Start preschool is located at the central portion of Franklin D. Roosevelt Park, and some noise reducing measures may be prudent during construction despite compliance with noise regulations.

Some Environmental Constraints. The City of San Fernando has established construction noise controls that set limits on when construction could occur, and the noise levels at the property line. Section 34-28 (a)(10) (Specific noises prohibited) and Section 34-31(5) (Exclusions) of the San Fernando Municipal Code provide the following provisions for construction noise:

> *Noise sources associated with construction, repair, remodeling or grading of any real property are allowed up to 70 dB measured at the property line, provided such activities do not take place between the hours of 6:00 p.m. and 7:00 a.m. on weekdays, including Saturday, or at any time on Sunday or a federal holiday.*

Construction at Recreation Park would comply with the construction time restrictions (no construction between the hours of 6:00 p.m. to 7:00 a.m. Monday through Friday, or at any time on Saturdays and Sundays); however construction noise at the property line of the park could exceed the 70dBA restriction level established in the code. As such, construction of the water quality improvements at Recreation Park could conflict with the City's noise regulations. This potential environmental constraint could result in increased time required for CEQA compliance for SF01.

b. Expose persons to or generate excessive groundborne vibration or groundborne noise?

No Environmental Constraints. Construction activities of the Regional Projects would generate some level of vibration. Construction equipment such as excavators, loaders, and haul trucks would generate vibrations that could result in groundborne noise or vibration that could affect nearby structures or residences. Transient vibration levels greater than 0.5 inches per second (in/sec) and continuous/frequent intermittent vibration levels greater than 0.3 in/sec have the potential to damage older residential structure. Additionally, transient vibration levels greater than 2.0 in/sec or continuous sources greater than 0.4 in/sec would be severely noticeable to a human (Caltrans, 2013b). All phases of the construction involve multiple trucks and other vibration producing equipment resulting in vibration levels approximately up to 0.02 in/sec at the closest residences. Excessive groundborne vibration and/or groundborne noise are not anticipated. Therefore, substantial vibrations are not expected to occur during construction of the Regional Projects.

Operation of the Regional Project could include changing of filters in runoff treatment units and general inspections; however, these types of maintenance activities do not produce substantive vibrations. Therefore, operation of the proposed Project would not result in impacts related to groundborne vibration or noise.

c. Result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?

No Environmental Constraints. Operation of the Regional Projects would include pump stations or wet wells that transfer stormwater from storm drains to the water quality improvement structures, as well as general maintenance activities. Pump stations would be underground or housed in small structures, and are not expected to produce audible noise. Because of this, operation of the Regional Projects are not expected to result in permanent increase in ambient noise levels.

d. Would the project result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?

Some Environmental Constraints. Construction of the Regional Projects would occur within the hours allowed for in the applicable local noise regulations or would be exempt from noise regulations, and although construction would result in temporary increases in noise levels compared to ambient conditions without construction, the noise levels are presumably not considered to be substantial due to consistency with noise regulations.

However, for construction projects in the City of Los Angeles that last more than 10 days within a three-month period, the City recommends using the threshold of significance of 5 dBA or more increase in noise levels over existing ambient community noise equivalent level (CNEL), which is a type of 24-hour average noise level (City of Los Angeles, 2006). Given the extent of construction, the anticipated construction durations, and the surrounding noise receptors, it is likely that construction of the Regional Projects in the City of Los Angeles (NHP) would result in temporary elevations of the CNEL in excess of the 5dBA threshold, which would have the effect of increasing the length of time required for individual project approvals and CEQA compliance.

e. For a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

No Environmental Constraints. The Regional Project site that is closest to a public airport is SF01, which is located approximately 1.4 miles northwest of the Whiteman Airport runways. Although SF01 is located within 2 miles of an airport, the water quality improvements would be automated, and would not expose people to excessive noise related to proximity to an airport. None of the other Regional Project sites are located within an airport land use plan or within 2 miles of a public airport.

f. For a project located within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?

No Environmental Constraints. There are numerous private airports throughout Los Angeles County, which include heliports. The proximity of the heliports to any of the Regional Projects would not result in exposure of people to excessive noise levels, as the Regional Project would have no effect on air transport activities or their flight paths, and would not cause people to move closer to a private airport.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XIII.	**POPULATION AND HOUSING.** Would the project:				
a.	Induce substantial population growth in an area, either directly (e.g., by proposing new homes and businesses) or indirectly (e.g., through extension of roads or other infrastructure)?				X
b.	Displace a substantial number of existing housing units, necessitating the construction of replacement housing elsewhere?				X
c.	Displace a substantial number of people, necessitating the construction of replacement housing elsewhere?				X

Discussion:

a. Would the project induce substantial population growth in an area, either directly (e.g., by proposing new homes and business) or indirectly (e.g., through extension of roads or other infrastructure)?

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not result in substantive employment demand and do not have a housing component that could induce population growth.

b. Would the project displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?

No Environmental Constraints. No housing is located on any of the Regional Project sites, and no housing displacements would occur.

c. Would the project displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?

No Environmental Constraints. There is no housing within the Regional Project site boundaries that would be displaced. The Regional Projects would not result in the displacement of any persons, or the need for replacement housing.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XIV.	**PUBLIC SERVICES.** Would the project:				
a.	Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities or a need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the following public services:				
	i.) Fire protection?				X
	ii.) Police protection?				X
	iii.) Schools?				X
	iv.) Parks?				X
	v.) Other public facilities?				X

Discussion:

a. **Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities or a need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:**

i.) Fire Protection

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not increase housing or induce population growth that could in turn increase the need for new fire protection services. Although the Regional Projects would involve some construction within the street system to connect to storm drains, the construction is not expected to substantively increase fire protection response times because prior notifications to emergency service providers occur as a standard permit condition for in-street construction.

ii.) Police Protection

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not increase housing or induce population growth that could in turn increase the need for new police protection services. Although the Regional Projects would involve some construction within the street system to connect to storm drains, the construction is not expected to substantively increase police protection response times because prior notifications to emergency service providers occur as a standard permit condition for in-street construction.

iii) Schools

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not increase housing or induce population growth that could in turn increase the need for new schools.

iv) Parks

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not increase housing or induce population growth that could in turn increase the need for new parks. Environmental constraints related to impacts on existing community parks are discussed under Checklist Item XV.b. below.

v) Other Public Facilities

No Environmental Constraints. The Regional Projects are water quality improvement projects that would not increase housing or induce population growth that could in turn increase the need for new public facilities.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XV.	**RECREATION.** Would the project:				
a.	Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b.	Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?		X		

Discussion:

a. Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?

No Environmental Constraints. The Regional Projects would construct and operate water quality improvement facilities at specific community parks in the Cities of San Fernando, Los Angeles, Glendale, San Marino, Alhambra, and Monterey Park, and the County of Los Angeles. The water quality improvement facilities are considered to be infrastructure projects that do not increase the housing stock and do not result in the movement or relocation of people from one area to another. As a consequence, the Regional Projects would not result in increased demand for recreational facilities and would therefore not directly or indirectly result in physical deterioration of parks or other recreational facilities.

b. Does the project include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?

Some Environmental Constraints. The Regional Projects would construct and operate water quality improvement facilities at specific community parks. Construction is estimated to take up to 18 months, and would result in the temporary disruption of park activities within the construction zone. The likely disruption to recreational uses at each Regional Project site are discussed below.

- <u>SF01 – Recreation Park.</u> The water quality improvement features at Recreation Park include buried storage basins and infiltration units within southern portion of the park. The improvements, depending on where they would be located, would require substantial excavation of the main park site, which could result in temporary closure of the softball field and other areas within the south end of the park. The closures would occur for the duration of construction (estimated to be 12-18 months) and the amount of time it would take to restore the fields, and other affect recreational features (estimated at 1-2 months). The temporary loss of recreational areas of Recreation Park is likely to require close coordination between the City of San Fernando, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- NHP – North Hollywood Park. The water quality improvements at North Hollywood Park would likely be subsurface infiltration and/or storage structures. Construction of these facilities would result in the temporary closure of some existing walking paths areas used for passive recreation. The temporary closure of a large portion of North Hollywood Park during construction is likely to require close coordination between the City of Los Angeles, local residents, and community stakeholders to develop suitable mitigation options for addressing impacts to passive recreational uses of the park. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- GL01 - Fremont Park. The water quality improvements proposed for the Fremont Park include a subsurface infiltration or storage facility within the southeastern portion of the park (beneath the active field). The improvements would require the temporary closure (up to approximately 18 months) of this portion of the park, including the active field and potentially relocation of other recreational facilities within the park. The temporary closure of a portion of Fremont Park during construction will likely to require close coordination between the City of Glendale, local residents, and community stakeholders to develop suitable mitigation options for addressing impacts to Fremont Park. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- SP01 – Arroyo Park. The water quality improvement facilities at Arroyo Park would include buried infiltration structures storage basins beneath the 3 baseball and softball fields in the northern part of the park, beneath the baseball field at the portion of the park west of the Arroyo Seco, and potential surface bio-retention improvements east of the Arroyo Seco to Stoney Drive. This latter area contains vegetation and does not appear to be used for active recreation. The improvements are likely to require substantial excavation within the park, which would result in temporary closure of multiple active areas (baseball and softball fields) and the periphery. Other park uses such as picnic areas and playgrounds may require relocation to elsewhere in the park. The closures would occur for the duration of construction (estimated to be up to 18 months) and the amount of time it would take to restore the fields and recreational areas. The temporary closure of the recreational uses within Arroyo Park is likely to require close coordination between the City of South Pasadena, City of Los Angeles (a small section of the park west of the Arroyo Seco is located within the City of Los Angeles), local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- SM01 – Lacy Park. The water quality improvement facilities at Lacy Park would include buried infiltration and/or storage basins in approximately the center of the park. The improvements would require substantial excavation, which could result in temporary closure of the ball field and potentially several picnic areas around the periphery of the central green space. The temporary closure would occur for the duration of construction (estimated to up to 18 months) plus the amount of time it would take to restore the central green space area (estimated at 1-2 months). The temporary closure of the central portion of Lacy Park is likely to require close coordination between the City of San Marino, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary closure. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- AL01 – Almansor Park. The water quality improvement facilities proposed for Almansor Park include buried infiltration units and storage basins beneath the ball fields. The improvements would require substantial excavation, which would result in temporary closure of the ball fields for the duration of construction (estimated to be up to 18 months) plus the amount of time it would take to restore the fields, and other affect recreational features (estimated at 1-2 months). The temporary closure of the recreational uses within Almansor Park is likely to require close coordination between the City of Alhambra, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- MP01 – Sierra Vista Park. The water quality improvement facilities proposed for Sierra Vista Park include buried infiltration units and/or storage basins at the southern end of the park, beneath the softball field. The improvements would require substantial excavation, which would result in temporary closure of the softball field and tennis courts. The closures would occur for the duration of construction (estimated to be up to 18 months) plus the amount of time it would take to restore the field, and other affect recreational features (estimated at approximately 1 month). The temporary closure of the recreational uses within Sierra Vista Park is likely to require close coordination between the City of Monterey Park, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational uses. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

- LAC01 – Franklin D. Roosevelt Park. The water quality improvement facilities proposed for the Franklin D. Roosevelt Park would include buried infiltration units and/or storage basins beneath the northern, middle, and southern areas of the Park. The improvements are likely to require substantial excavation and result in temporary closure of these areas of the park, which include soccer fields, ball fields, basketball courts, and picnic areas. The closures would occur for the duration of construction (estimated to be up to 18 months) plus the amount of time it would take to restore the affected recreational areas (estimated at 1-2 months). The temporary closure of large portions of Franklin D. Roosevelt park will require close coordination between the County of Los Angeles, local residents, and community stakeholders to develop suitable mitigation options for addressing the temporary loss of recreational areas. This represents an environmental constraint which would have the effect of increasing the length of time required for project approval and CEQA compliance.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XVI.	**TRANSPORTATION/TRAFFIC.** Would the project:				
a.	Exceed the capacity of the existing circulation system, based on an applicable measure of effectiveness (as designated in a general plan policy, ordinance, etc.), taking into account all relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?			X	
b.	Conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?				X
c.	Result in a change in marine vessel traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				X
d.	Substantially increase hazards because of a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e.	Result in inadequate emergency access?				
f.	Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X

Discussion:

a. Would the project increase the capacity of the existing circulation system, based on an applicable measure of effectiveness (as designated in a general plan policy, ordinance, etc.), taking into account all relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?

No Environmental Constraints. The Regional Projects would involve water quality improvements at eight community parks within the Upper Los Angeles River watershed.

Although the Regional Projects would require some construction within the streets surrounding each site to make connections with storm drains, the construction would be temporary and subject to traffic control plans as required by the applicable city. Once the connections are made, the streets would be repaired and returned to service. Because the Regional projects would not make substantive changes to the circulation system or street capacities, they are not expected to pose environmental constraints in this area.

b. Would the project conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?

No Environmental Constraints. The Regional Projects are not located along a designated or interim CMP highway or arterial (Metro, 2010), and are not considered traffic generators. Therefore, the Regional Project would not conflict with the LA County Congestion Management Plan.

c. Would the project result in a change in marine vessel traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?

No Environmental Constraints. The Regional Projects are land based and are not generators of marine vessel traffic. Therefore, the Regional Project would not result in any environmental constraints related to marine vessel traffic.

d. Would the project substantially increase hazards because of a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?

No Environmental Constraints. The Regional Projects would involve water quality improvements at seven community parks. Although the Regional Projects would require some construction within the streets surrounding each site to make connections with storm drains, the construction would be temporary and subject to traffic control plans as required by the applicable city. Once the connections are made, the streets would be repaired and returned to service. Because no substantive changes would be made to the street system, the Regional Projects would not increase roadway hazards.

e. Would the project result in inadequate emergency access?

No Environmental Constraints. As discussed under Checklist Item VIII.g. above, the Regional Projects would not result in substantial interruptions to emergency access.

f. Would the project conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?

No Environmental Constraints. The Regional Projects proposed for the community park sites would not result in permanent changes to the street systems that could affect alternative transportation routes, such as bike lanes or bike paths.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XVII.	**UTILITIES AND SERVICE SYSTEMS.** Would the project:				
a.	Exceed wastewater treatment requirements of the applicable regional water quality control board?				X
b.	Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c.	Require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d.	Have sufficient water supplies available to serve the project from existing entitlements and resources, or would new or expanded entitlements be needed?				X
e.	Result in a determination by the wastewater treatment provider that serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X
f.	Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?			X	
g.	Comply with federal, state, and local statutes and regulations related to solid waste?				X

Discussion:

a. **Would the project exceed wastewater treatment requirements of the applicable regional water quality control board?**

No Environmental Constraints. The Regional Projects are water quality improvements projects that are not generators of wastewater. Therefore, the Regional Projects would not affect wastewater treatment requirements.

b. **Would the project require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?**

No Environmental Constraints. The Regional Projects are water quality improvements projects would not consume or require potable water, and would not generate wastewater. Therefore, the Regional Projects would not increase require new potable water supplies or additional wastewater treatment capacity.

c. **Would the project require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?**

No Environmental Constraints. The Regional Projects are water quality improvements projects that would divert a portion of the runoff generated in the Upper Los Angeles River watershed, and would store, treat, and infiltrate the diverted runoff. The Regional Projects would have beneficial effects on downstream storm drain capacity.

d. **Would the project have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?**

No Environmental Constraints. The Regional Projects are water quality improvements projects that would not consume water. Therefore, the Regional Projects would not require new water supplies.

e. **Has the wastewater treatment provider that serves or may serve the project determined that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?**

No Environmental Constraints. The Regional Projects are water quality improvements projects that would not generate wastewater and would not have an effect on existing wastewater treatment capacity.

f. **Is the project served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?**

No Environmental Constraints. The Regional Projects are water quality improvements projects would not generate substantial amounts of solid wastes. The Regional Projects would include a pre-treatment or filtration device that removes sediment, oils, particulates, and other contaminants from stormwater. The filters would periodically be removed and disposed of in accordance with applicable laws and regulations. Although some solid wastes would be generated by the Regional Projects, the amounts would be minimal and would not adversely affect landfill capacity. During construction, excavated soil would be hauled away and reused elsewhere in the area, or used as landfill cover, which does not contribute to reductions in landfill capacity.

g. **Would the project comply with federal, state, and local statutes and regulations related to solid waste?**

No Environmental Constraints. As discussed above, the Regional Projects would generate minimal solid wastes, but would comply with applicable solid waste regulations.

		Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XVIII.	**MANDATORY FINDINGS OF SIGNIFICANCE**				
a.	Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?		X		
b.	Does the project have impacts that are individually limited but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.)		X		
c.	Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?		X		

Discussion:

a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?

Construction of the Regional Projects could affect nesting birds if tree removals are required during the nesting season. Construction of water quality improvements at the Regional Project sites has the potential to encounter archaeological and paleontological resources, which could require site-specific mitigation. These potential constraints have been identified above, and would be addressed during site-specific CEQA compliance.

b. Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past

projects, the effects of other current projects, and the effects of probable future projects.)

Construction of the Regional Projects could contribute to cumulative air quality and potentially cumulative noise impacts, as well as other resource area cumulative impacts. However, cumulative impacts would be addressed in the County's Program EIR or in site-specific CEQA documentation.

c. Does the project have environmental effects that would cause substantial adverse effects on human beings, either directly or indirectly?

The Regional Projects would result in impacts on human beings related to air quality, hazardous materials, water quality, noise, and recreation, as described above. These impacts would be addressed in future site-specific CEQA documentation.

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APPENDIX C

OPTIMIZATION RESULTS

by TetraTech

Assumptions

- BMP area was fixed at the maximum footprint; depth was varied
- Maximum BMP depth was assumed based on the assumptions below
- Each curve is cut off at the maximum BMP size, per assumptions below

Cluster ID	Site Name	Max Drainage Area[1] (ac)	Min Drainage Area[2] (ac)	BMP Footprint (ac)	Max. BMP Depth[3] (ft)	Max. Practical Active Depth (ft)	Aggregate Infiltration Rate[4] (in/hr)	Comment on Max Drainage Area
AL01	Almansor Park	1145	51	10.205	165	25	0.70	Max updated to now include San Pascual Wash as max.
GL01	Fremont Park	~~13375.7~~	206.2264	0.3743	50	20	0.30	Max is not applicable as it is accepting the Verdugo Wash
LAC01	Roosevelt Park	2249.62	168.564	9.5979	80	20	0.30	Okay as is
MP01	Sierra Vista Park	2927.7265	799.4605	0.652	80	20	0.30	Okay as is
SF01	San Fernando	~~4429.9353~~	422.2799	2.7103	50	20	0.80	Max is not applicable as this is accepting the Pacoima Wash
SM01	Lacy Park	927.52563	1067.2045	2.3892	145	20	0.39	Okay as is
SP01	Lower Arroyo Park	~~15380.546~~	145.2086	10.588	25	25	0.80	Max is not applicable as it is accecpting the Arroyo Seco
NHP	North Hollywood Park	~~13909.873~~	5122.0118	7.9579	65	20	0.80	Max is not applicable as it is accepting the Tujunga Wash

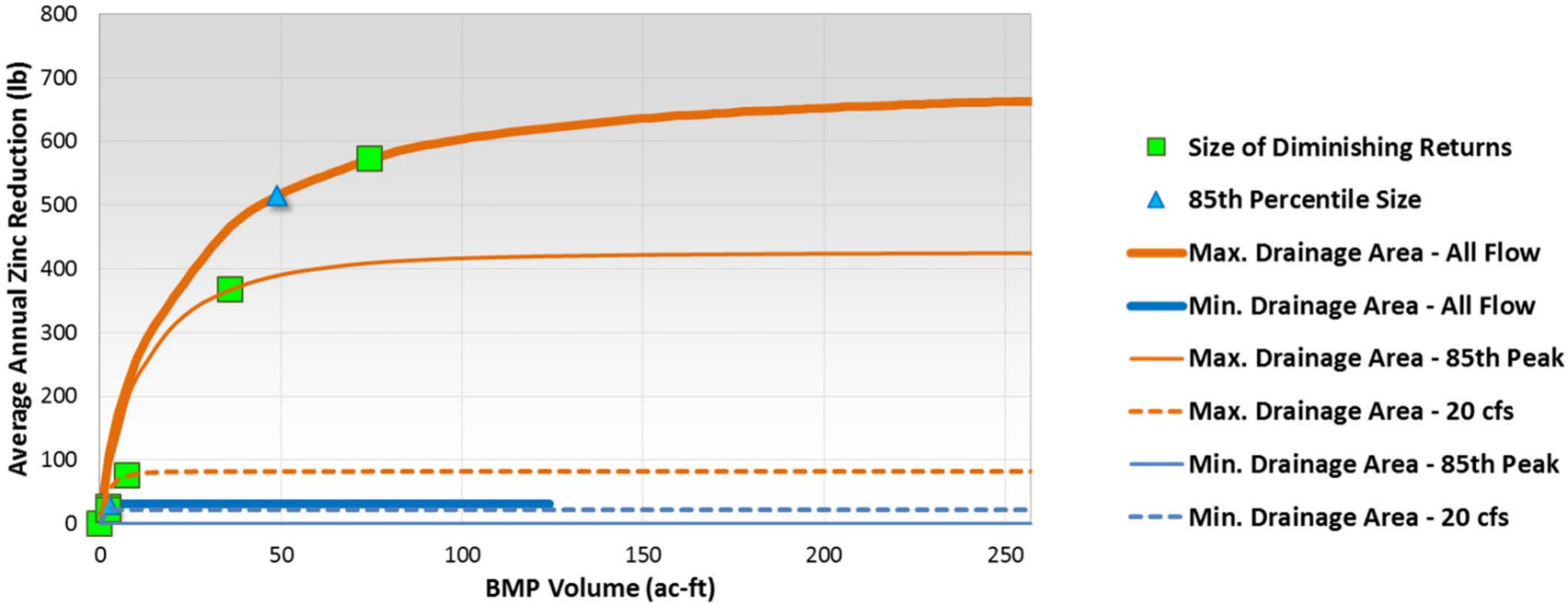
[1] Max Drainage Areas were delineated from subwatersheds from LA County GIS

[2] Min Drainage Areas were provided by Tetra Tech

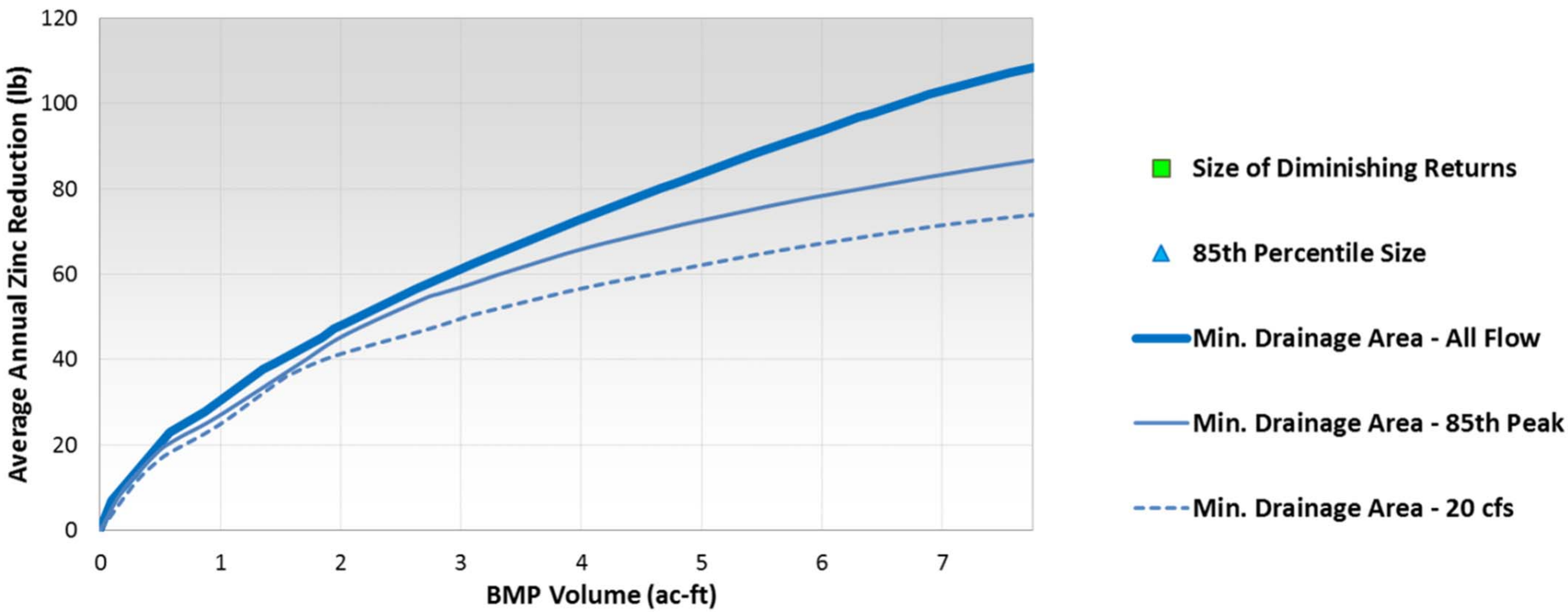
[3] BMP depth was determined using Groundwater Depth Contours provided by Tetra Tech. 10 feet of seperation is a
conformance with the County's LID ordinance.

[4] Soil data was taken from LA County GIS and associated infiltration rates were provided by Eliza Jane

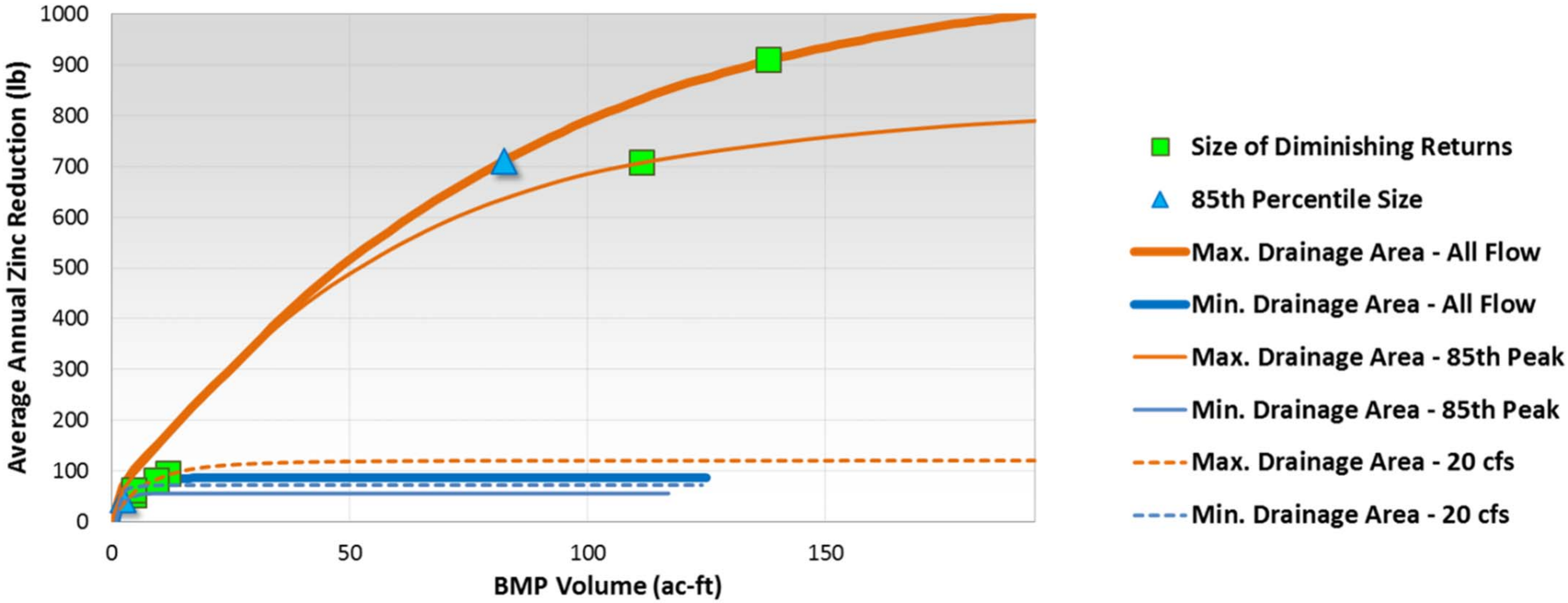
AL01 – ALMANSOR PARK



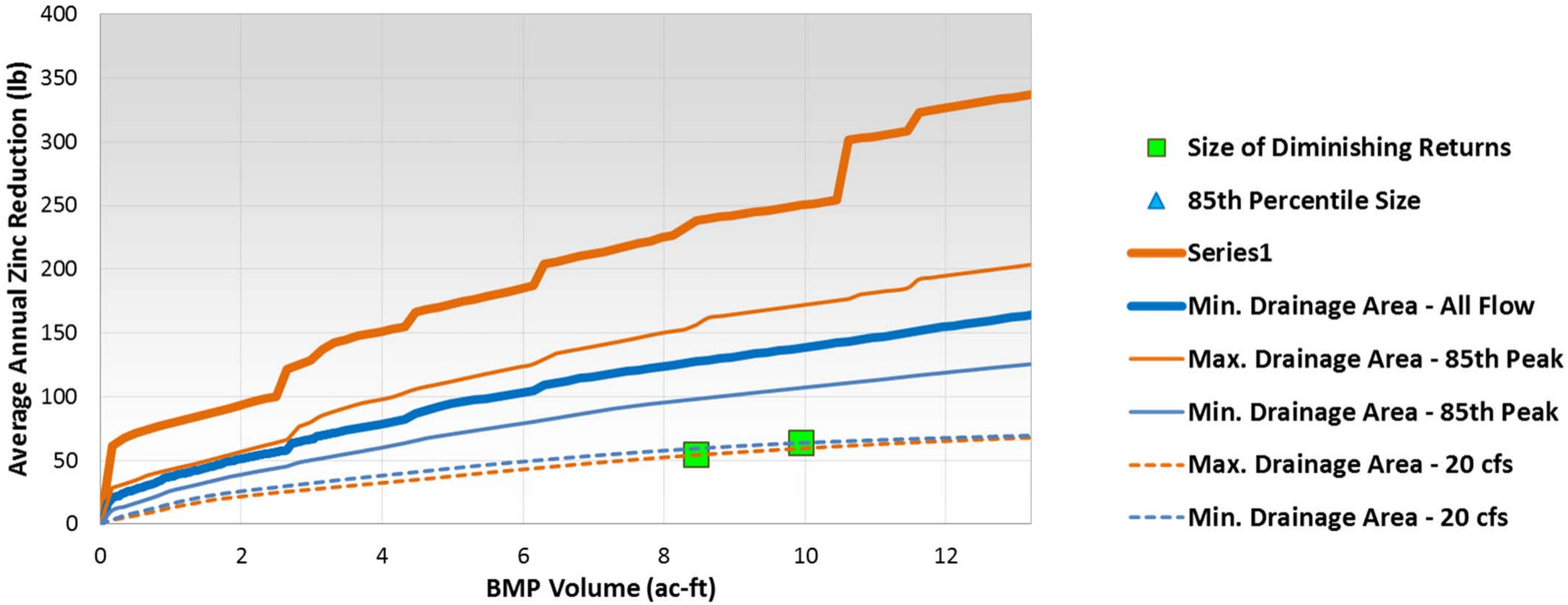
GL01 – Fremont Park



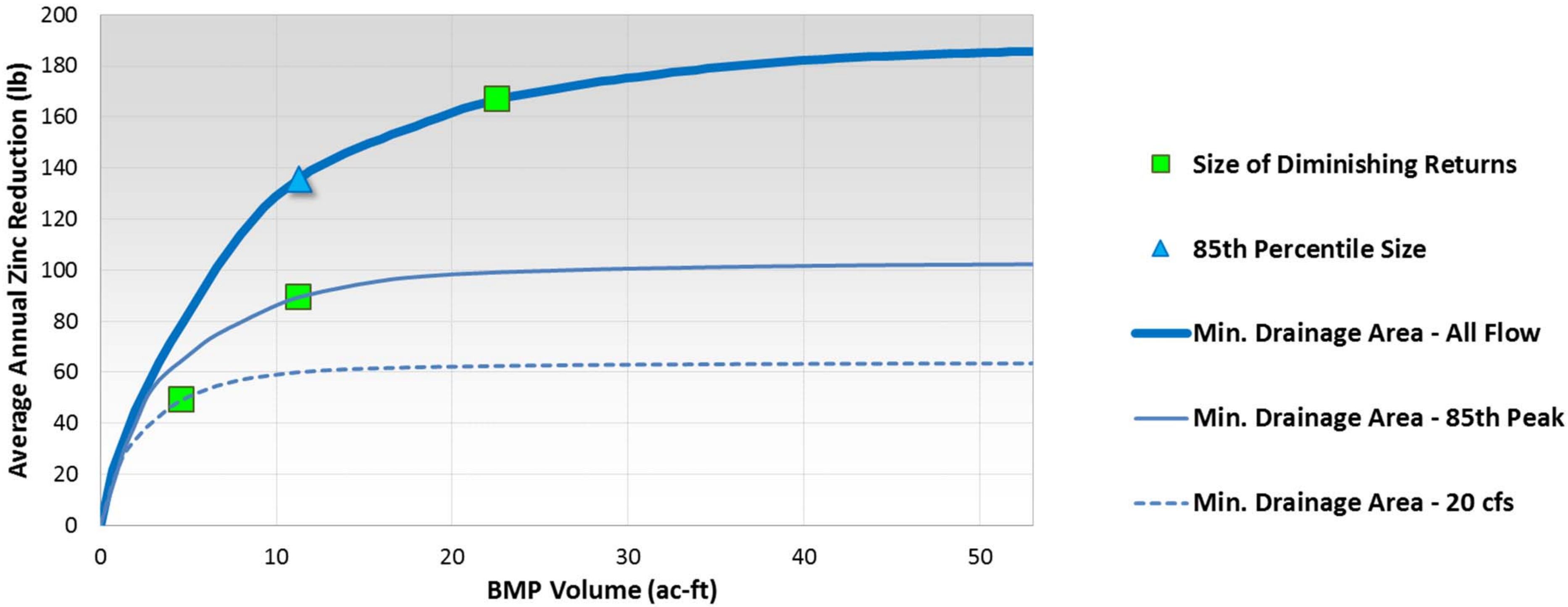
LAC01 – Roosevelt Park



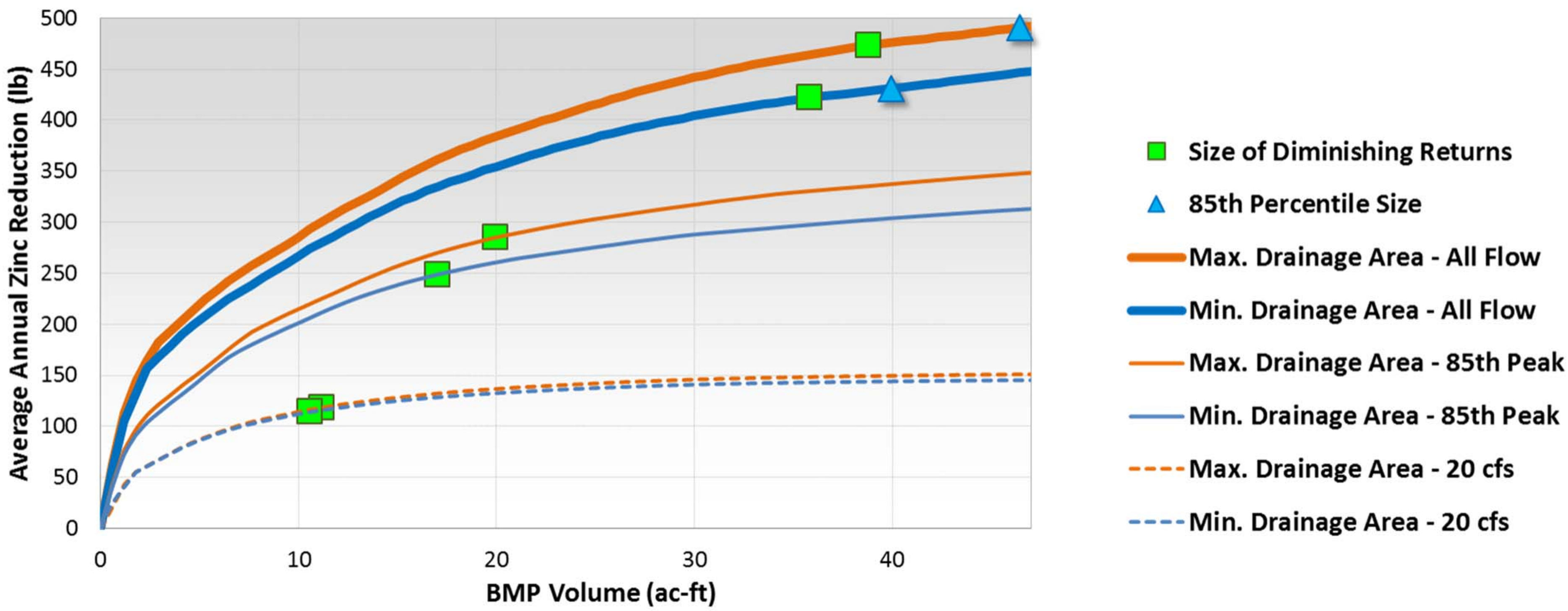
MP01 – Sierra Vista Park



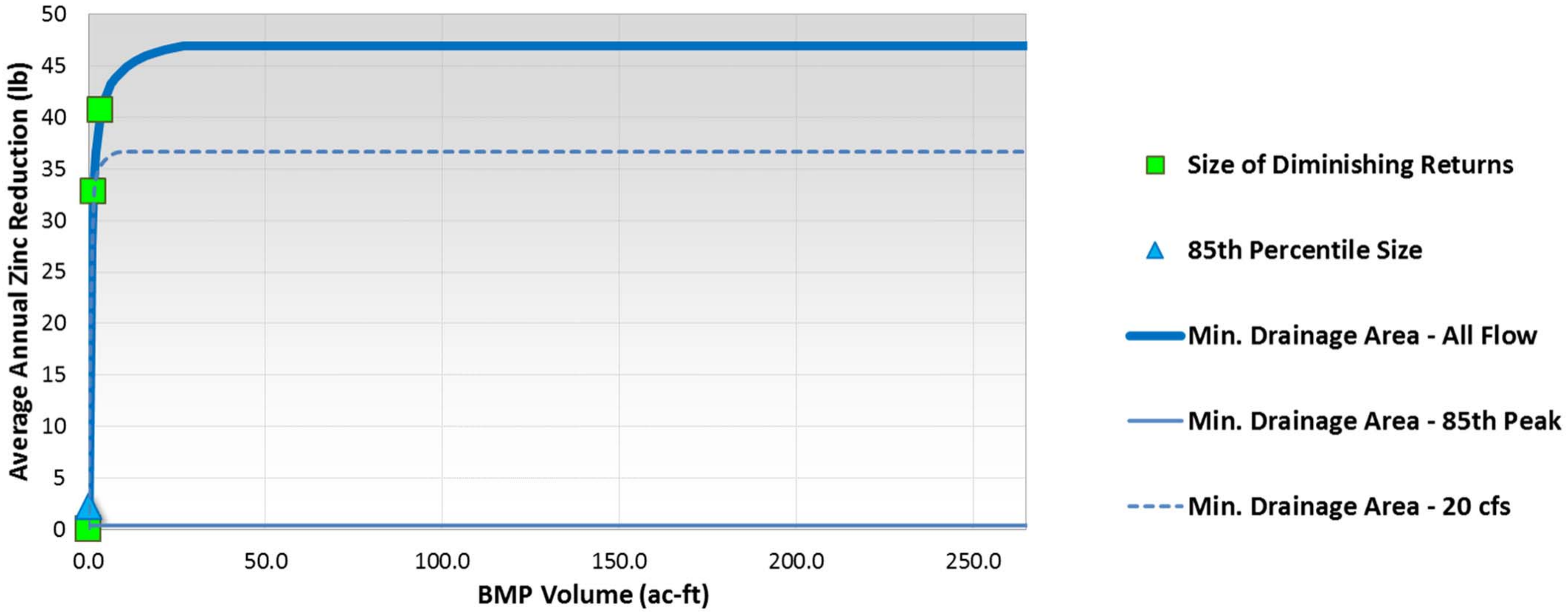
SF01 – San Fernando



SM01 – Lacy Park

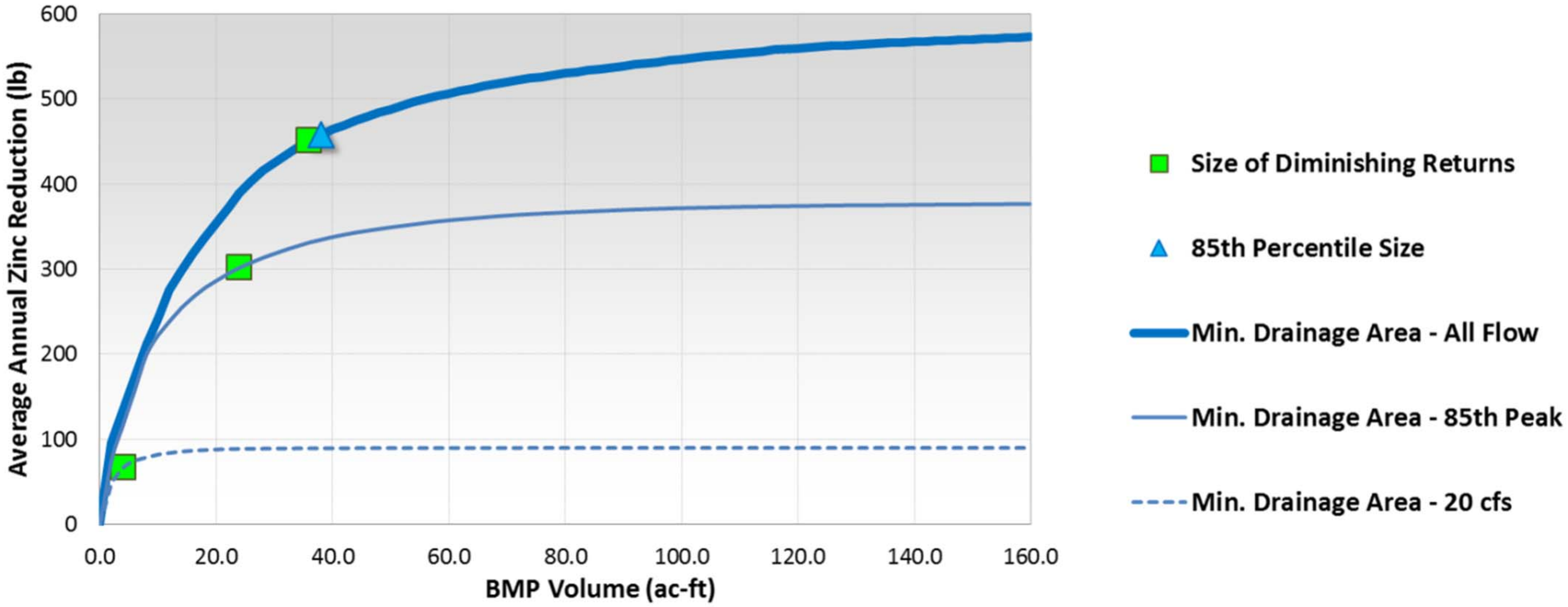


SP01 – Lower Arroyo Park



Small drainage area and large BMP footprint; small incremental increases in BMP size result in high pollutant load reduction

NHP – North Hollywood Park



Summary of Recommended Solutions

Cluster ID	Site Description	Max BMP Footprint (ac)	Minimum Drainage Area (ac)	Maximum Drainage Area (ac)	Recommended Size					
					Minimum Drainage Area			Maximum Drainage Area		
					20 cfs Diversion	85th %-ile Peak Diversion	Online (All Flow)	20 cfs Diversion	85th %-ile Peak Diversion	Online (All Flow)
AL01	Almansor Park	10.2	51	1,145	85th	85th	85th	PDR	85th	PDR*
GL01	Fremont Park	0.4	206	--	MAX	MAX	MAX			
LAC01	Roosevelt Park	9.6	169	2,250	PDR*	PDR*	PDR*	PDR	PDR*	PDR*
MP01	Sierra Vista Park San	0.7	799	2,928	PDR	MAX	MAX	PDR	MAX	MAX
SF01	Fernando	2.7	422	--	PDR	85th	PDR*			
SM01	Lacy Park	2.4	1,067	928	PDR	85th	85th	PDR	85th	85th
SP01	Lower Arroyo Park	10.6	145	--	PDR*	PDR*	PDR*			
NHP	North Hollywood Park	8.0	5,122	--	PDR	85th	85th			

*Solutions highlighted green also capture 85th percentile volume

Cluster ID	Site Description	Max BMP Footprint (ac)	Minimum Drainage Area (ac)	Maximum Drainage Area (ac)	Recommended Size (ac-ft)					
					Minimum Drainage Area			Maximum Drainage Area		
					20 cfs Diversion	85th %-ile Peak Diversion	Online (All Flow)	20 cfs Diversion	85th %-ile Peak Diversion	Online (All Flow)
AL01	Almansor Park	10.2	51	1,145	2.6	2.6	2.6	7.7	49.0	74.7*
GL01	Fremont Park	0.4	206	--	MAX	MAX	MAX			
LAC01	Roosevelt Park	9.6	169	2,250	4.8*	4.8*	9.7*	12.1	111.5*	8.4*
MP01	Sierra Vista Park San	0.7	799	2,928	10.0	MAX	MAX	8.5	MAX	MAX
SF01	Fernando	2.7	422	--	4.6	11.3	22.6*			
SM01	Lacy Park	2.4	1,067	928	10.6	40.0	40.0	11.2	46.4	46.4
SP01	Lower Arroyo Park	10.6	145	--	1.6*	0.4*	3.7*			
NHP	North Hollywood Park	8.0	5,122	--	4.0	38.0	38.0			

*Solutions highlighted green also capture 85th percentile volume

Summary of Recommended Solutions

Cluster ID	Site Description	Modeled Comparative Cost*					
		Minimum Drainage Area			Maximum Drainage Area		
		20 cfs Diversion	85th %-ile Peak Diversion	Online (All Flow)	20 cfs Diversion	85th %-ile Peak Diversion	Online (All Flow)
AL01	Almansor Park	$ 20,646,707	$ 20,646,707	$ 20,646,707	$ 21,162,044	$ 25,284,741	$ 27,861,427
GL01	Fremont Park	$ 1,524,245	$ 1,524,245	$ 1,524,245			
LAC01	Roosevelt Park	$ 19,674,980	$ 19,674,980	$ 20,160,010	$ 20,402,525	$ 30,345,640	$ 33,013,305
MP01	Sierra Vista Park San	$ 2,307,954	$ 2,639,726	$ 2,639,726	$ 2,158,657	$ 2,639,726	$ 2,639,726
SF01	Fernando	$ 5,715,033	$ 6,378,577	$ 7,506,602			
SM01	Lacy Park	$ 5,709,005	$ 8,647,885	$ 8,647,885	$ 5,767,782	$ 9,294,438	$ 9,294,438
SP01	Lower Arroyo Park	$ 21,161,459	$ 21,055,292	$ 21,373,793			
NHP	North Hollywood Park	$ 16,210,321	$ 19,607,081	$ 19,607,081			

*Diversion and pumping costs held constant between scenarios

APPENDIX D

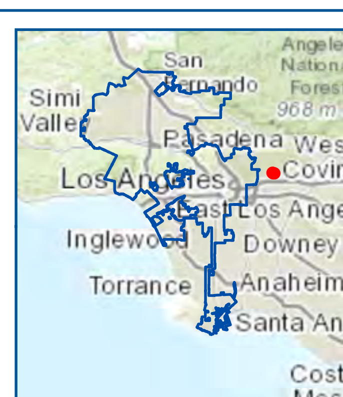
PROJECT SITE MAPS WITH BMP OPPORTUNITY AREAS

N
W E
S

0 400 800
Feet

1 inch = 500 feet

- BMP Site Data Points
- Contour
- Catch Basin
- Storm Drain Netowrk
- Open Channel
- ULAR_BMPAreas
- Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation AL01: Almansor Park

PN 182198

BLACK & VEATCH
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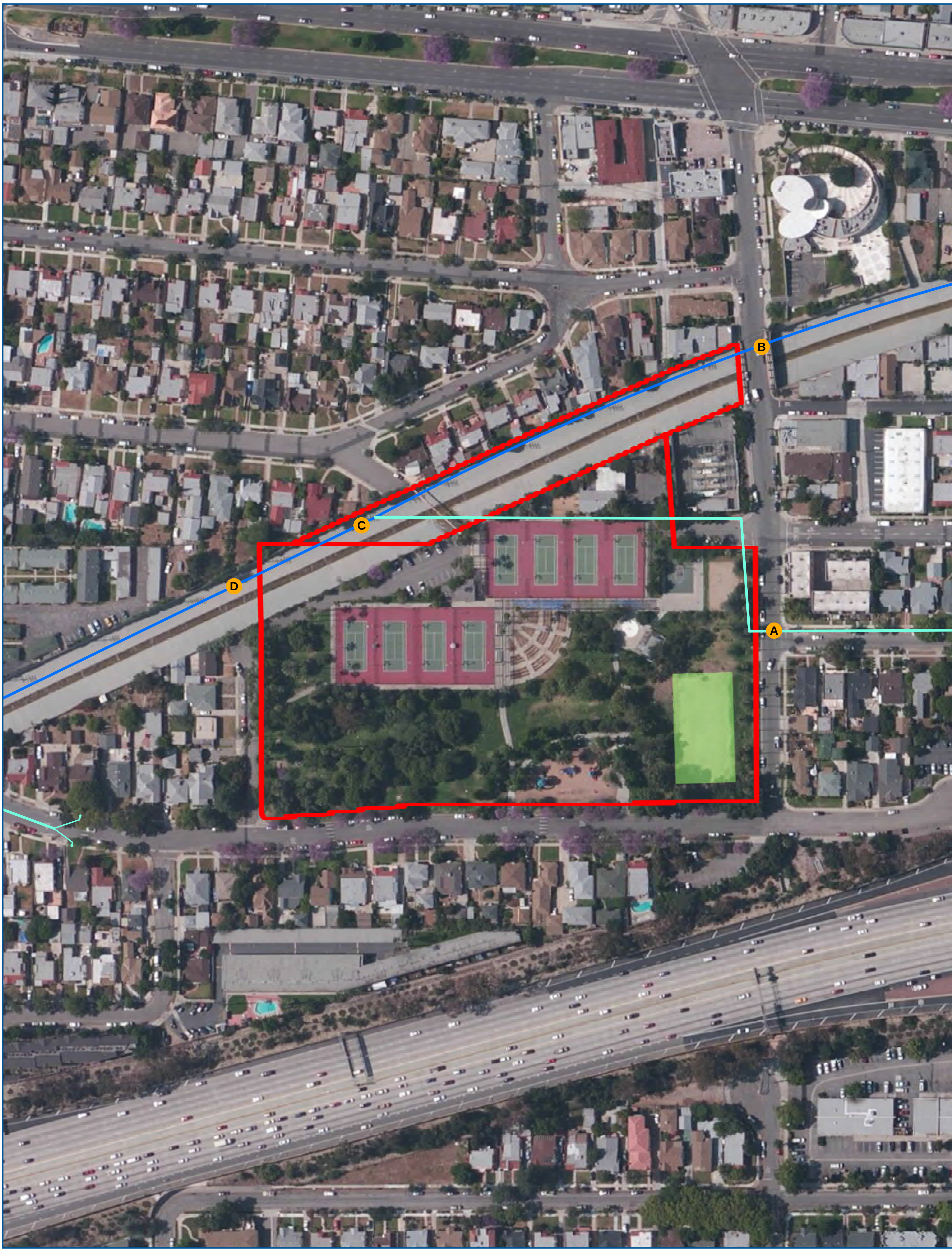
AL01 February 18, 2015 J. Thompson

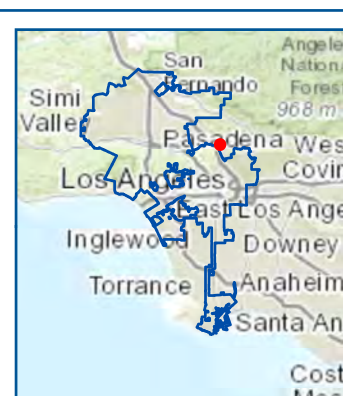


N
W E
S

0 100 200
Feet

1 inch = 150 feet

- BMP Site Data Points
- Contour
- Catch Basin
- Storm Drain Netowrk
- Open Channel
- ULAR_BMPAreas
- Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

GL01: Fremont Park PN 182198

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N
W E
S

0 250 500
Feet

1 inch = 333 feet

BMP Site Data Points

Contour

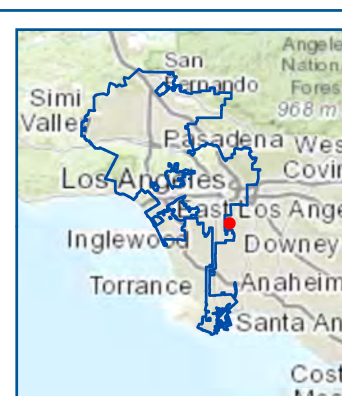
Catch Basin

Storm Drain Netowrk

Open Channel

ULAR_BMPAreas

Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

LAC01: RooseveltPark

PN 182198

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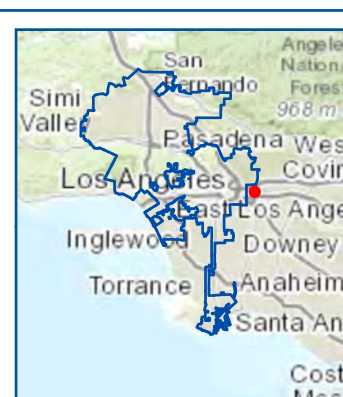
N
W E
S

0 100 200
Feet

1 inch = 112 feet

- BMP Site Data Points
- Selected BMP Site
- Contour
- CatchBasin
- GravityMain
- LateralLine
- OpenChannel
- ULAR_BMPAreas



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation
MP01: Sierra Vista Park

PN 182198

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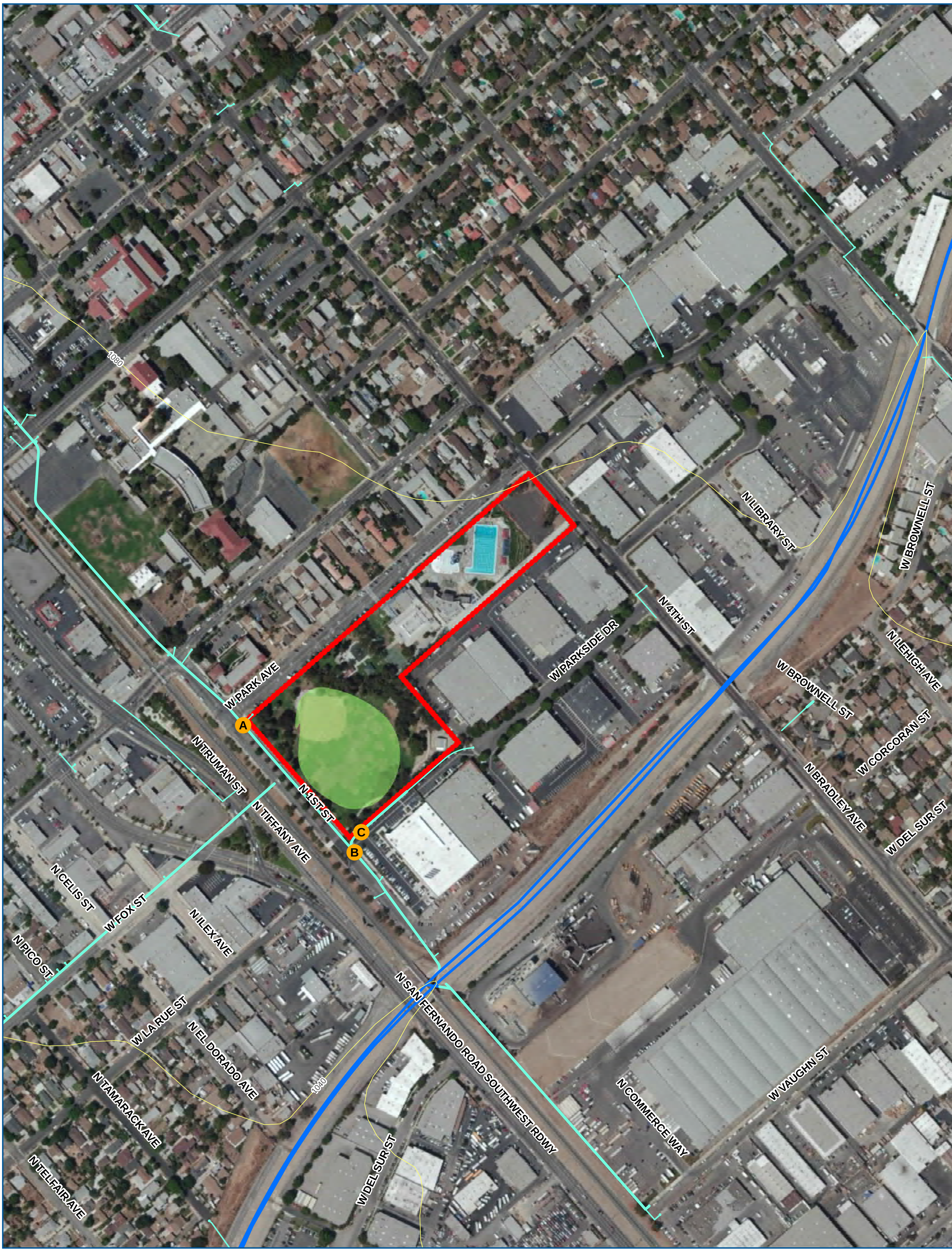
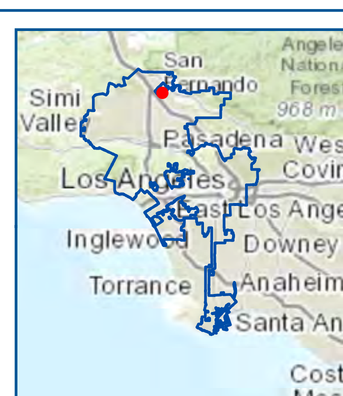


N
W E
S

0 200 400
Feet

1 inch = 333 feet

- BMP Site Data Points
- Contour
- CatchBasin
- GravityMain
- LateralLine
- OpenChannel
- ULAR_BMPAreas
- Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

SF01: San Fernando

PN 182198

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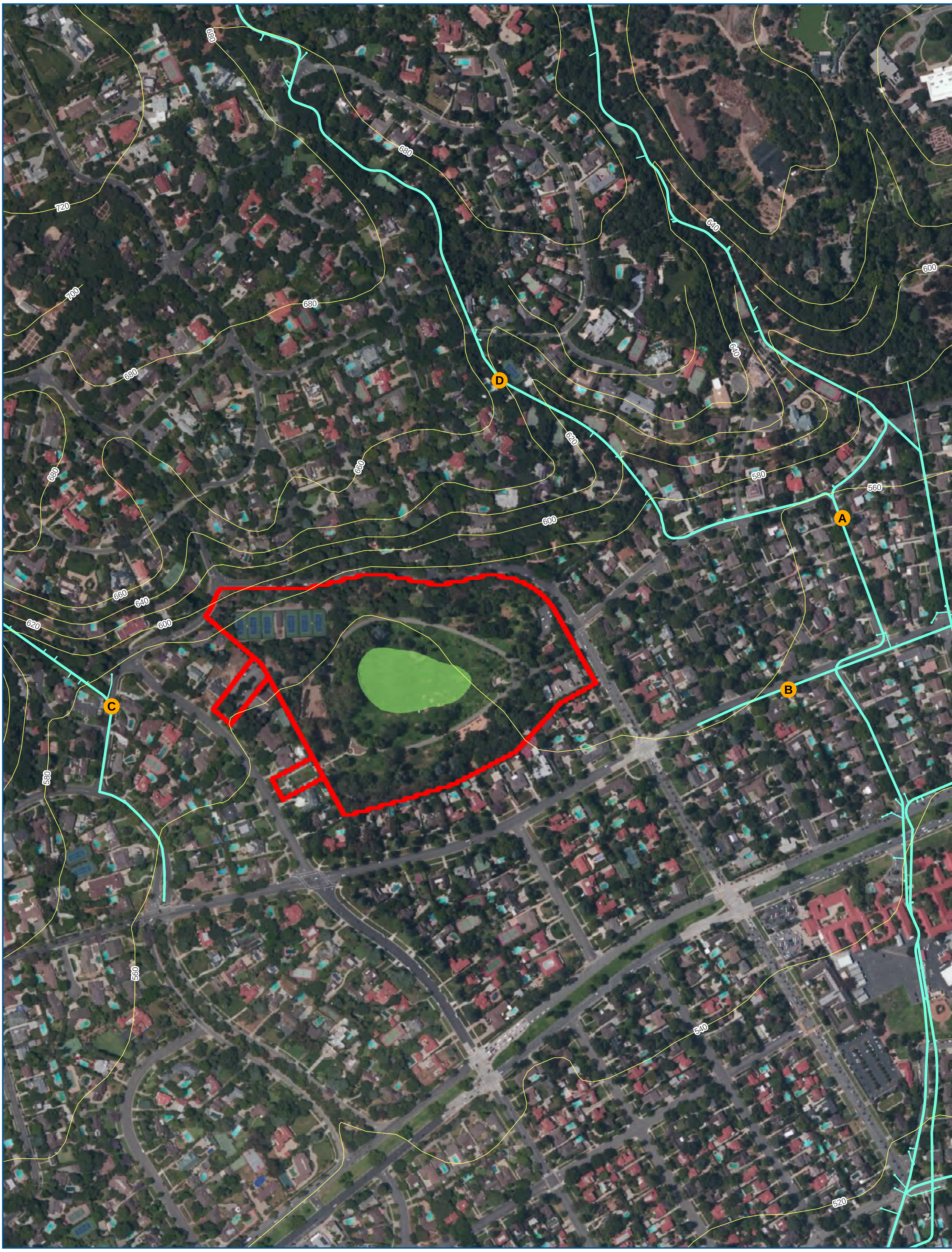
SF01 February 18, 2015 J. Thompson

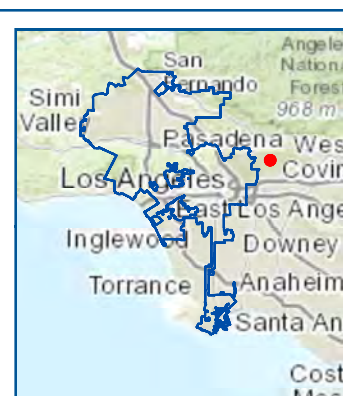


N
W E
S

0 300 600
Feet

1 inch = 417 feet

- BMP Site Data Points
- Contour
- CatchBasin
- GravityMain
- LateralLine
- OpenChannel
- ULAR_BMPAreas
- Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

SM01: Lacy Park

PN 182198

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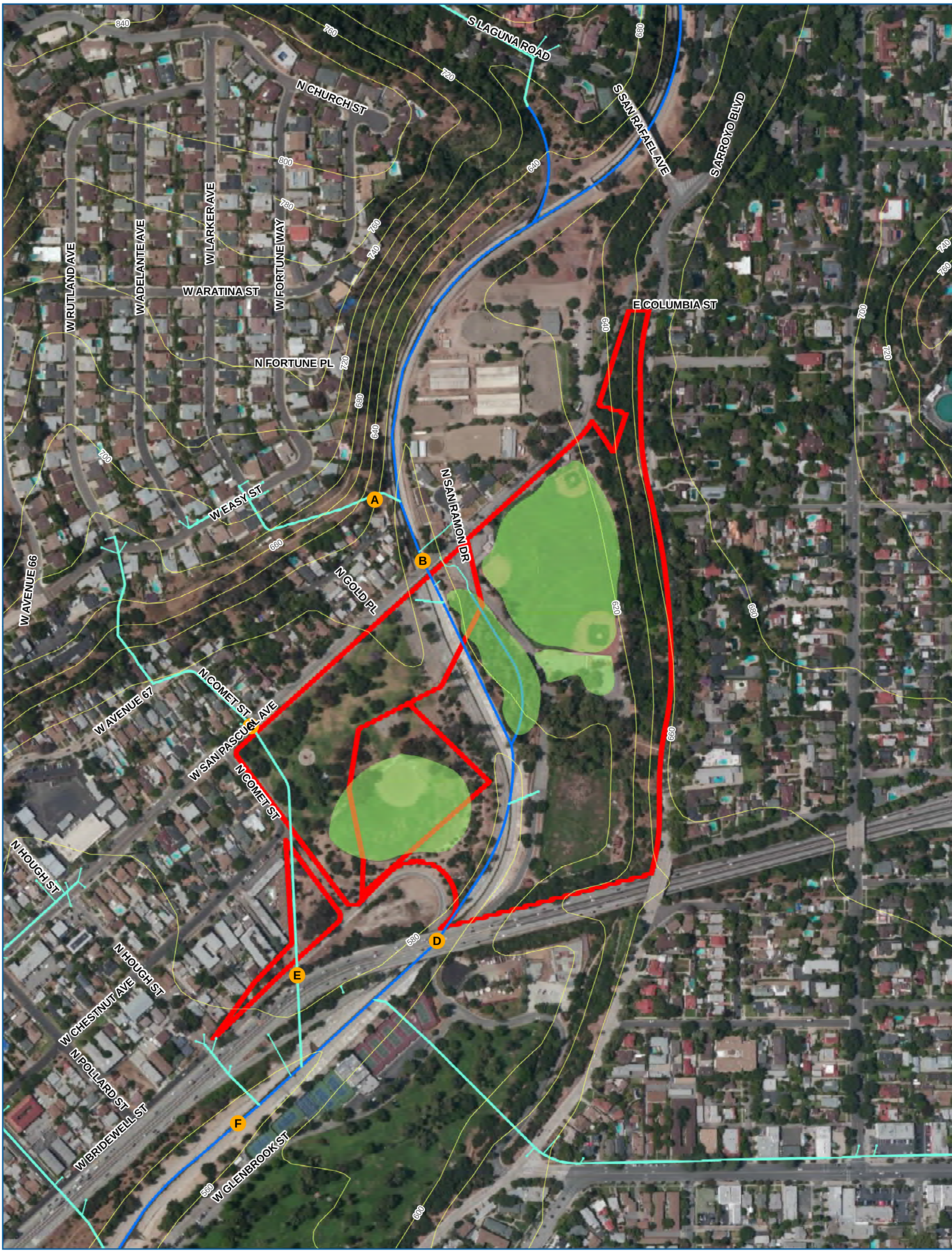
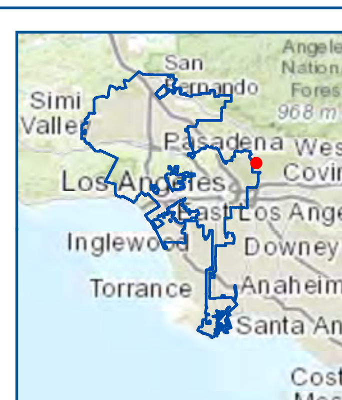
SM01 February 18, 2015 J. Thompson



N
W E
S

0 300 600
Feet
1 inch = 333 feet

- BMP Site Data Points
- Contour
- Catch Basin
- Storm Drain Netowrk
- Open Channel
- Opportunity Areas
- Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

SP01: Lower Arroyo Park

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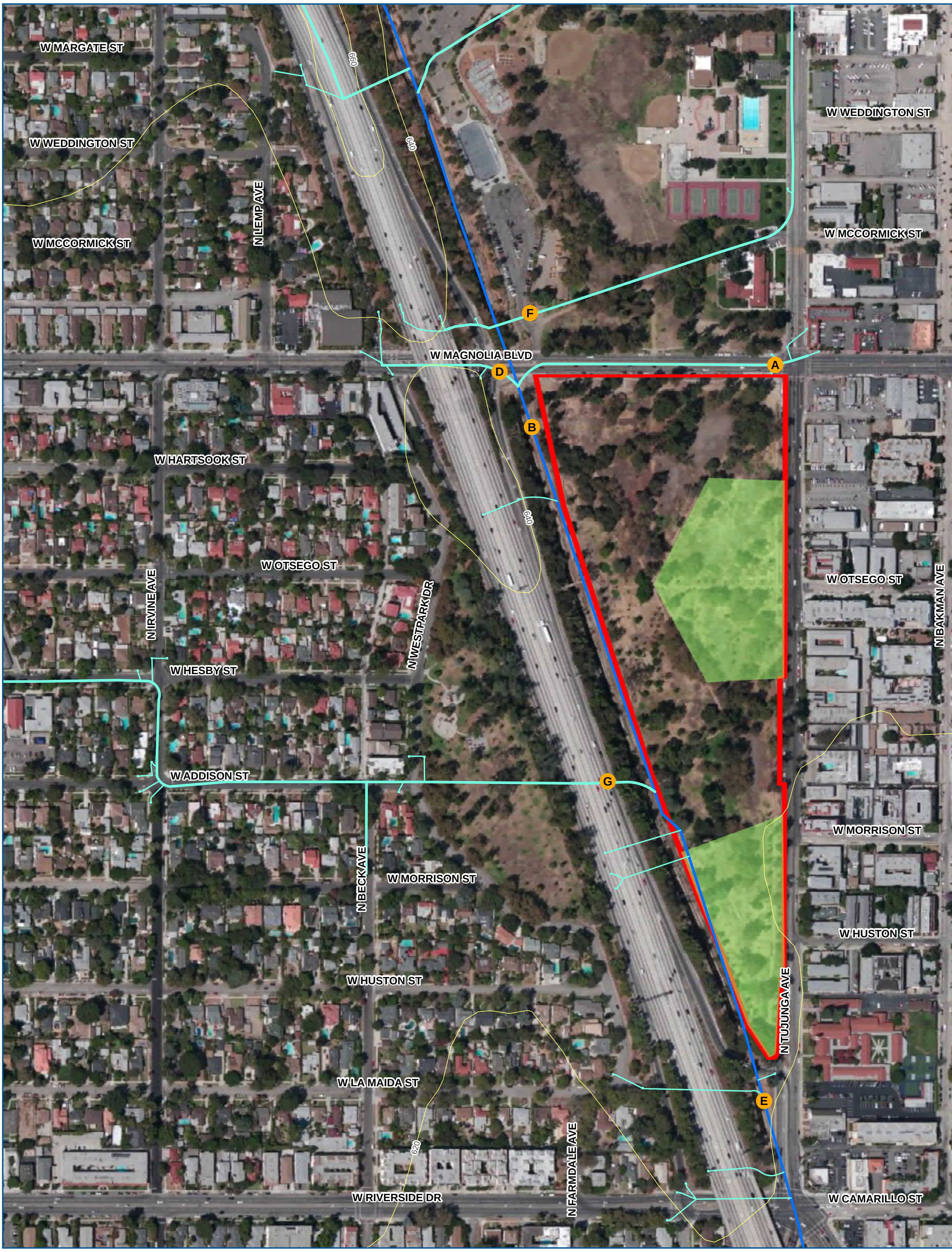
SP01 February 18, 2015 J. Thompson

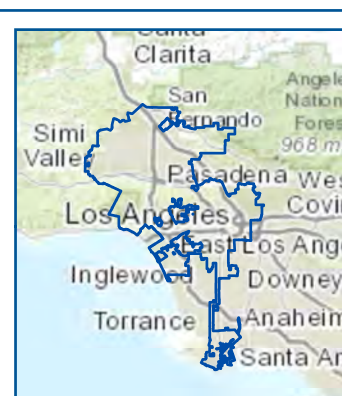


N
W E
S

0 250 500
Feet

1 inch = 300 feet

BMP Site Data Points
Contour
Catch Basin
Storm Drain Netowrk
Open Channel
ULAR_BMPAreas
Selected BMP Site



Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

NHP: North Hollywood Park

PN 182198

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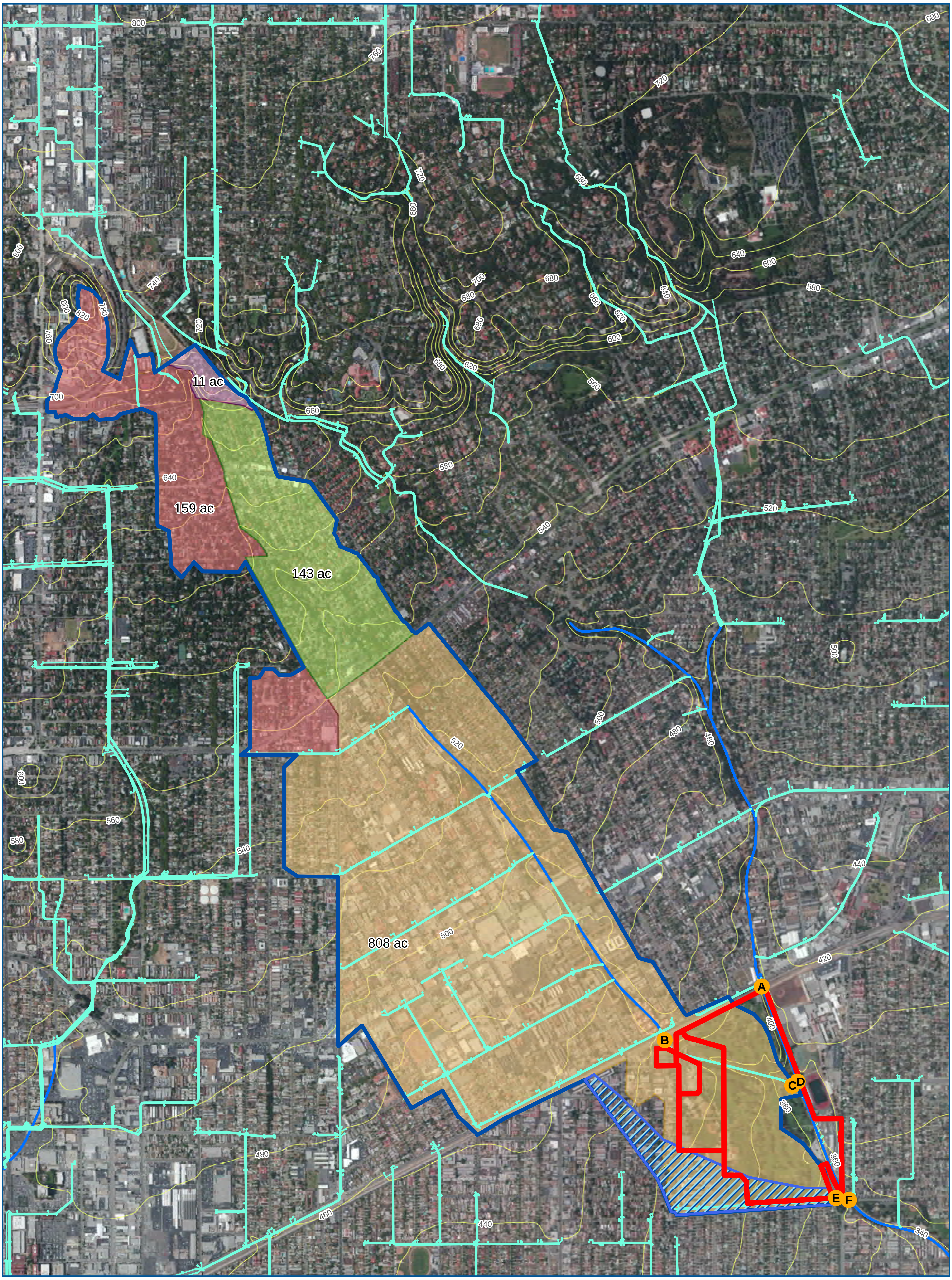
NHP February 18, 2015 J. Thompson

APPENDIX E

TRIBUTARY DRAINAGE AREA MAPS PER PROJECT



- BMP Site Data Points
- Selected BMP Site
- Contour
- Catch Basin
- Gravity Main
- Lateral Line
- Open Channel

Drainage Area per City

- Alhambra
- Pasadena
- San Marino
- South Pasadena

Drainage Area

- Min Drainage Area
- Max Drainage Area

N W E S

0 900 1,800
Feet
1 inch = 1,500 feet

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation AL01: Almansor Park

PN 182198

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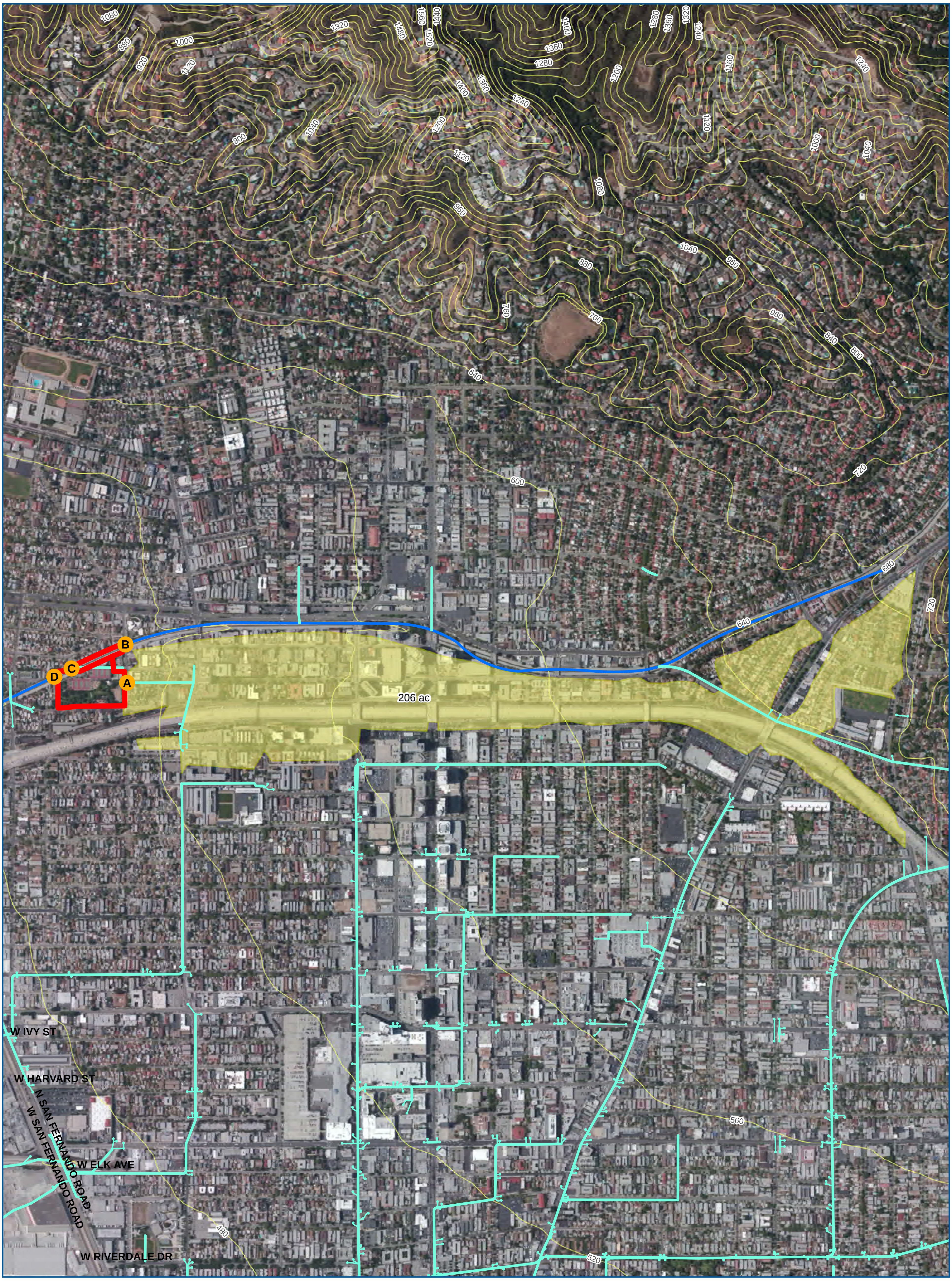
AL01 February 17, 2015 J. Thompson



N
W E
S

0 650 1,300
Feet
1 inch = 1,100 feet

- BMP Site Data Points
- Selected BMP Site
- Contour
- Catch Basin
- Lateral Line
- Gravity Main
- Open Channel

Drainage Area per City

- Glendale

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

GL01: Fremont Park PN 182198

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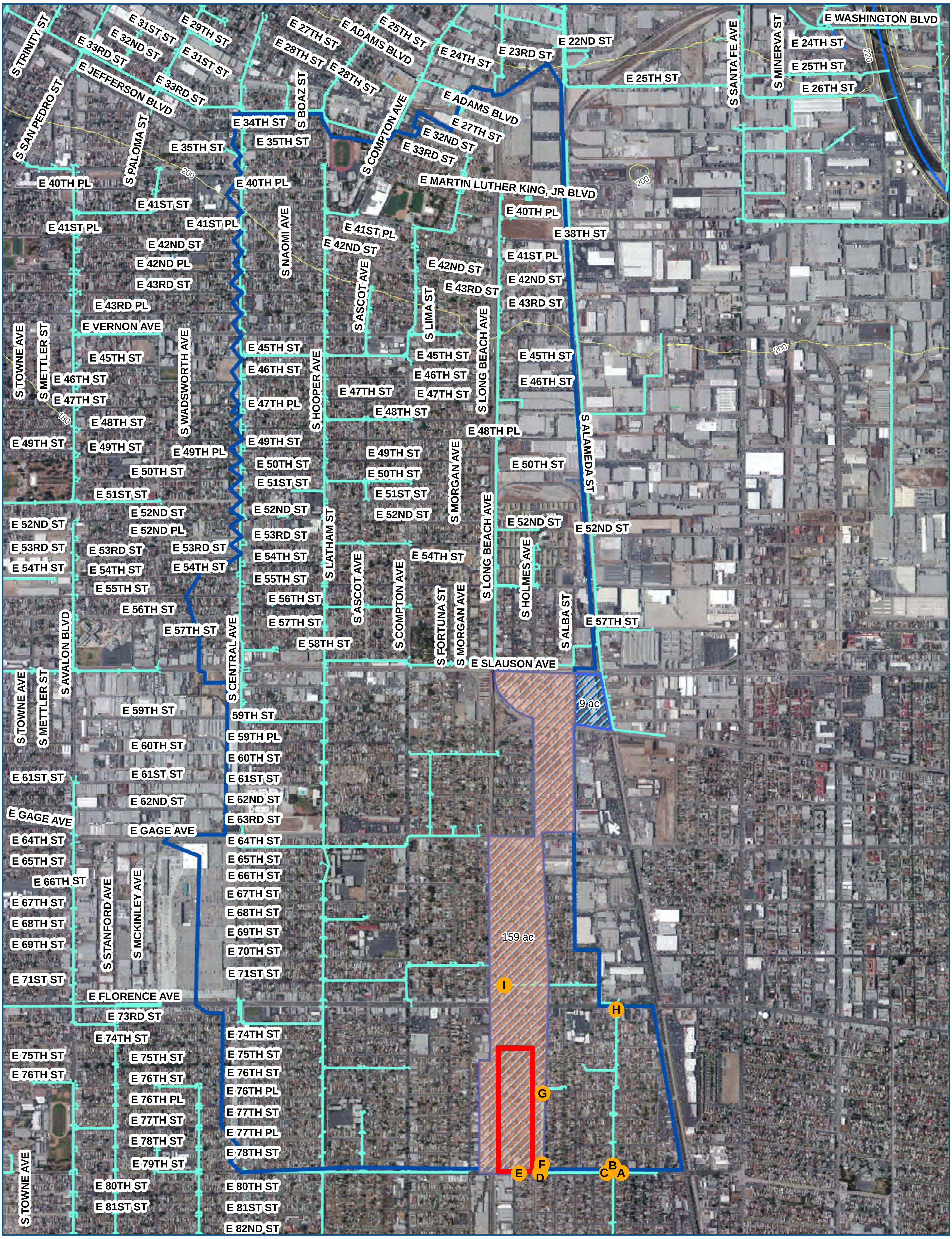

N
W E
S

0 900 1,800

Feet

1 inch = 1,500 feet

- BMP Site Data Points
- Selected BMP Site
- Catch Basin
- Lateral Line
- Gravity Main
- Open Channel
- Contour

Drainage Area per City

- Unincorporated

Drainage Area

- Min Drainage Area
- Max Drainage Area

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

LAC01: RooseveltPark

PN 182198

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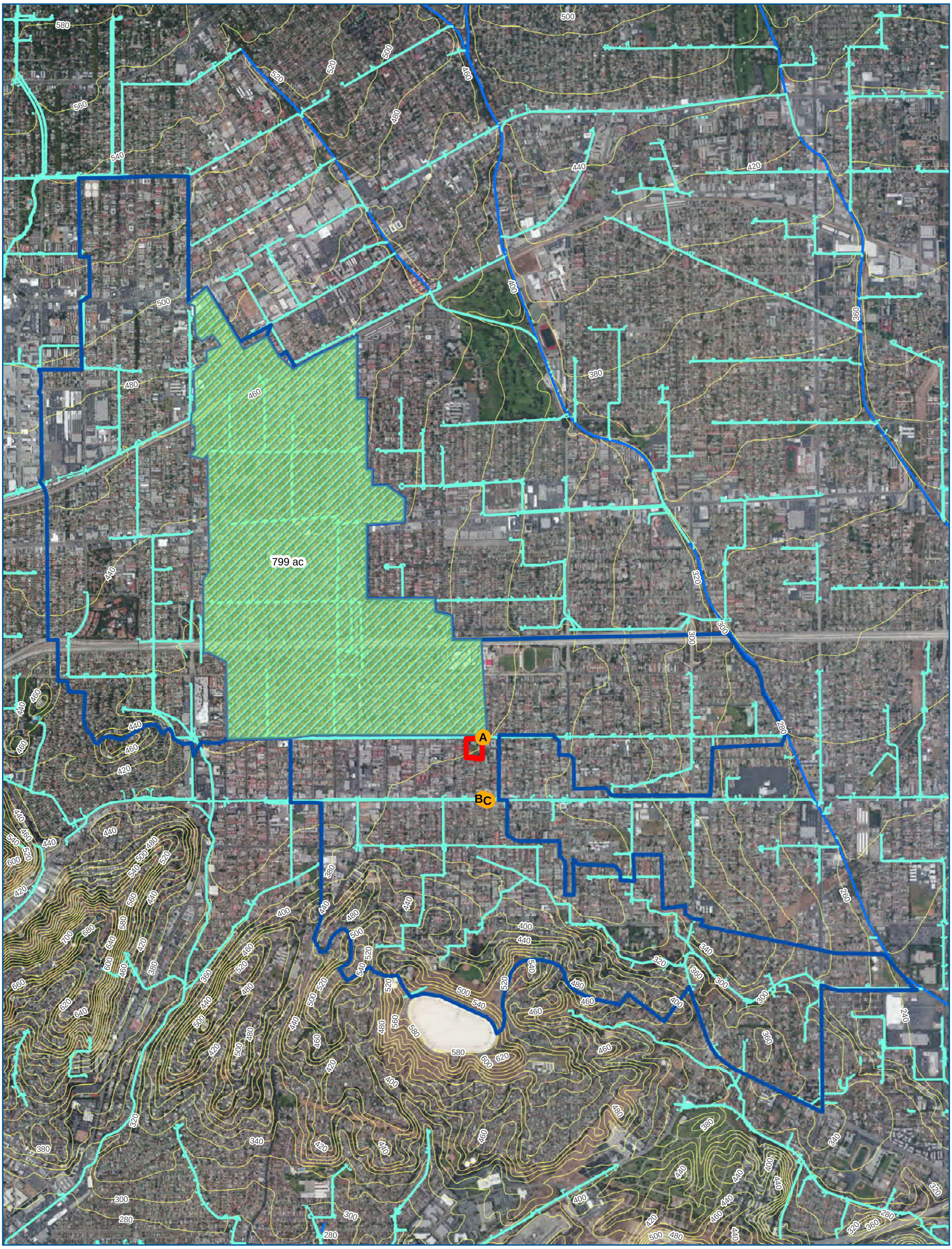
LAC01 February 17, 2015 J. Thompson



BMP Site Data Points
Selected BMP Site
CatchBasin
GravityMain
LateralLine
OpenChannel
Contour

Drainage Area per City
MP01

Drainage Area
Min Drainage Area
Max Drainage Area

N W E S

0 1,200 2,400
Feet
1 inch = 2,000 feet

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation
MP01: Sierra Vista Park
PN 182198

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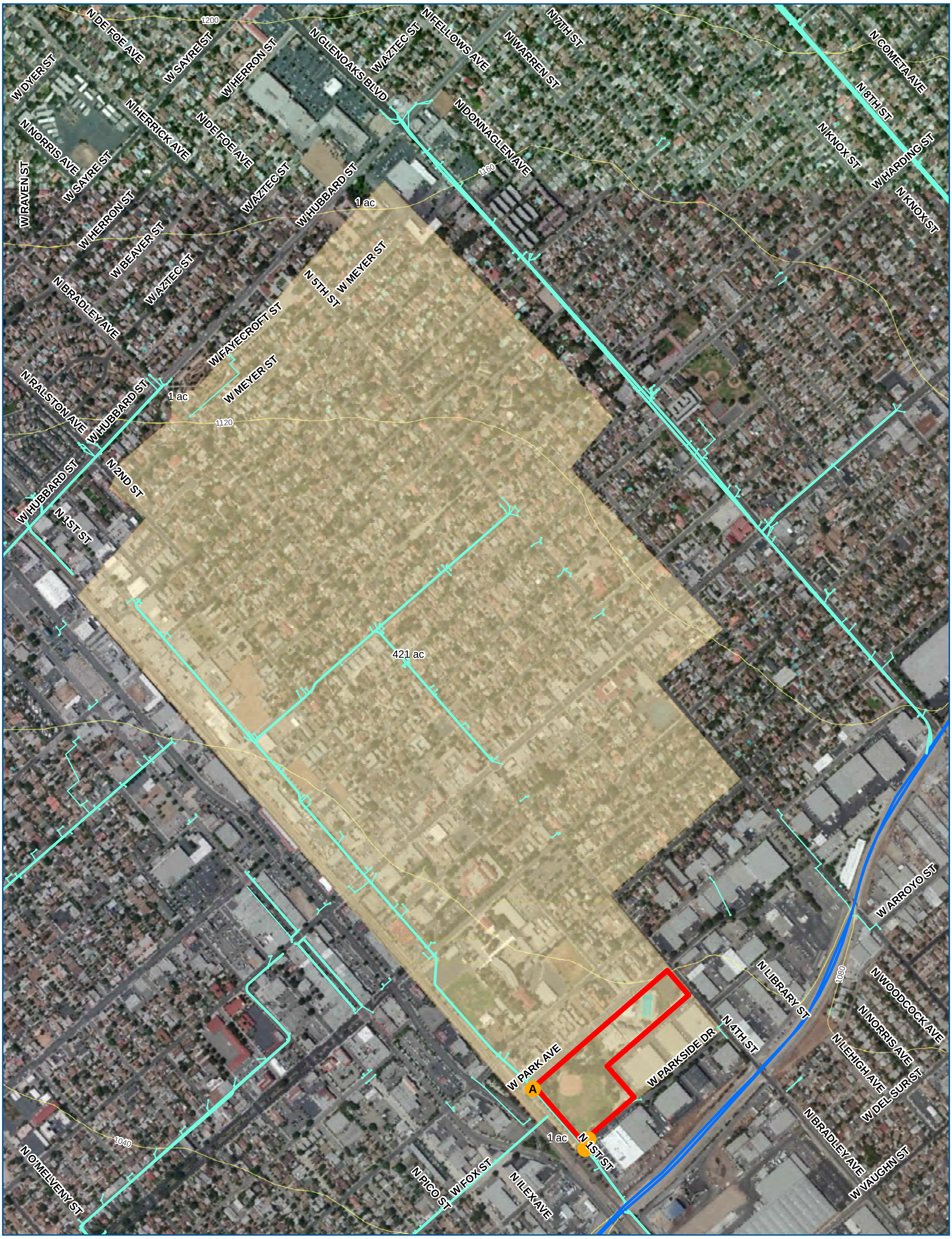

N
W E
S

0 420 840
Feet
1 inch = 700 feet

- BMP Site Data Points
- Selected BMP Site
- Contour
- Catch Basin
- Gravity Main
- Lateral Line
- Open Channel

Drainage Area per City

San Fernando

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

SF01: San Fernando

PN 182198

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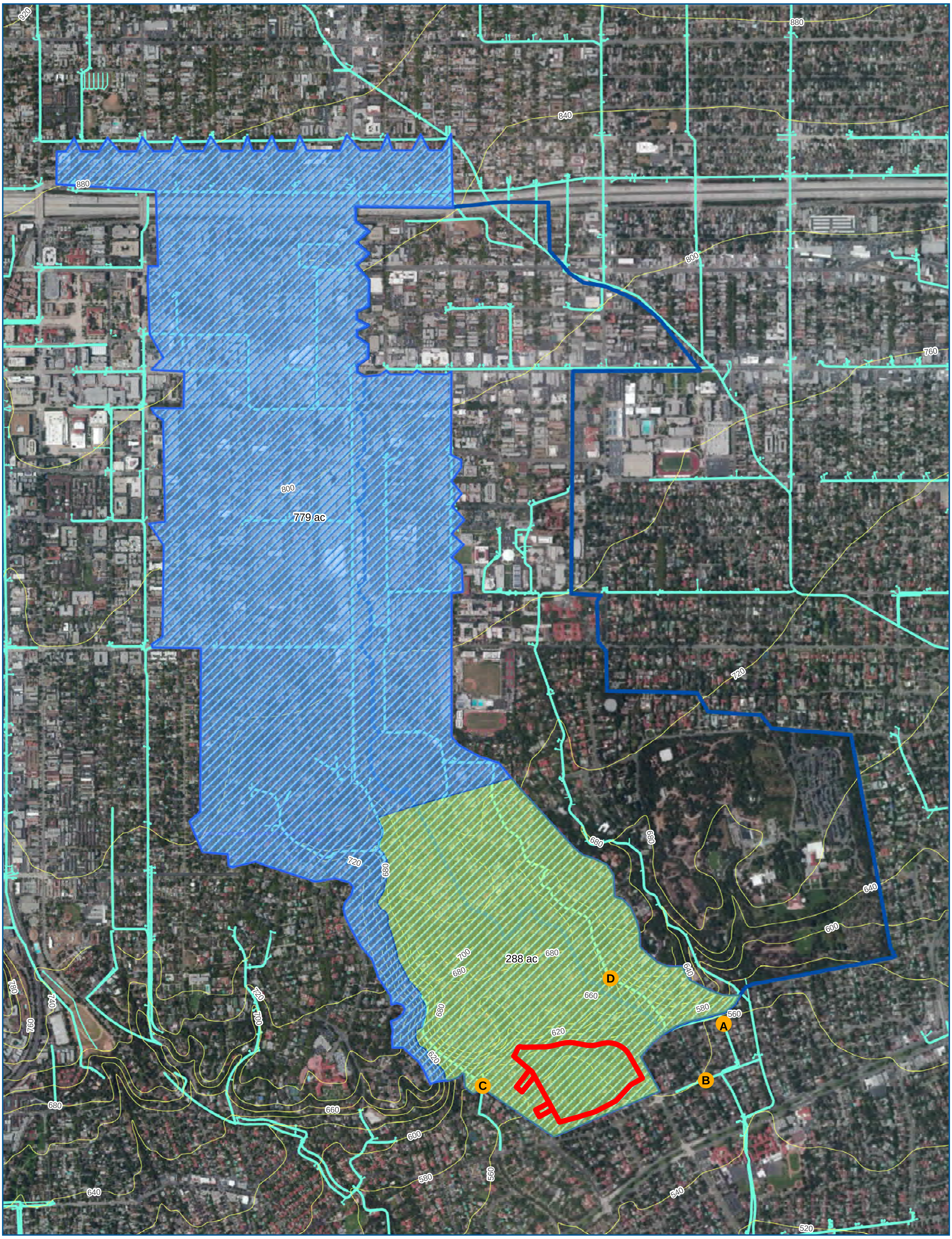
SF01 February 17, 2015 J. Thompson



BMP Site Data Points
Selected BMP Site
Contour
CatchBasin
GravityMain
LateralLine

Drainage Area per City
Pasadena
San Marino

Drainage Area
Min Drainage Area
Max Drainage Area

0 750 1,500
Feet
1 inch = 1,250 feet

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

SM01: Lacy Park

PN 182198

BLACK & VEATCH
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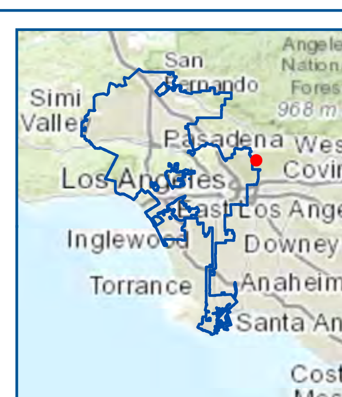
SM01 February 17, 2015 J. Thompson



N W E S

0 385 770 Feet

1 inch = 600 feet

- BMP Site Data Points
- Selected BMP Site
- Catch Basin
- Gravity Main
- Lateral Line
- Open Channel
- Contour

Drainage Area per City

- Los Angeles
- South Pasadena

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation
SP01: Lower Arroyo Park

PN 182198

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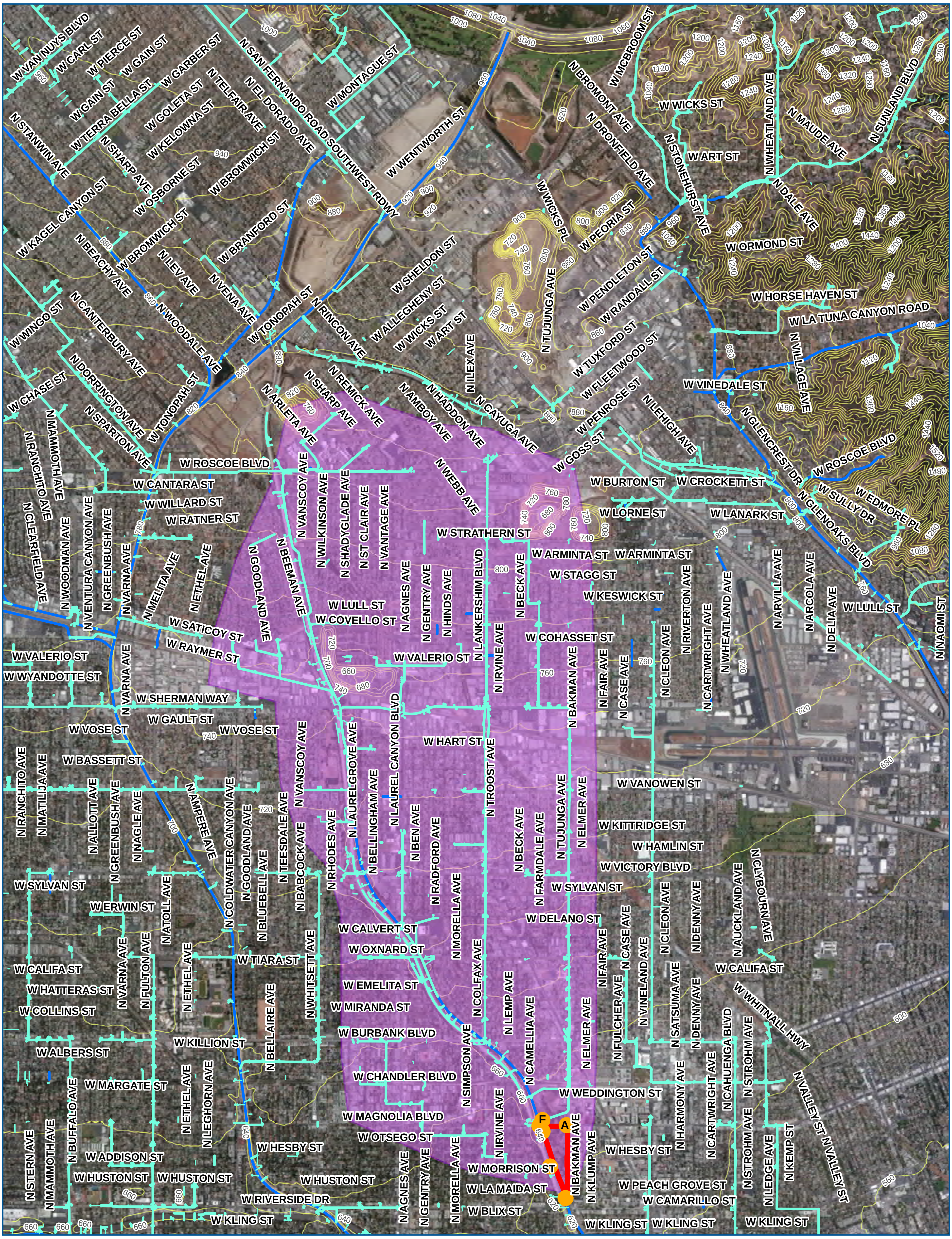

N

W E

S

0 1,800 3,600

Feet

1 inch = 3,000 feet

- BMP Site Data Points
- Selected BMP Site
- Contour
- Catch Basin
- Gravity Main
- Lateral Line
- Open Channel

Drainage Area per City

- Los Angeles

Upper Los Angeles River Enhanced Watershed Plan

BMP Site Investigation

NHP: North Hollywood Park

PN 182198

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NHP February 17, 2015 J. Thompson

Appendix 4.D
Pump Plant Conceptual Design Reports

Appendix 4.D.1

Upgrades to Pump Plants and Associated Stormwater Treatment Opportunities in the City of Los Angeles Upper Los Angeles River Watershed

Implementation Strategy for Pump Plant 621

Upgrades to Pump Plants and Associated Stormwater Treatment Opportunities in the City of Los Angeles Upper Los Angeles River Watershed

Implementation Strategy for Pump Plant 621

Jointly prepared by:

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City of Los Angeles
LA Sanitation
Watershed Protection Division
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Los Angeles, CA 90015-2213

June 11, 2015

Contents

1. Introduction

Multiple pollutants currently impair the beneficial uses of the Los Angeles River. To address these impairments, the City of Los Angeles (City) must comply with the water quality requirements presented in the Municipal Separate Storm Sewer System (MS4) Permit and State-mandated total maximum daily loads (TMDLs). Recently prepared Enhanced Watershed Management Programs (EWMPs) prescribe collaborative and adaptive strategies for the City to attain compliance with these requirements; however, the scale of implementation is extraordinary.

EWMP Requirement:
Implement >3,000 acre-feet of BMPs in the ULAR basin before 2037

The EWMPs currently forecast implementation of over 3,000 acre-feet of green infrastructure, best management practices (BMPs) and regional control measures by the City (totaling $3.8 billion in capital cost) in the Upper Los Angeles River (ULAR) watershed alone. At this scale, cost-effective implementation will be challenging in many locations, particularly when the suitable opportunities for stormwater treatment are *not* located near runoff and pollutant sources. One solution is to divert runoff to the highest efficiency opportunities using existing infrastructure.

There are multiple aging pump plants located strategically throughout the City of Los Angeles – each intended to alleviate or prevent flooding in low lying areas where gravity flow is not feasible (Figure 1). If upgrades to these pumps can be leveraged to provide water quality benefits (Figure 2), the advantages are two-fold:

1. ***Creating* High-Efficiency Treatment Opportunities:** The efficiency (pollutant reduction per dollar) is maximized by routing runoff to areas with high treatment potential and maximizing the treated drainage area using existing infrastructure.
2. **Improving Resilience:** Control measures sited upstream from pumps can reduce pump cycle frequency, energy use, and maintenance burden by intercepting and retaining runoff volume from small storm events.

This conceptual design describes recommended upgrades to the aging infrastructure at Pump Plant 621 along with integrating multi-benefit stormwater treatment strategies into the plant upgrades. A cost-effective solution that addresses Permit water quality requirements in tandem with flood control functions will be recommended. These solutions would also provide multiple other benefits for residents and businesses in the area, and promote a greener, healthier, and more sustainable urban landscape. The concepts will justify incorporating water quality components into future infrastructure upgrades, and will have wider implications when considering leveraging existing infrastructure to support integrated water planning (OneWater) in the Los Angeles region.

EXISTING CONDITIONS

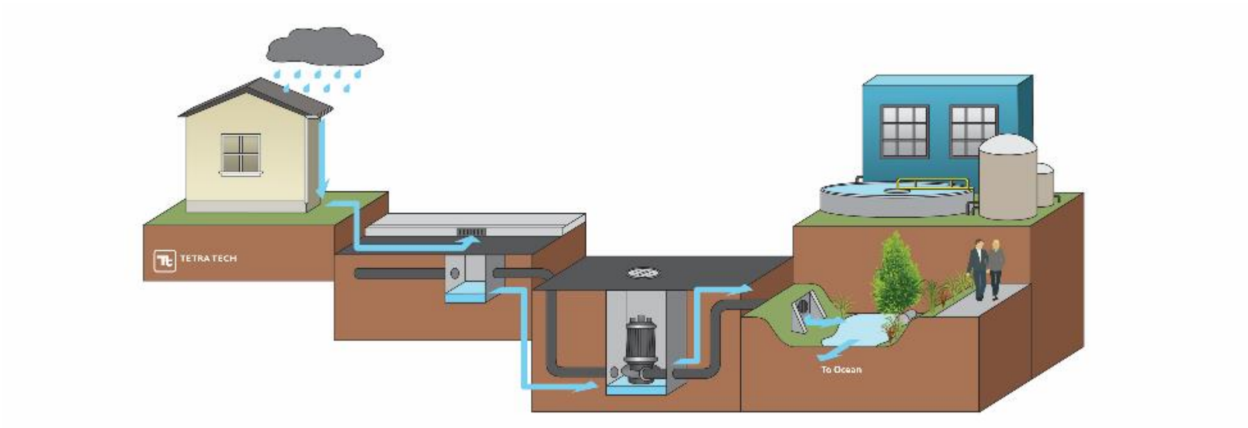


Figure 1. Conceptual diagram illustrating a typical infrastructure design. Pumps in low-lying areas use energy to convey runoff directly to the receiving water without treatment. In some instances, dry weather flows are diverted to the sanitary sewer for treatment.

POTENTIAL SYNERGY: LEVERAGING INFRASTRUCTURE UPGRADES

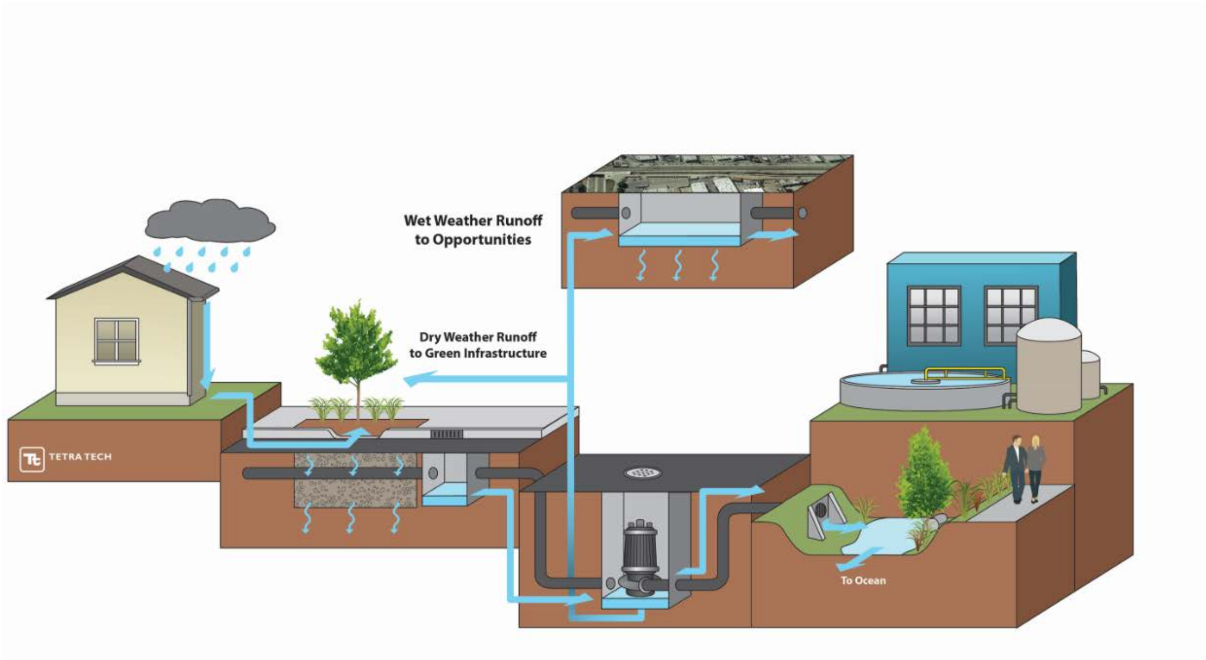


Figure 2. Conceptual diagram illustrating the potential benefits of integrating water quality design into future upgrades. Integrating water quality and flood control can lead to cost-effective treatment by taking advantage of existing facilities to move runoff to BMP opportunities. Upstream control measures can also reduce the burden on pumps by intercepting runoff near the source.

2. Background

This conceptual design focuses on the rehabilitation and green infrastructure modification of Pump Plant 621. Key background information, such as regulatory context and a description of the project site is provided in the following paragraphs.

2.1. Stormwater Regulations and Work to Date

The LA River is on the *Clean Water Act 303(d) List of Water Quality Limited Waterbodies* for ammonia, bacteria, zinc, copper, lead, algae, oil, and trash. To address these impairments, the State has developed TMDLs for metals, nitrogen, and trash, which contain compliance schedules for the City to reduce impacts from stormwater discharges. The LA River Metals TMDL has a final wet weather compliance date of 2028, and zinc is recognized in the EWMP as a priority pollutant. The LA River Bacteria TMDL, perhaps the most challenging TMDL faced by the City, has a wet-weather compliance date of 2037. Moreover, compliance of these TMDLs would also address the pollutant reduction requirements of the 2012 MS4 (MS4) Permit (Order No. R4-2012-0175; NPDES Permit No. CAS004001). The stormwater project described herein would be a key component of the metals and bacteria Load Reduction Strategies for Segment D-Reach 4 of the LA River, and would address many other stormwater pollutants from the targeted subwatershed during wet weather.

2.2. Project Location and Site Description

The targeted drainage area, containing portions of subwatersheds 667349 and 685049, is a T-shape area bordered by Pacoima Wash to the west, Van Nuys Boulevard to the east, Arminta Street to the north, and Keswick Street to the south, as shown in Figure 3 and Figure 4. The targeted drainage area is serviced by 2 catch basins that drain to a network of both city and county storm drains that ultimately discharge to the Los Angeles River (Figure 3 and Table 1). Pump Plant 621 dewaters the sag below a railroad bridge crossing on Van Nuys Boulevard and receives stormwater runoff from a 10-acre drainage area.

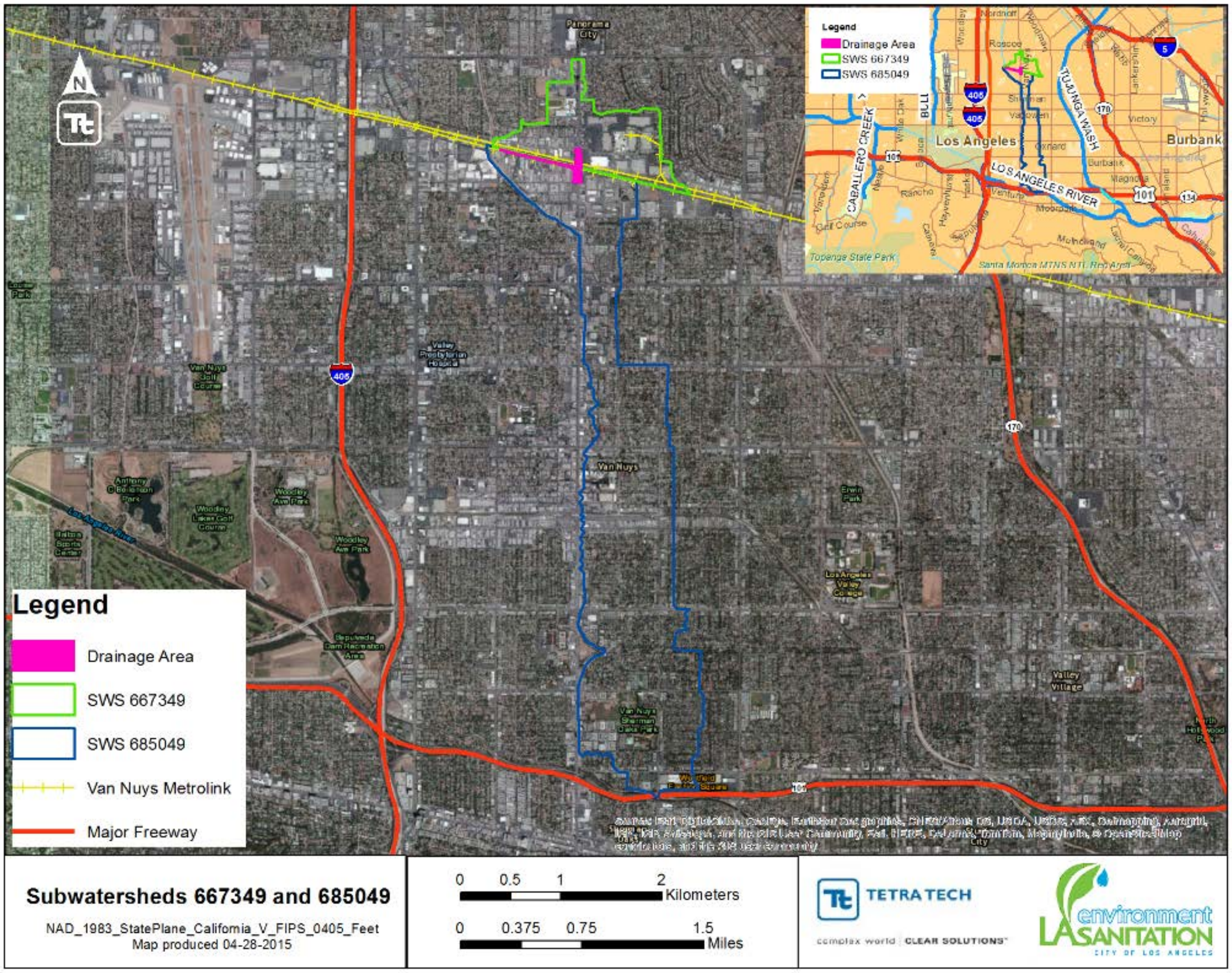


Figure 3. Subwatersheds 667349 and 685049.

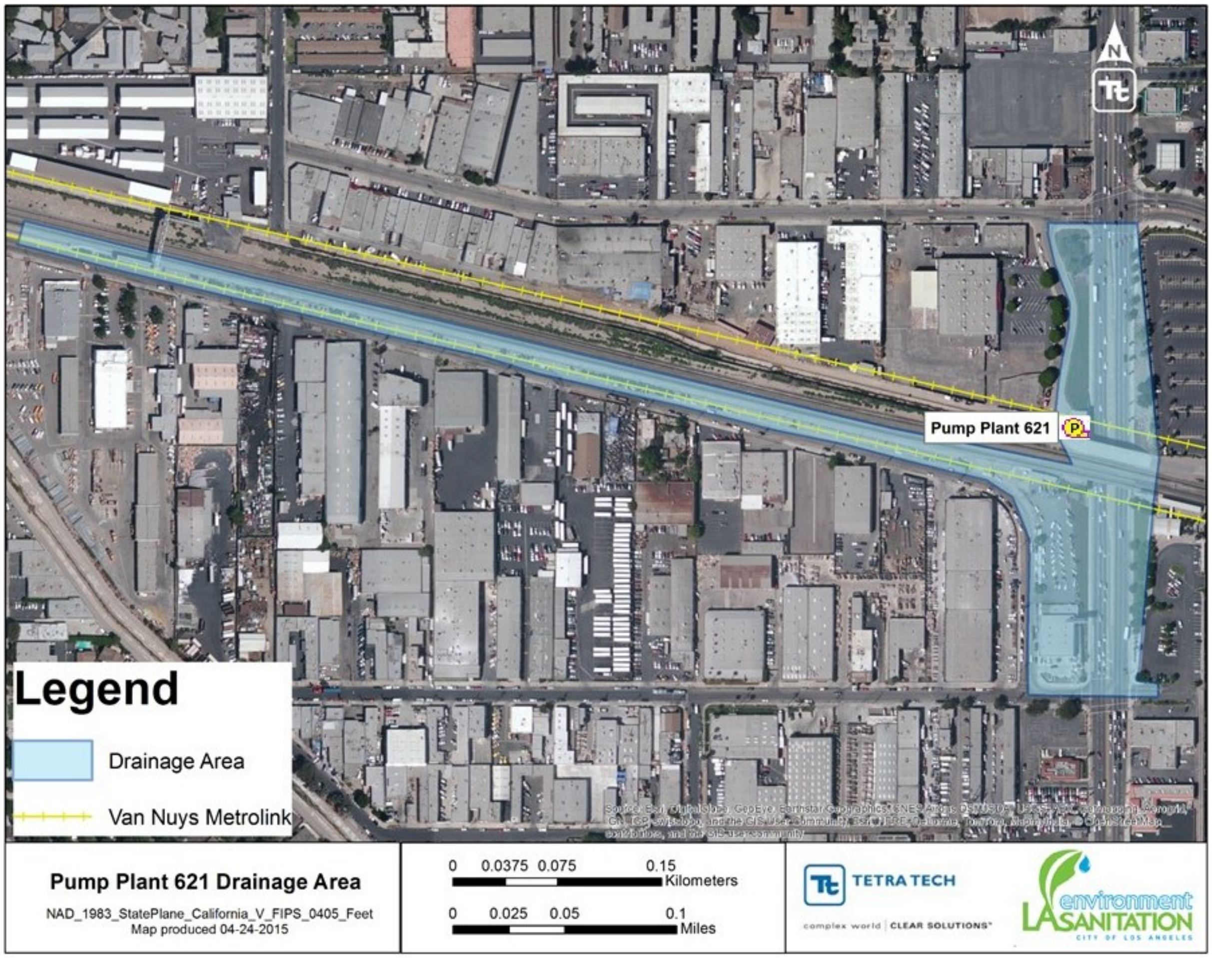


Figure 4. Target Drainage Area.

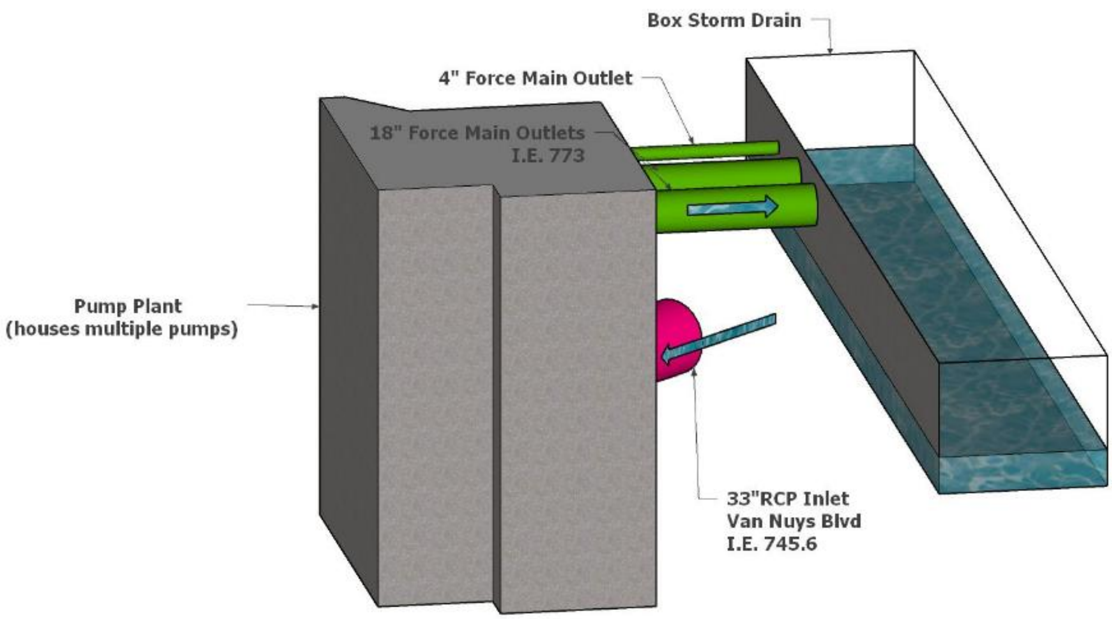
Table 1. Site summary.

Site attribute	Value
Watershed	Upper Los Angeles River
Subwatershed	SWS 667349 and 685049
Total Pump Plant Drainage Area	10 acres

3. Proposed Pump Plant Upgrades

Pump Plant 621 is intended to provide flood protection to Van Nuys Boulevard north of Keswick Street in the Van Nuys area of the City. It does so by lifting storm water flows from the sump in Van Nuys Boulevard below the Metrolink railroad tracks up to a box culvert storm drain located parallel and to the north side of the Metrolink railroad tracks. This box culvert generally flows southeast and eventually ties into the Los Angeles County drainage system and the Los Angeles River. The current configuration of the pumping station is shown in Figure 5.

A)



B)

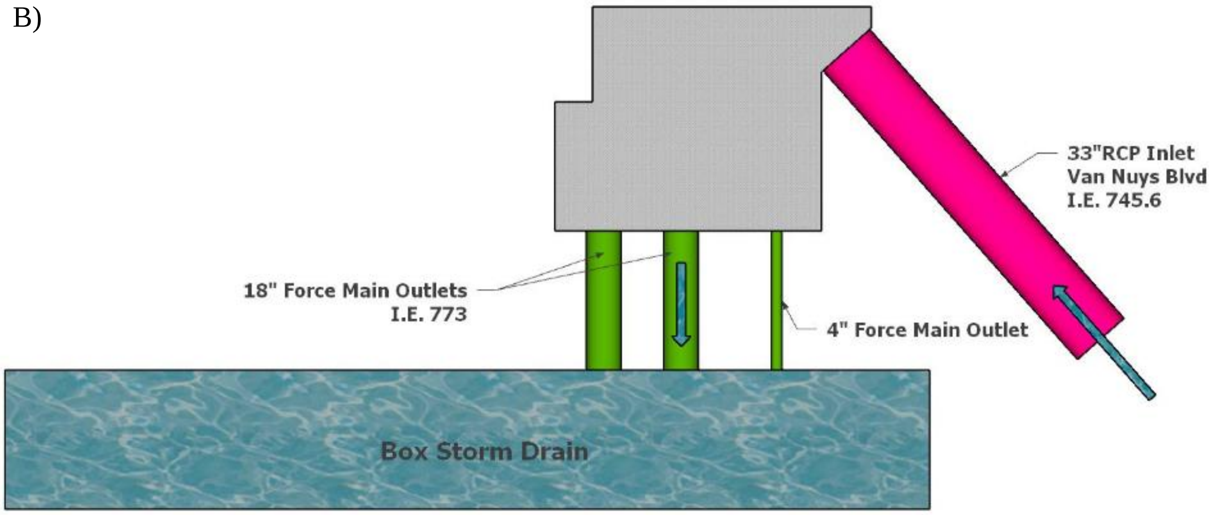


Figure 5. A) Isometric Configuration of Pump Plant 621. B) Plan Configuration of Pump Plant 621.
Note: Green indicates outlet pipes and pink indicates inlet pipes.

The characteristics of the Pump Plant 621 are summarized in the following sections. This information was obtained through a review of the as-built plans, a site visit to the plant, and information obtained from LA Sanitation.

3.1. General Description of Pump Plant No. 621 (Van Nuys)

- Street address: 7805 Van Nuys Boulevard, Van Nuys, CA.
- Constructed in 1964.
- Underground reinforced concrete structure with three levels: a motor/electrical room level, a bar screen room level, and a storage room level.
- Reinforced concrete stairs provide access to the interior of the pump plant from the ground surface and between levels.
- Miscellaneous metal items are damaged including railings, ladders, bar screens, and ventilation louvers.
- Lighting is original and inadequate for many maintenance operations.
- The plant incorporates three pumps: two service pumps and one sump pump.
- The plant wet well storage is approximately 28,905 gallons.
- Inlet pipe is a 33" ID RCP with an invert elevation of 745.66.
- Main outlets are dual 18" DIP force mains (one for each pump) with a peak invert elevation 776.0 and a discharge invert elevation of 773.16.
- Sump pump outlet is 4" CIP with an invert elevation of 771.0.
- A 150 KW Waukasha natural gas backup generator is located in the motor room.
- The trash hoist included in the original design is not operational.
- A warning tag is in place on the service section of the switchboard reading "CAUTION PLANT ELECTRICAL FEED IS UNGROUNDED 480 VOLT."
- The surface of the site is open to the public except for an approximately 160 square foot area that is enclosed by a chain link fence. The plant access stairs, gas meter, and backflow preventer are behind the fence.
- Security problems were noted at the site – the chain link fence has damage and there is evidence of intruders (graffiti, garbage, etc.).
- Based on discussions with maintenance staff, flooding on Van Nuys Boulevard occurred earlier in 2015, possibly due to a bubbler level control failure.

3.2. Existing Pumps and Proposed Upgrades

This section describes the existing and proposed pump types and capacities for Pump Plant 621.

3.2.1. Existing Duty Pumps

Based upon information provided by operations staff, the two duty pumps are Johnson vertical turbine pumps each with a pumping capacity of 6,750 gpm (15.0 cfs) at a static head of 32'. These pumps are each powered by a single speed, 75 HP motor manufactured by Fairbanks Morse. The intent is for one pump to operate at a time, providing 100% back-up redundancy.

Per the City of Los Angeles Storm Drain Design Manual, sump areas like this are to be sized for the 50-year storm. The 50-year storm for this this area was calculated to be approximately 21 cfs in Appendix B. The pump capacity of Plant 621 is 15 cfs, approximately 25% less than the 50-year storm.

The Pump # 2 housing appears to have a wear hole that has been patched.

3.2.2. Existing Sump Pump

Based upon information provided by operations staff, the sump pump is a Pacific submersible pump with a single speed 5 HP motor with a rated flow rate of 250 gpm. The purpose of this pump is to slowly drain the storage room from the low water level to the sump level after a storm is over. Based upon discussions with maintenance staff, this pump is not operational.

3.2.3. Proposed Duty Pumps

Due to the age, condition, and flow capacity, the two main duty pumps should be replaced and upgraded to meet the 50-year storm of 21 cfs. This would provide 100% redundancy for the station. Because of the flow requirements and available space within the existing station, vertical turbine solids handling pumps (similar to the existing ones) are considered.

The preliminary pumps selected for this application are Fairbanks Morse model 20" VTSH LH solids handling pump with 150 HP motors. To reduce the power load demand on motor start-up, solid state soft starters should be considered for the motor control center. The pump system curve for the duty pumps is included in Appendix C.

3.2.4. Proposed Sump Pump

The existing sump pump is rated at 250 gpm and has a 5 HP motor, but is not currently operational and should be replaced. To replace this pump, a submersible pump with integral motor is considered to dewater the wet well and convey flow to the downstream treatment BMP (Section 5.1).

To meet the BMP 85th percentile flow of 1.2 cfs (as discussed in Section 4), the preliminary pump selected for this application is a Fairbanks Morse model 4" 5434 M&W submersible pump with 10 HP motor. The pump system curve for the sump pump is included in Appendix C.

3.2.5. Pump System Summary

The existing and proposed pump system for Pump Plant 621 is summarized in Table 2.

Table 2. Existing and proposed pump system components.

Existing Conditions				
Pump	Pump Type	Pump Capacity (gpm)	Static Head (feet)	Power (HP)
Duty Pump #1	Johnson vertical turbine	6,750	32	75
Duty Pump #2	Johnson vertical turbine	6,750	32	75
Sump pump	Pacific sump pump	250	N/A	5
Proposed Conditions				
Duty Pump #1	Fairbanks Morse 20" VTSH	9,450	43	150
Duty Pump #2	Fairbanks Morse 20" VTSH	9,450	43	150
Sump pump	Fairbanks Morse model 4" 5434 M&W	520	38	10

3.3. Structural Integrity

Based upon our cursory visual examination of the pump plant, which was limited to those portions that were exposed to view (top of roof slab and pump plant interior), the structure appeared to generally be in good to very good condition. There are hairline concrete cracks that occur at various locations throughout the structure, which is not uncommon for conventionally reinforced concrete. There are cracks in the concrete roof beams around the steel roof access hatch, as well as light surficial corrosion of the hatch cover (see Figure 6). There are also water stains at the beam cracks, indicating through-cracks with some minor leakage from above. Adjacent to the steel roof hatch, there are a couple of roof slab through-cracks with water stains (Figure 7). Around the concrete roof hatches, there are through-cracks in the roof beams with water stains (see Figure 8). In the Motor Room, there is some cracking at the bottom of the floor slab around the square slab openings (see Figure 9). In the Bar Screen Room, there are some vertical hairline cracks in the east wall with minor water stains, indicating through-cracks with some moisture penetration (see Figure 10 and Figure 11).

Figure 6. Surface Corrosion at Steel Access Hatch Cover and Roof Beam Cracks with Water Stains.

Figure 7. Roof Slab Cracks Adjacent to Steel Roof Access Hatch.

Figure 8. Roof Beam Cracks with Water Stains at Concrete Roof Hatches.

Figure 9. Cracks at Bottom of Motor Room Floor Slab Opening.

Figure 10. Vertical Wall Cracks in East Wall of Bar Screen Room (left of center and right of center).

Figure 11. Close-up View of Vertical Wall Crack.

3.3.1. Proposed Structural Upgrades

The overall condition of the structure appears to be satisfactory. Concrete cracks should be repaired by polyurethane injection in order to protect the concrete reinforcement from corrosion and to prevent future degradation and spalling of the concrete. Corrosion of the hatch cover should be monitored, and removal of the corrosion and recoating of the cover should be considered. Because there are no physical barriers preventing vehicular traffic from driving on top of the roof slab, it should be checked for its capability to support HS20 wheel loading. Alternatively, signs may be posted to limit the vehicular loads permitted on the roof or some physical features added to keep vehicular traffic from driving on top of the roof slab, such as bollards, barriers or curbs, placed around the roof slab.

Due to the proposed modifications noted below, minor structural modifications may be required to accommodate the new equipment.

3.4. Miscellaneous Upgrades

Based upon site observations and discussions with maintenance staff, the following miscellaneous repairs and upgrades should be considered:

- Replace damaged bar screens.
- Upgrade the Motor Control Center.
- Upgrade the SCADA / Instrumentation and Control Equipment.
- Replace pump discharge piping and valves.
- Install level control through ultrasonic sensors (primary) with float backup.
- Upgrade railings and ladders.
- Replace the chain-link fence access.
- Sand blast and paint the interior and exterior of the building.
- Replace the ventilation system.
- Upgrade the interior and exterior lighting.
- Replace generator in plant.
- Implement recommendations from the forthcoming Arc Flash Study (to be determined).

3.4.1. Conceptual Layout and Design

The concept elements of the Pump Plant are as follows:

- Replace and upgrade the duty pumps, sized to convey the 50-year storm.
- Replace the existing sump pump with a new submersible pump to dewater the wet well and convey the 85th percentile flow to the BMP.
- Perform miscellaneous upgrades.

3.4.2. Power Requirements

This section describes the power requirements needed to supply Pump Plant 621.

3.4.2.1. Electrical Supply

The pump plant has an existing 480V/250A service. A preliminary review indicates that the existing service is inadequate for the replacement pumps and should be upgraded to a 480V/500A service. The new motor control center should include a solid state soft starter to reduce the required load at pump startup.

3.4.2.2. Backup Power Supply

The existing 150 KW backup generator is not of sufficient size to power the replacement pumps. The generator is aging and it is not known if it complies with current regulations, particular for indoor installations. As an alternate to this generator, a new 250 KW natural gas powered backup generator could be installed within the motor room of the existing pump plant building.

3.4.3. Operations and Maintenance

Operations and maintenance (O&M) procedures will be very similar to those currently conducted at Pump Plant 621. Major O&M items include monthly exercising of pumps and generator, as well as annual in-depth inspection, lubrication, and scheduled/worn-out part replacement.

3.5. Preliminary Opinion of Cost

Including a 25% contingency, the preliminary opinion of cost to complete the Pump Plant upgrades is approximately $2.2 million. A more detailed breakdown of costs is included in Section 8.

Due to the preliminary level of this study, this preliminary opinion of cost should be considered suitable for the early planning stage of the project. As the work becomes more defined in the subsequent project stages, it is expected that the opinion of cost will be revised.

4. Green Infrastructure Alternative Analysis Evaluation for Wet Weather Treatment

Integrating green infrastructure improvements into the rehabilitation of Pump Plant 621 can enhance the overall performance of the system and expand the benefit of Pump Plant beyond its original function as a flood control mechanism. By linking the "gray infrastructure" (i.e. the physical pump plant) with the green infrastructure, multiple objectives can be achieved within a seamless system, reducing the overall cost of achieve each individual objective separately. In addition to the flood control function, this integration can help to achieve EWMP water quality improvement objectives while simultaneously providing the numerous advantages that green infrastructure brings to the City, such as an improvement to the community's overall well-being, increased property values, enhanced aesthetics, and recreational opportunities.

According to the ULAR EWMP, right-of-way along streets are the most extensive opportunity to implement BMPs on public land. In developed areas, curb and gutter in the road provide an opportunity to intercept both dry and wet weather runoff prior to entering the storm drain system and treat it within the extents of the public right-of-way. Green streets have been demonstrated to provide "complete streets" benefits in addition to stormwater management, including pedestrian safety and traffic calming, street tree canopy and heat island effect mitigation. The City of Los Angeles is planning to implement a Great Streets Initiative that seeks to enhance various areas of the City by making changes with temporary treatments such as plazas and parklets, and permanent changes to curbs, street lighting, and street trees (www.lamayor.org/greatstreets). The Great Streets Initiative is being implemented in aims of activating public spaces, providing economic revitalization, increasing public safety, and enhancing local culture. One setback for this area is narrow sidewalks, preventing the street from reaching its full potential. Because bicycle riding is permitted on sidewalks in the City of Los Angeles, a potential solution to narrow sidewalks would be to create a bicycle lane, decreasing sidewalk traffic In addition to the Great Streets initiative, the City of Los Angeles 2010 Bicycle Plan (LDCP 2010) proposes a bike lane for Sepulveda Boulevard from Rinaldi Street to Sherman Oaks Avenue. The plan notes that bicycle lanes along streets has been shown to have multiple economics, social, and environmental benefits such as, improvement to the businesses, increased number of riders, and enhanced safety. Utilizing permeable pavement in the bike lane can add an enhancement to water quality to the long list of benefits.

Localized flooding can result from insufficient capacity to drain a site and/or from excessive (and often unanticipated) offsite flows. Many causes of localized flooding can be remedied by repairing or replacing the existing infrastructure; however, it is often more practical to reduce the peak discharge and volume of runoff that are conveyed to the existing storm drainage network. As suggested in Alternative 2 below, retrofitting the study area with green infrastructure could provide a viable strategy to regulate runoff and alleviate localized flooding.

Implementing the green infrastructure concepts presented in the following sections provides an opportunity to integrate multiple initiatives currently proposed and in various stages of implementation across the City, the EWMP, Great Streets Initiative, and the 2010 Bicycle Plan. Combining all of these initiatives into one approach is a key component of the One Water plan approach.

There are two alternatives for incorporating treatment for wet weather flow into the pump station upgrades that could be implemented in tandem or independently. Water from the pump plant could be diverted into an underground infiltration basin (post-pump treatment) and/or stormwater flows could be treated before flowing into the pump plant (pre-pump treatment), using green infrastructure concepts suited for implementation in a protected bicycle lane and right-of-way, including permeable pavement and bioretention. Each alternative proposes incorporating treatment through green infrastructure in an attempt to improve the water quality of stormwater prior to discharge into the Los Angeles River (Segment D-Reach 4) and ultimately into the Pacific Ocean. Both alternatives incorporate diverting stormwater runoff from the street and the surrounding lands through a series of BMPs and allowing stormwater to infiltrate.

Alternative 1, referred to as "**Post-Pump Treatment**", includes two different scenarios that are designed to either pump or divert stormwater runoff into an underground infiltration basin underneath Cabrito Road on the west side of Van Nuys Blvd (Figure 12). Stormwater runoff is routed from two catch basins under the railroad bridge crossing Van Nuys Blvd., into a wet well in the pump plant. The runoff will be pumped out of the wet well and into the City of LA owned box culvert at a rate of approximately 21 cfs, once the pumps have been upgraded. There is also a sump pump that is allocated to slowly drain the storage room with the rate of 1.2 cfs from the low water level to the sump level after a storm is over. Scenario 1 proposes a gravity diversion structure and sized to divert a portion of the flow from the pump outlet pipe into a proposed underground infiltration basin and scenario 2 proposes upgrading the existing sump pump to pump stormwater runoff directly from the existing wet well into the proposed underground infiltration basin.

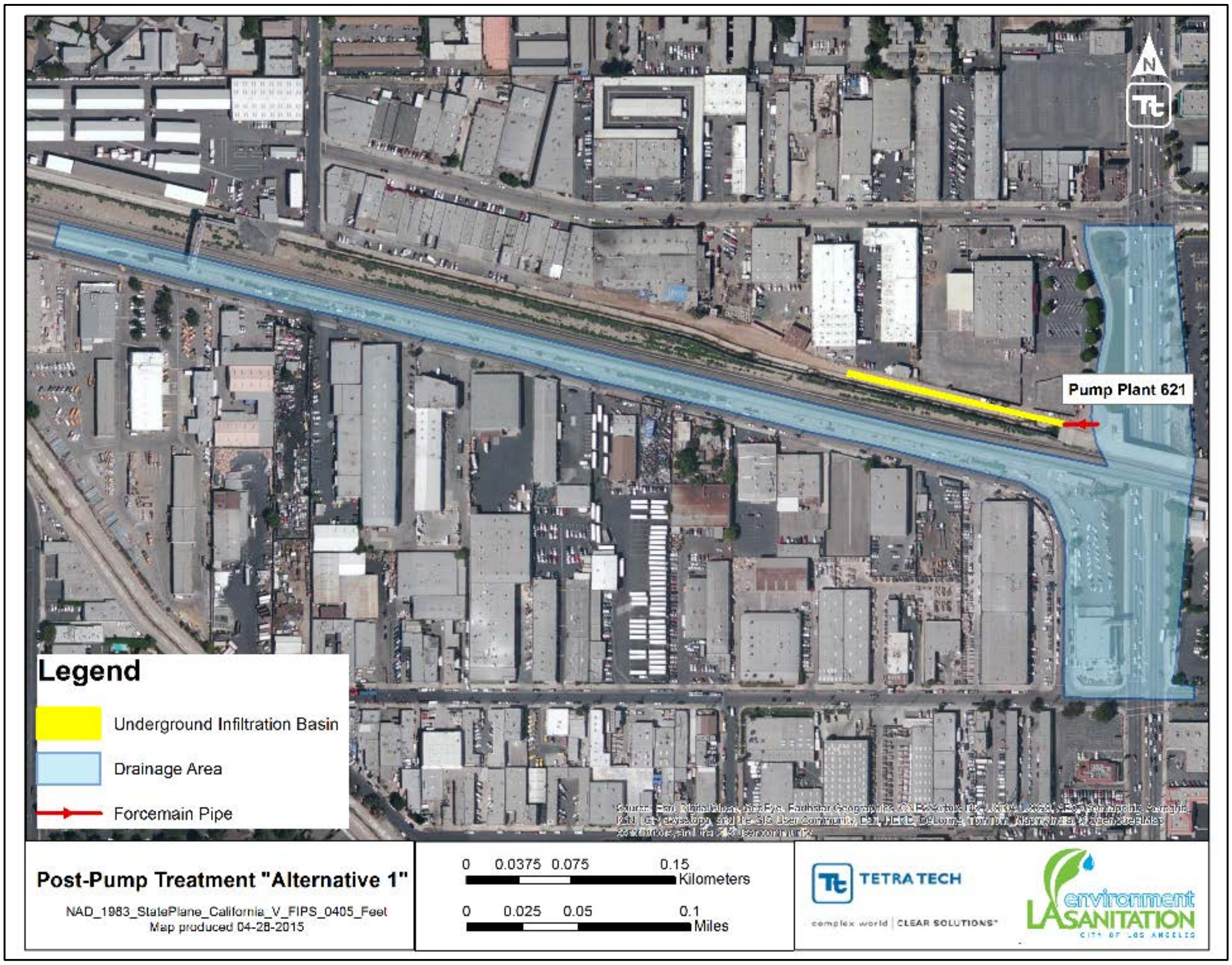


Figure 12. Alternative 1 potential BMP location.

Alternative 1-Scenario 1: Under this Scenario, it is assumed that the wet weather runoff would be pumped out at a rate of 21 cfs, once the pumps have been upgraded, from the storage room and discharge to the existing City of LA owned box culvert. A gravity diversion structure with the maximum diversion rate of 11 cfs (half of the pumping rate and half of the approximate peak flow rate for 50-year storm design) would then divert the water from existing pump outlet pipe into the proposed underground infiltration basin through the proposed 18-inch outlet pipe (Figure 13). The remainder of the flows that are higher than the diversion structure capacity will drain to the existing 18-inch storm drain that discharges to a box culvert resulting in approximately half of the flow reaching the pump plant being diverted into the BMP.

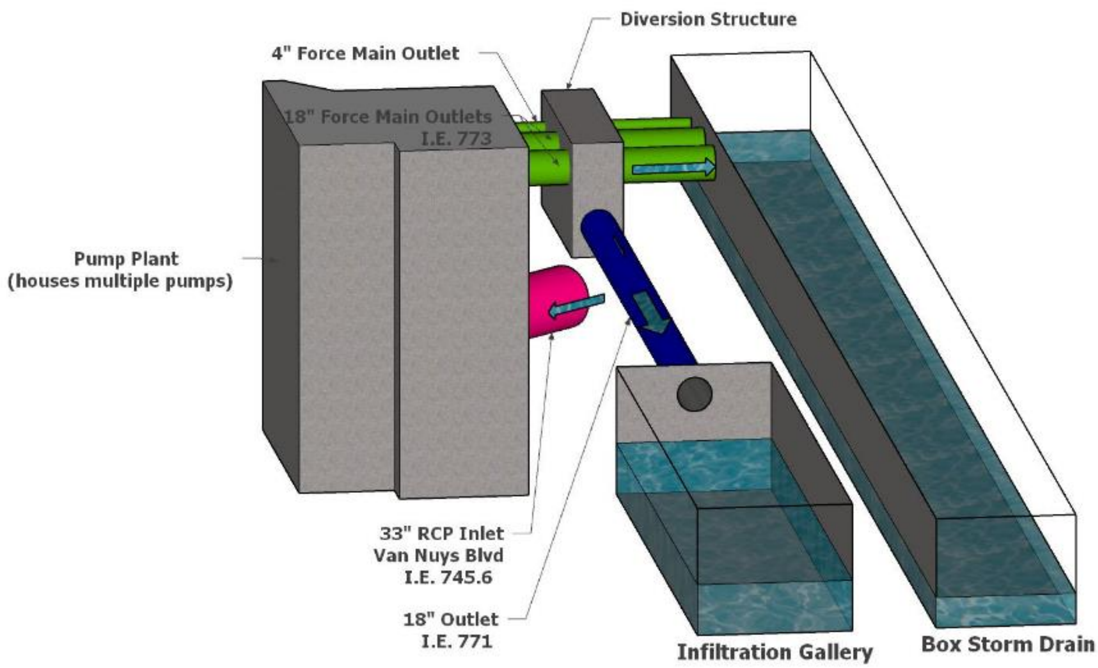


Figure 13. Weir-based Gravity Diversion System for Alternative 1-Scenario 1.

Alternative 1-Scenario 2: In this scenario, the wet weather runoff from the existing storage room would be pumped out at a constant rate of 1.2 cfs. To achieve this flow would require that the existing sump pump be upgraded and the existing 4 inch force main be upgraded to a 6 inch pipe to allow pumping of the peak flow rate for the 85th percentile storm design. The proposed 6" outlet pipe would be routed to divert the water from sump pump to the proposed infiltration gallery Treatment of the 85th-percentile runoff volume would constitute compliance with all water quality requirements for the tributary drainage area (based on current interpretation of the MS4 Permit, as discussed in the EWMPs). This flow would be pumped into a underground infiltration basin underneath Cabrito Road on the west side of Van Nuys Blvd similar to the one proposed in scenario 1 (Figure 14). Utilizing the sump pump to pump runoff to the underground infiltration basin not only can significantly improve water quality but also, could greatly reduce the need for the main pumps to turn on during small storm events and decrease the operation time considerably during larger storm events.

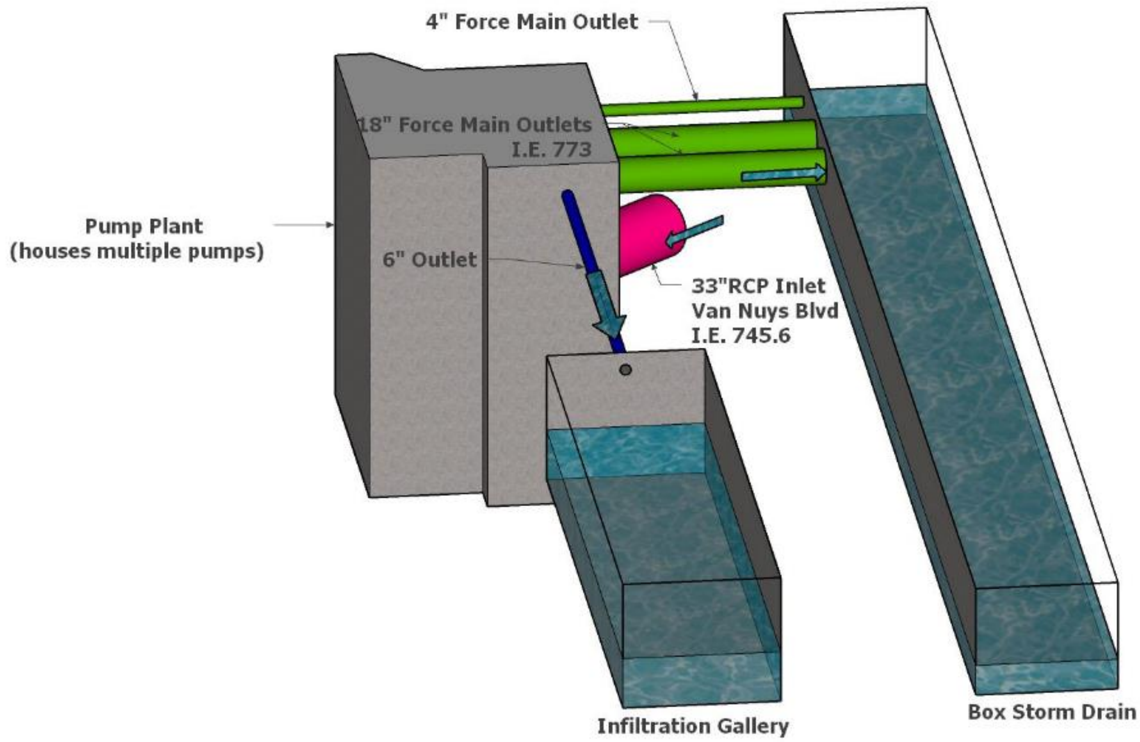


Figure 14. Direct Pumping System for Alternative 1-Scenario 2.

Alternative 2, referred to as "**Pre-Pump Treatment**", is intended to treat the wet weather runoff from a 10-acre drainage area through permeable pavement and bioretention areas implemented within the bicycle lane and the right-of-way of Van Nuys Boulevard (Figure 15) prior to its arrival at the pump plant. To treat this runoff, bioretention areas could be implemented along the outside edge of a newly created bicycle lane on both sides of Van Nuys Blvd. Additional runoff should be treated in permeable pavement implemented within the newly created bicycle lanes on Van Nuys Blvd. Overflow from permeable pavement will be treated via bioretention.

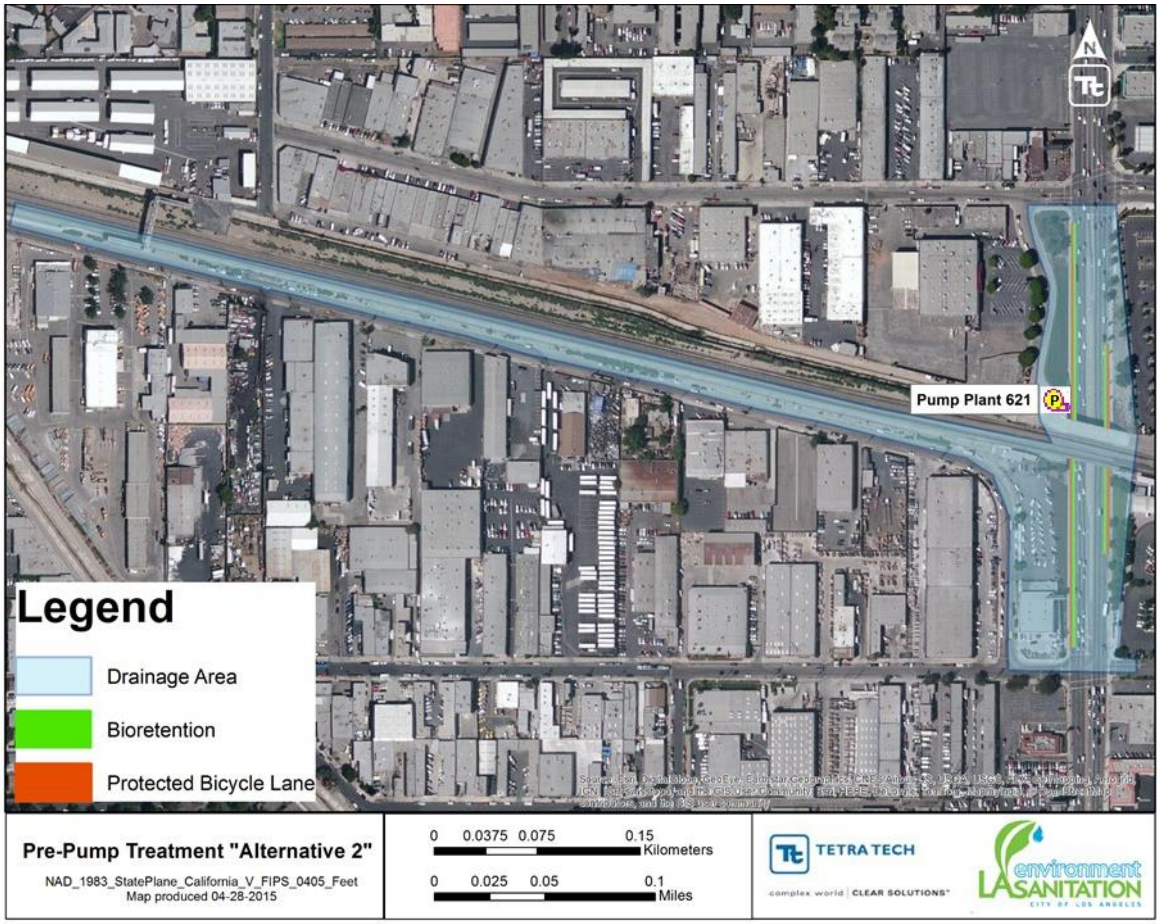


Figure 15. Alternative 2 recommended areas for BMP implementation.

Table 3 presents a comparison of the configuration of each alternative. Details for the sizing and evaluation of each alternative is presented in Section 4.1.

Table 3. Comparison of Alternatives.

BMP Type	Post-Pump Treatment								Pre-Pump Treatment		
	Scenario 1				Scenario 2						
	Sump Pump Flow Rate (cfs)	Area (ac)	Depth (ft)	Annual Volumetric Treatment (ft³)	Area (ac)	Depth (ft)	Annual Volumetric Treatment (ft³)	Low Flow Diversion Rate (cfs)	Area (ac)	Depth (ft)	Annual Volumetric Treatment (ft³)
Underground Infiltration Basin	1.2	0.12	4	152,391	0.12	4	193,867	11	N/A	N/A	N/A
Bioretention	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.06	4.75	213,952
Permeable Pavement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.18	3.75	

4.1. BMP Sizing and Evaluation

The entire drainage area primarily encompasses industrial and secondary roadway land uses, and contains approximately 85 percent impervious surface. Table 4 and Table 5 illustrate the predominant soil texture and the land use types within the drainage area. The details of the two proposed alternatives are outlined below.

Table 4. Soils Summary for Pump Plant 621 Drainage Area.

Soil Series	Infiltration Rate (in/hr) (Source: LA Soils GIS Layer)	Percentage of Drainage Area
Hanford Silt Loam	0.2	53%
Hanford Fine Sandy Loam	0.5	47%

Table 5. Distribution of Land Use Types for Pump Plant 621 Drainage Area.

Landuse type	Acres	Percent
Commercial	0.58	5.79%
Industrial	2.90	29.0%
Transportation	0.85	8.46%
Secondary Roads	5.69	56.75 %
Total	**10.0**	**100**%

4.1.1. Wet Weather Flow

Wet weather flow can vary significantly from storm to storm and from year to year. To analyze the proposed system and determine the potential inflow, a 10-year continuous simulation period from January 1, 2002 to December 31, 2011 was used. Hourly wet weather runoff time series for each contributing land use were obtained from the calibrated Watershed Management Modeling System (WMMS; Tetra Tech 2010a and Tetra Tech 2010b).

4.1.2. Existing Pollutant Loading Assessment

According to the ULAR EWMP, for the Van Nuys Boulevard study area, zinc is found to be the limiting pollutant among metals and bacteria, and the initial EWMP suggested that a 34% reduction of zinc throughout the Los Angeles River Reach 4 watershed would be necessary for final compliance. Therefore for this study area, zinc was used as the basis for removal comparison. The zinc load entering the storm drain varies depending on the size of the storm and the number of dry days between storms. A 10-year continuous simulation period from January 1, 2002 to December 31, 2011 was used to analyze the zinc removal and water quality improvement. The long-term time series for zinc load across the watershed was obtained from the calibrated WMMS at an hourly timestep (Tetra Tech 2010a and Tetra Tech 2010b). Other pollutants including copper, lead, nitrogen, phosphorous, and pathogens, long-term time series from the calibrated WMMS were used to analyze the comprehensive water quality benefits for the recommended alternative.

4.1.3. Geotechnical Literature Review

A geotechnical literature review was performed to identify potential geologic or subsurface issues that could affect BMP implementation or configuration. According to the City of LA Bureau of Standards soil report adjacent to the pump plant 621, the first 5 feet of the site soils consist of silty clay (CL) following by very fine-grained poorly graded sand (SP) in the next 10 feet. The rest of site soils consist of vary fine-grained silt (M) up to the depth of 30 below ground and no water table is detected up to that depth. In addition, based on the United State Department of Agriculture (USDA), the site soils consist of Hanford Silt Loam and Hanford Fine Sandy Loam with estimated infiltration rates of 0.2 inches per hour and 0.5 inches per hour, respectively. The USDA identifies Hanford series as deep, well drained soils that have formed in moderately coarse textured alluvium mostly from granite. Hanford soils appear on stream bottoms, floodplains, and alluvial fans. The soils are also medium acid and become more alkaline with depth. Soil borings from the area around the pump plant are include in Appendix F.

This review was limited to existing data and should be supplemented with a full, site-specific geotechnical and seismic investigation prior to preliminary designs. Infiltration rates and other subsurface conditions must be verified to ensure project success and public safety.

4.1.4. BMP Optimization and Performance

To optimize the size of the proposed BMPs, a range of possible BMPs sizes for both alternatives were modeled in the EPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) using the 10-year, continuous simulation data to measure the overall impact on the water quality. SUSTAIN was developed by the EPA Office of Research and Development to facilitate selection and placement of BMPs and green infrastructure techniques at strategic locations in urban watersheds. It assists to develop, evaluate, and select optimal BMP combinations at various watershed scales on the basis of cost and effectiveness. In this study, the BMP's effectiveness was measured by its ability to remove total zinc. Total zinc was determined to be the limiting pollutant, indicating that if total zinc is controlled, other pollutants would have similar or greater removal rates.

In addition, identifying appropriate numeric targets is necessary to evaluate and optimize performance of the stormwater facilities. One common hydrologic criterion for integrated water quality, flow reduction, and resources management is retention of the runoff volume generated by the 85th percentile storm event. At the study area, the 85th percentile storm event depth is 0.94 inch, according to the Los Angeles County isohyetal map. As a result, an additional analysis was performed to identify the size required to capture and treat the 85th percentile, 24-hour design storm event. The 10-year continuous time period (from 2002 to 2011) was then modeled through the identified BMP size to measure the overall, long-term expected water quality impacts. Three sets of analyses were performed for different solutions including Alternative 1"Post-Pump Treatment" (Scenario 1, and 2) and Alternative 2 "Pre-Pump Treatment".

Figure 16 shows the 85th percentile 24-hour hydrograph for the drainage area (10 acres), derived from the HydroCalc (Version 0.3.0 beta). The peak flow for the 85th percentile storm for the 10-acre study area was calculated to be approximately 1.2 cfs, as illustrated in Figure 16.

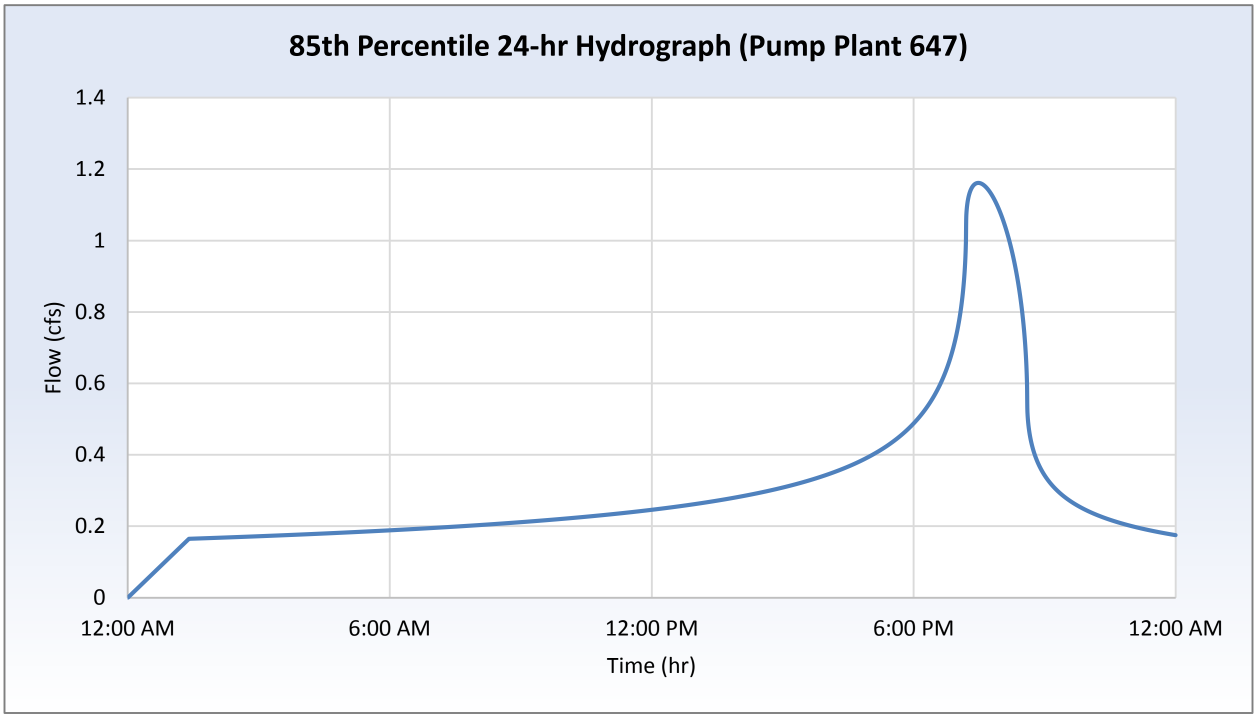


Figure 16. 85th Percentile 24-Hour Hydrograph for the 10- acre drainage area with 0.94 inch Rainfall Depth.

For alternative 1, scenario 1 it is assumed that the main pumps cycle on when the wet well reaches a certain level. At that point, all of the volume in the wet well is pumped out at a rate of 21 cfs. This pumping scheme results in the pump cycling on and off multiple times throughout the duration of the storm event. It may not be feasible to assume that all of the 21 cfs flow can be diverted into a BMP. For the purpose of this analysis it was assume that a portion of the flow is diverted to the BMP at a diversion rate of 11 cfs. This would result in approximately half of the volume that reaches the pumping plant being diverted into the BMP. For comparison purposes, a BMP capable of treating the volume of runoff produced by the 85th percentile storm was evaluated for both scenario 1 and scenario 2. A BMP foot print of 5,260 ft^2 with a capacity of approximately 21,040 ft^3 would provide a 32% reduction in volume (Figure 17) and a 43% reduction in zinc (Figure 18).

For alternative 1, scenario 2, the smaller sump pump would cycle to pump all of the flow entering the pump plant at a rate of 1.2 cfs or less. This pump would operate throughout the duration of the storm providing a more consistent flow into the BMP, ultimately diverting a higher volume than in scenario 1 despite the much lower flow rate. Diverting flow into a similar sized BMP would results in a 41 percent reduction in volume (Figure 17) and a 50 percent reduction in zinc (Figure 18).

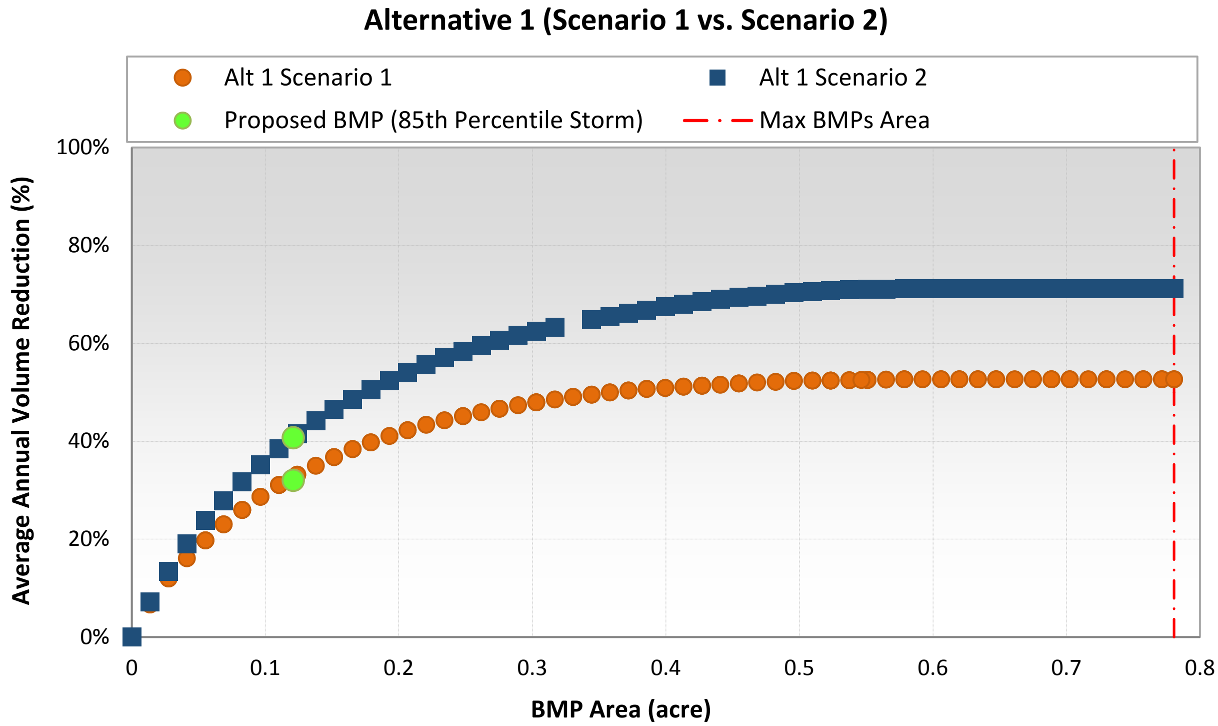


Figure 17. Comparison of 11 cfs diversion versus 1.2 cfs direct pumping for Alternative 1 (Post-Pump Treatment).

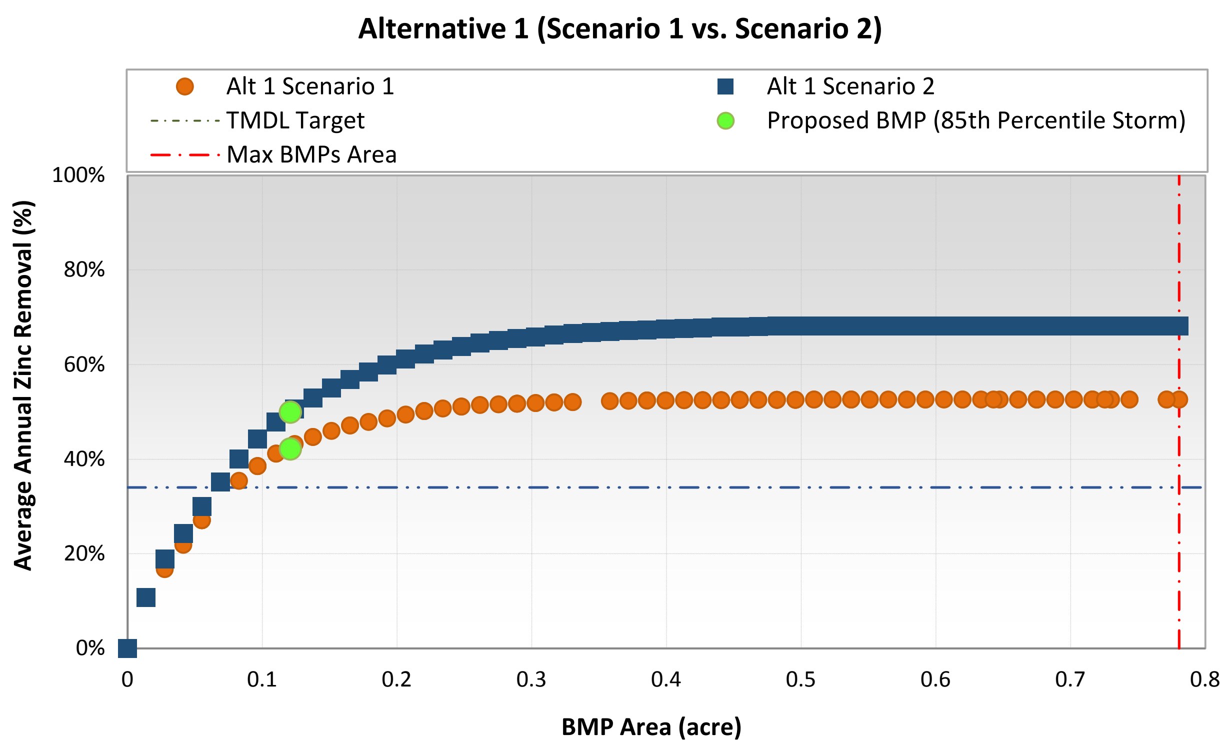


Figure 18. Comparison of water quality benefit for scenario 1 and scenario 2 (Post-Pump Treatment).

Upgrading the sump pump, while requiring some extra cost, will provide a higher level of treatment efficiency in the system (see Section 8 pump plant upgrade cost estimates).

For alternative 2 the BMP opportunities would be implemented along Van Nuys Boulevard to treat wet weather runoff from a 10-acre drainage before reaching the Pumping Plant. The 10-year continuous time period (from 2002 to 2011) is modeled to generate the cost-effectiveness curve and measure the overall, long-term expected water quality impacts (Figure 19 and Figure 20). Relative cost is presented in Figure 19 and Figure 20 (instead of BMP footprints like those shown in Figure 17 and Figure 18) because a combination of multiple BMPs were modeled. The result of the analysis showed that the combination of permeable pavement and bioretention with the sizes of 8,050 and 2,660 square feet and retention volumes of 12,075 and 8,412 cubic feet respectively provide the capacity to treat the 85th percentile storm event. The respective BMPs sizes would result in 45 percent flow volume removal and 53 percent zinc.

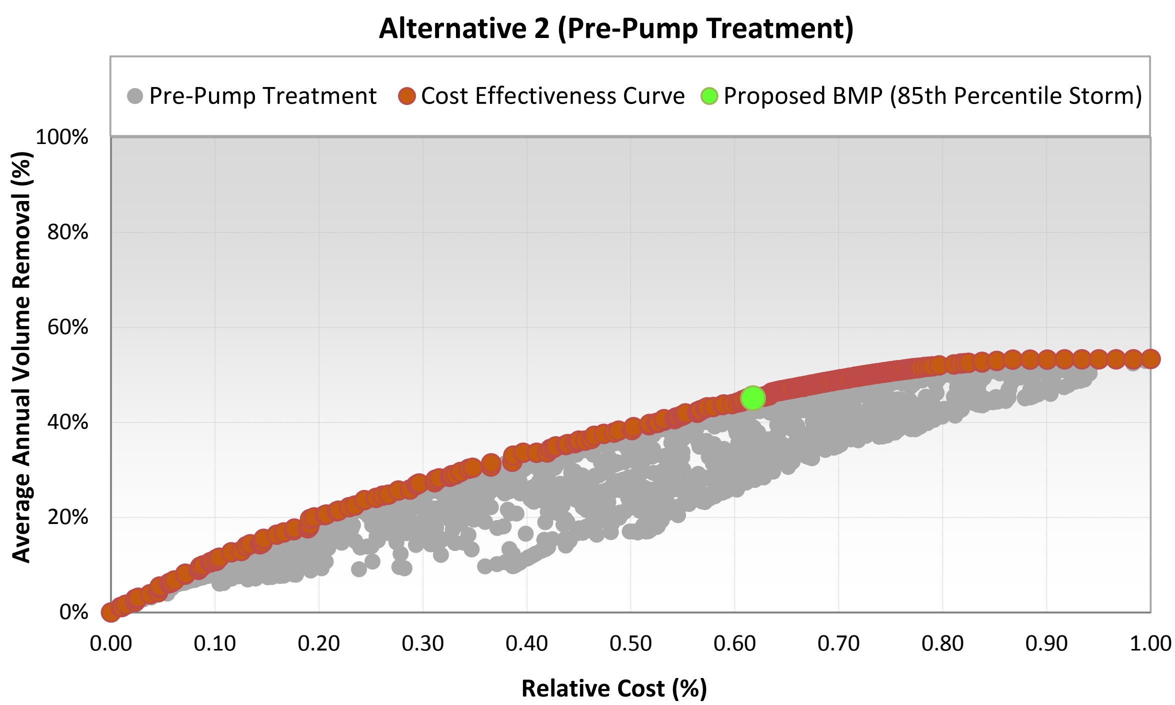


Figure 19. Relative Cost vs Average Annual Total Volume reduction.

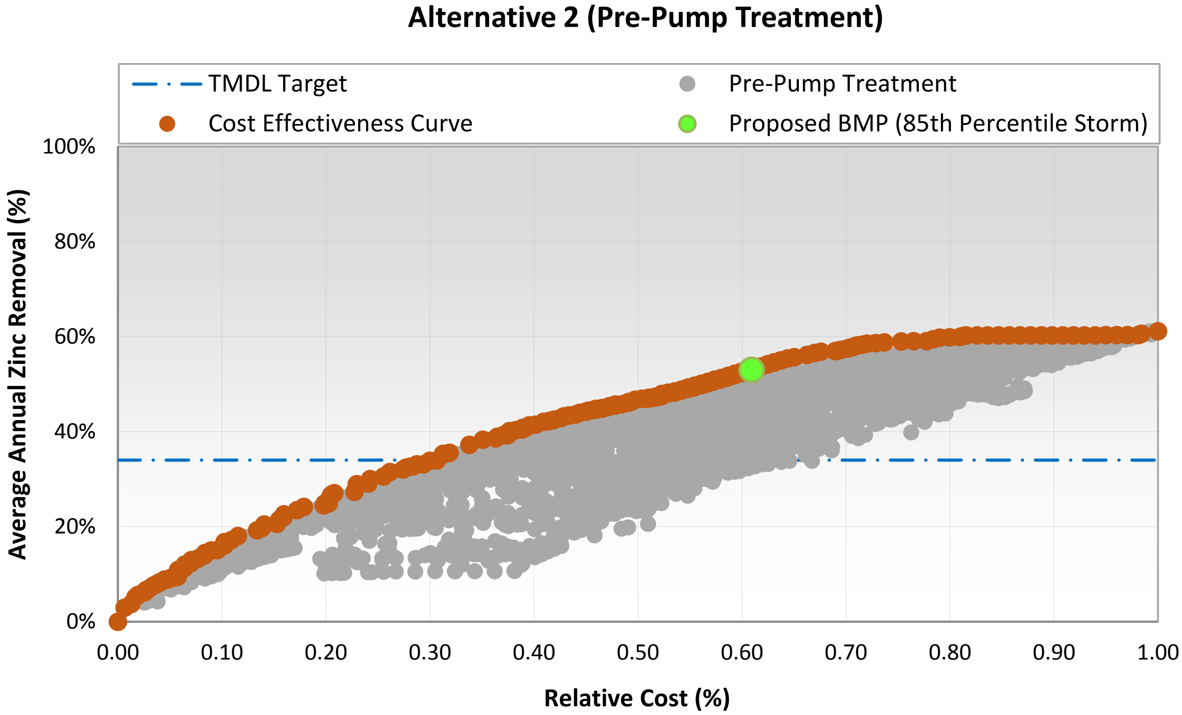


Figure 20. Relative Cost vs Average Annual Total Zinc Reduction.

4.1.5. Treatment Alternative Comparison and Conclusions

Based on the comparison of the two alternatives presented in Table 6, Alternative-1-Scenario 1 (11 cfs gravity diversion) will provide the reasonable volume and associated pollutant load reduction however, that benefit comes at a cost. The higher construction cost associated with Alternative 1-Senario 1 is due to the deeper excavation required for the gravity diversion of the flow to the underground infiltration basin (See Section 5).

Table 6. Average annual expected pollutant reductions and cost.

Constituent	Average annual loads	Average annual reduction					
		Post-Pump Treatment				Pre-Pump Treatment	
		Scenario 1		Scenario 2		Alternative 2	
	Pre-BMP	Reduction	Percentage	Reduction	Percentage	Reduction	Percentage
Volume, (ft^3)	475,359	152,391	32%	193,867	41%	213,952	45%
TSS, (lbs)	1750	745.6584	43%	870.6887	50%	927.5	53%
TN,(lbs)	59.4	21.4127	36%	26.66378	45%	29.2	49%
TP, (lbs)	36.3	13.08721	36%	16.3	45%	18.0	50%
Copper, (lbs)	0.6	0.25885	43%	0.3	50%	0.3	53%
Lead, (lbs)	0.5	0.22908	43%	0.3	50%	0.3	53%
Zinc, (lbs)	6.0	2.57202	43%	3.0	50%	3.2	53%
Fecal Coliform (counts)	5.E+11	2.05E+11	37%	2.60E+11	47%	2.96E+11	54%
Cost		$849,040		$769,100		$809,130	

Note: TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorous

Implementing Alternative 1, scenario 1 will require the least impact to the existing function and performance of the pump plant but also has the lowest performance for stormwater treatment. The excavation cost of this scenario for the BMP implementation is also more costly because of the depth of excavation required to divert flows from the pump plant by gravity. Alternative 1, scenario 2 will require a small upgrade to the current pump plant configuration to provide a larger sump pump. This cost will be offset by the cost saving from excavation since the BMP can be implemented closer to the surface when the flow would be pumped into the infiltration basin. This scenario also provides some resiliency for the large and more costly main pumps. By using the sump pump to divert flows to the BMP, the main pumps will not have to operate as often. Among all solutions, Alternative 2 is recommended since it requires no alteration to the current sump pump configuration. This alternative provides maximum resiliency for the main pumps. Treating the volume produced by the 85th percentile storm before the pump plant significantly reduces the amount of time that the main pumps have to operate by approximately 65%.

5. BMP Conceptual Layout, Design, and Performance Specifications

5.1. Post Pumping Alternative 1

The recommended BMP for alternative 1 is an underground infiltration basin. An infiltration basin is typically an excavated area containing amended soils functions like a bioretention area but is implemented at a larger scale. Infiltration basins can be designed as surface or subsurface units allowing for implementation around paved streets, parking lots, and buildings to provide initial stormwater detention and treatment of runoff (Figure 21). Such applications offer an ideal opportunity to minimize directly connected impervious areas in highly urbanized areas. In addition to stormwater management benefits, surface infiltration galleries provide green space and improve natural aesthetics in urban environments.

Figure 21. Subsurface Infiltration Gallery. (Source: www.oldcastlestormwater.com)

Typically, runoff percolates through the bottom of the gallery and an approximately 1-foot amended, tilled native soil layer, which has an infiltration rate capable of draining the infiltration gallery within a specified design drawdown time (usually up to 72 hours). After the stormwater infiltrates through the amended surface, it percolates into the subsoil, if site conditions allow for adequate infiltration and slope protection. If site conditions do not allow for adequate infiltration or slope protection, filtered water is directed toward a stormwater conveyance system or other stormwater runoff BMP via underdrain pipes. Observation ports and cleanouts should be included at the inlet of the infiltration gallery and along the length of the system to allow maintenance access and observation of any potential sediment accumulation. Infiltration galleries can be designed to help meet hydromodification criteria and also for conveyance of higher flows.

There are multiple systems available designed to provide storage for underground systems. Most systems are intended to provide void space; however, some systems provide greater void space than others. Two products that provide the greatest voice space are StormCapture system developed by OldCastle (Figure 22), and the StormTrap system (Figure 23).

Source: www.oldcastlestormwater.com

Source: www.oldcastlestormwater.com

Figure 22. StormCapture System.

Source: stormtrap.com

Source: City of Los Angeles

Figure 23. Typicall StormTrap System.

5.1.1. Scenario 1

Because of the invert elevation of the existing outlet pipe, the surface of the infiltration basin will be at approximately 774 feet (approximately 5 feet below ground surface). Figure 24 shows the relative configuration of the pump station, the diversion, and the underground infiltration basin.

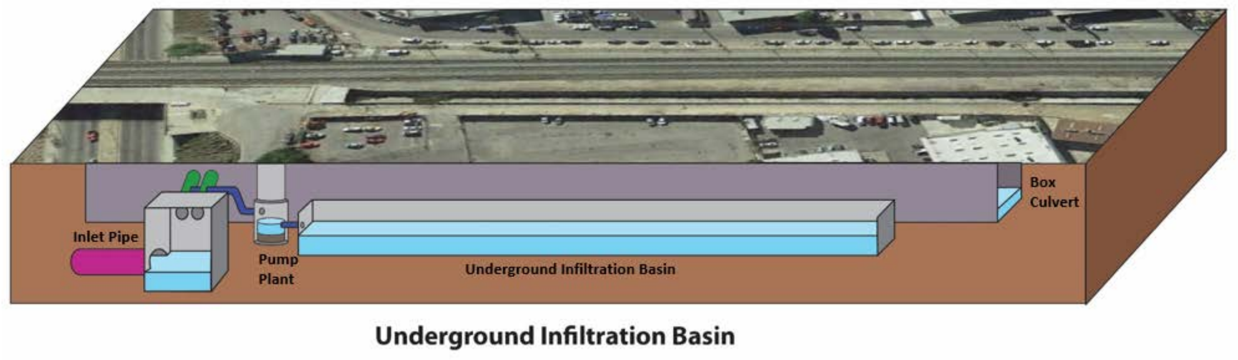


Figure 24. BMP configuration for Alternative 1, scenario 1.

5.1.2. Scenario 2

Utilizing the sump pump to divert flow into the BMP will allow some flexibility in the configuration and depth of the BMP allowing the underground infiltration basin to be close to the surface (approximately two feet below ground surface). Figure 25 shows the relative configuration of the diversion and underground infiltration basin.

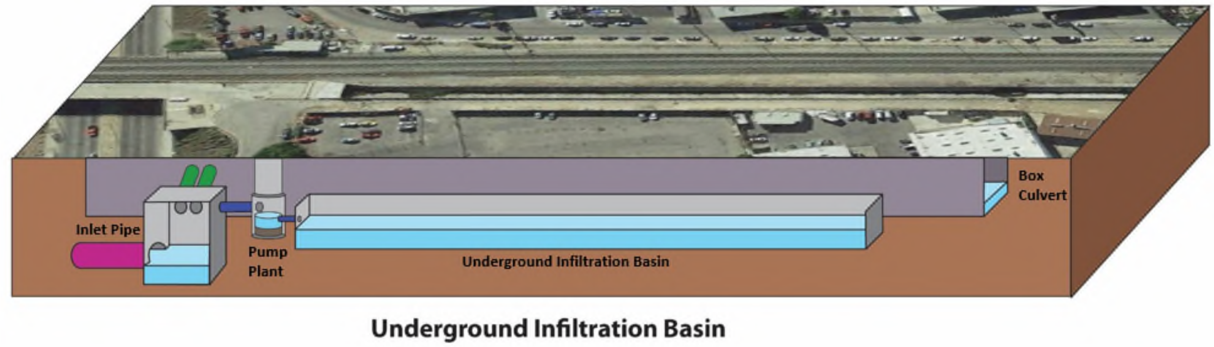


Figure 25. BMP configuration for Alternative 1, scenario 2.

5.2. Pre-Pumping Alternative 2

For alternative 2, the conceptual configuration of the BMPs providing the optimum level of treatment is intended to divert and treat water flowing from the street and surrounding parcels. Van Nuys Boulevard is designated as a Major Highway – Class II with a required right of way width of 104 feet (details of original street design in Bureau of Engineering ”D” plans, D-18469, is provided in Appendix D). Bike lanes are proposed for this section in the 2010 Bicycle Plan (LDCP 2010). BMPs proposed are intended to fit within the typical widths for the designation and the proposed bike lanes and should be coordinated with proposed plans for the area. Runoff from Van Nuys Boulevard should be treated in bioretention areas in accordance with LA Standard Plan S-481 on Van Nuys Boulevard. The depth of engineered soil layer, storage layer and ponding zone of the bioretention cells should be 2’, 2’-9”, and 2’-6” respectively. Both sides of Van Nuys Boulevard will have a newly constructed protected bicycle lane, in which bioretention will be placed along the outside edge of the lane serving as protection, and permeable pavement will be the foundation of the bicycle lane. The depth of paving surface, and storage layer of the permeable pavement should be 1”, and 2’-9” respectively. In addition to the water quality benefits, protected bicycle lane along streets has been shown to have multiple economics, social, and environmental benefits such as, improvement to the businesses, increased number of riders, and enhanced safety. According to the City of Los Angeles 2010 Bicycle Plan, Van Nuys Blvd. from Nordhoff Street to 101 Freeway is listed for the future bicycle lane. Treating the 85th percentile runoff volume by these BMPs would significantly reduce the amount of time that the main pumps have to operate by approximately 65%. Current Van Nuys Blvd. conditions are shown in Figure 26. Example BMP configurations are shown in Figure 27 and Figure 28.

Figure 26. Existing Van Nuys Blvd. conditions.

Figure 27. Conceptual rendering showing protected bike lane with permeable pavement and bioretention.

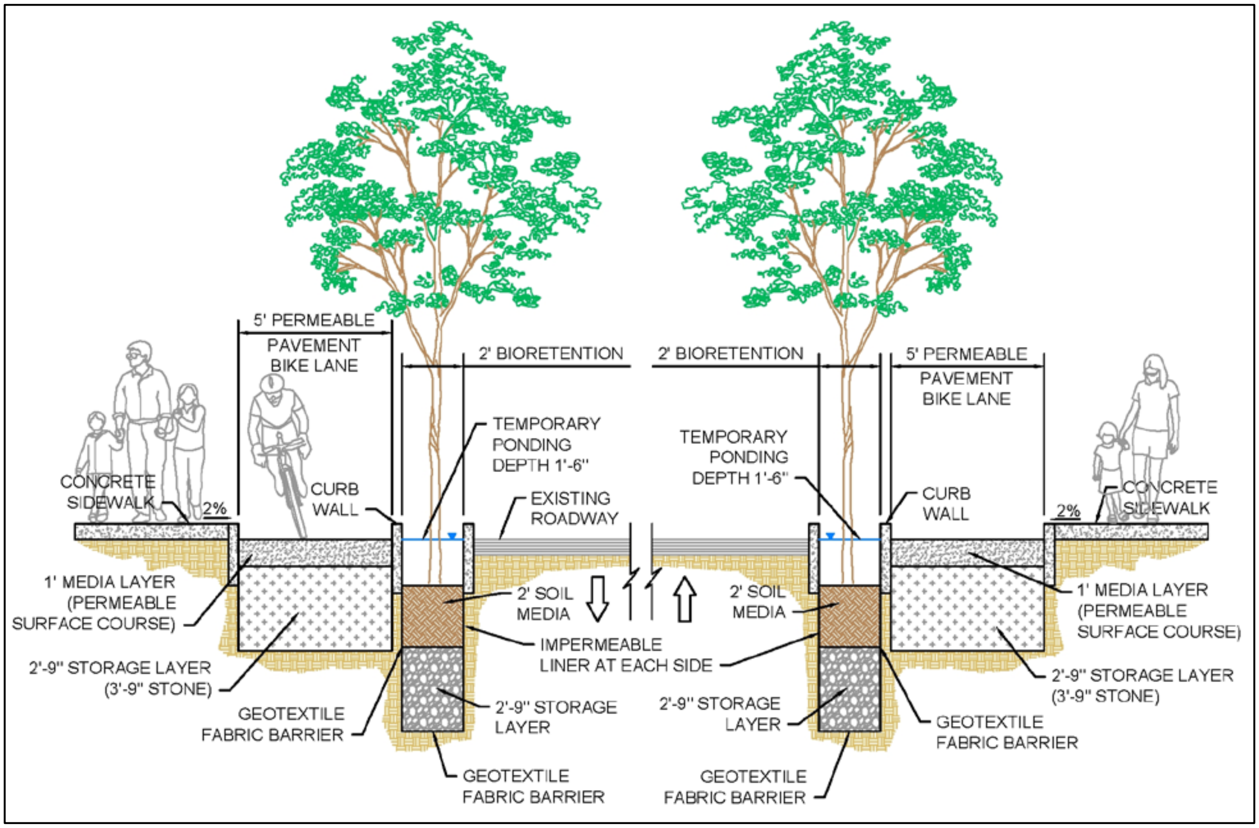


Figure 28. Expected cross section for Alternative 2.

The BMPs recommended in the Alternative 2 Pre Pumping should be designed to meet the following specifications and should comply with LA Standard Plan S-480 (Green Streets):

- Bioretention Areas
  - Ponding depth should be maintained at a minimum of 18 inches.
  - Infiltration rate in existing soils should be a minimum of 0.5 in/hr.
  - If the infiltration rate is less than 0.5 in/hr or if the site is located adjacent to a building foundation or in a liquefaction zone, underdrains and an engineered soil media should be installed. Bioretention soil media should have a minimum depth of 5 feet and should meet the following criteria:
    - Soil media consists of 85 percent washed course sand, 10 percent fines (range: 8–12 percent, and 5 percent organic matter. The expected infiltration rate should be 0.5 in/hr.
    - Soil media should have a porosity of 35 percent.
    - The sand portion should consist of concrete sand (passing a one-quarter-inch sieve). Mortar sand (passing a one-eighth-inch sieve) is acceptable as long as it is thoroughly washed to remove the fines.
    - Fines should pass a # 270 (screen size) sieve.

- Soil media must have an appropriate amount of organic material to support plant growth. Organic matter is considered an additive to help vegetation establish and contributes to sorption of pollutants but should generally be minimized (5 percent). Organic materials will oxidize over time, causing an increase in ponding that could adversely affect the performance of the bioretention area. Organic material should consist of aged bark fines, or similar organic material. Organic material should not consist of manure or animal compost. Newspaper mulch has been shown to be an acceptable additive.
- pH should be between 6–8, cation exchange capacity (CEC) should be greater than 5 milliequivalent (meq)/100 g soil.
- High levels of phosphorus in the media have been identified as the main cause of bioretention areas exporting nutrients. All bioretention media should be analyzed for background levels of nutrients. Total phosphorus should not exceed 15 ppm.

o Bioretention areas should be lined on the sides with a 30 mil liner to protect the surrounding infrastructure.

o PVC liners used for the lining of bioretention should meet the requirements of ASTM D-7176. The PVC liner should resist ultraviolet and shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45 degrees Fahrenheit without application of heat. A suitable geotextile fabric shall be placed on the top and bottom of the membrane for puncture protection.

o A minimum 5 feet of redial clearance between the BMP and any light pole or utility must be provided

o A minimum of 48 inches wide sidewalk access must be approved at each end of the BMPs from the sidewalk to the street curb.

o All geotextile shall comply with the following:

Property	Test Reference	Media Barrier
Grab Strength, lbs (N), Min.	ASTM D-4632	90 (400)
Elongation, Minimum (at peak load) %, Max.	ASTM D-4632	50
Puncture Strength, lbs (N), Min.	ASTM D-3787	65 (290)
Permittivity, Sec., Min.	ASTM D-4491	2.5
Burst Strength, psi (kPa), Min.	ASTM D-3786	225 (1550)
Toughness, lbs (N), Min.	% Elongation x Grab Strength	5500 (24500)
Ultraviolet Resistance % Strength Retained @ 500 Weatherometer Hours	ASTM D-D4355	70
Apparent Opening Size, US Sieve # (mm)	ASTM D-4751	70 (0.210)
Flow Rate, Gal/min/ft^2 (L/min/m^2)	ASTM D-4491	175 (7130)
Trapezoid Tear, lbs (N)	ASTM D-4533	45 (200)

- Permeable Pavement
  - o Bedding material should be a 1- to 2-inch layer of washed no. 8 or 9 stone. It must be completely free of fines.
  - o The structural layer below the permeable pavement must have a porosity of 40 percent and should extend to a depth of 3.75 feet below the paver surface. A washed no. 57 stone at a depth of at least 6 inches is recommended as a choker course overlaying no. 2 stone.
  - o Installation must have a slope of less than 0.5 percent unless internal check dams are incorporated.

- Permeable pavement should be lined on the sides with a 30 mil liner to protect the surrounding infrastructure. If geotechnical analyses suggest that infiltration should be restricted, the entire system should be lined and an underdrain installed.
- PVC liners used for the lining of permeable pavement should meet the requirements of ASTM D-7176. The PVC liner should resist ultraviolet and shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45 degrees Fahrenheit without application of heat. A suitable geotextile fabric shall be placed on the top and bottom of the membrane for puncture protection.

Design Details and Drawing

A photo log, conceptual plans, and cross-sectional details are provided in Appendix A. Example product details along with a list of certified professionals qualified to install pervious concrete and concrete pavers is included in Appendix E.

6. Plant Selection

For the BMPs to function properly for stormwater treatment and blend into the landscape, vegetation selection is crucial. Appropriate vegetation will have the following characteristics:

1. Plant materials must be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 10 to 48 hours.
2. It is recommended that a minimum of three shrubs and three herbaceous groundcover species be incorporated to protect against facility failure from disease and insect infestations of a single species. To match current site landscaping, only one tree has been recommended.
3. Native plant species or hardy cultivars that are not invasive and do not require chemical inputs are recommended to be used to the maximum extent practicable.

A selection of recommended plant species, along with additional details including the recommended landscape position, size at maturity and light requirements, is provided in Table 7 based on the City of Los Angeles' Urban Forestry Division Street Tree Selection Guide (City of Los Angeles Urban Forestry Division 2011) and landscape architect recommendations. The existing trees at the site are Platanus acerifoliae.

Table 7. Recommended plant list.

Trees		Los Angeles native - LA, California native - CA, Nonnative– X	Landscape position: 1 - Low[a], 2 - Mid[b], 3 - High[c]	Mature size (height x width)	Irrigation demands: High - H ▪ Moderate - M, Low - L ▪ Rainfall Only - N	Light requirements Sun - SU ▪ Shade - SH, Part Shade - PS, Sun or Shade - SS	Season Evergreen - E, Deciduous - D, Semi-Evergreen – SE
***Cercisoccidentalis*[d]**	**Western redbud**	**LA**	**1**	**10-18' x 10-18'**	**M**	**SU, PS**	**D**
***Chilopsislinearis*[d]**	**Desert willow**	**LA**	**1**	**15-30' x 10-20'**	**L-M**	**SU**	**D**
Umbellulariacalifornica	California bay	LA	1	20-25' x 20-25'	L-H	SU, PS, SH	E
Platanus acerifolia[e]	London Planetree	x	2	40-80' x 30-40	M-H	SU	D
Shrubs							
Baccharispilularis 'Pigeon Point'	Dwarf coyote bush	LA	3	1-2' x 6'	L-M	SU	E
Rhamnuscalifornica 'Little Sur'	Dwarf California coffeeberry	LA	2	3-4' x 3'	N-M	SU, PS	E
Heteromelesarbutifolia	Toyon	LA	3	6-10' x 6-10'	M	SU, PS	E
***Baccharissalicifolia*[d]**	**Mulefat**	**LA**	**1**	**4-10'x8'**	**M-H**	**SU, PS, SH**	**SE**
***Rosa californica*[d]**	**California rose**	**LA**	**1**	**3-6' x 6'**	**M-H**	**SU, PS, SH**	**SE**
Grasses and grass-like plants							
***Elymusglaucus*[d]**	**Blue wild rye**	**LA**	**1**	**2-4' x 5'**	**L-M**	**SU, PS**	**SE**
***Muhlenbergiarigens*[d]**	**Deer grass**	**LA**	**1**	**2-4' x 3-4'**	**L**	**SU**	**E**
***Juncuspatens*[d]**	**California gray rush**	**CA**	**1**	**2' x 2'**	**L-H**	**SU, PS**	**E**

Notes

The Landscape position is the lowest area recommended for each species. Plants in areas 1 and 2 might also be appropriate for higher locations. When specifying plants, availability should be confirmed by local nurseries. Some species might need to be contract-grown, and it might be necessary for the contractor to contact the nursery well before planting because some species might not be available on short notice.

[a]Landscape Position 1 (Low): These areas experience seasonal flooding. Seasonal flooding for bioretention areas is typically 9 inches deep, for up to 72 hours (the design infiltration period for a bioretention area). If parts of the bioretention area are to be inundated for longer durations or greater depth, the designer should develop a plant palette with longer term flooding in mind. Several of the species listed as tolerant of seasonal flooding might be appropriate, but the acceptability of each species considered should be researched and evaluated case by case.

[b]Landscape Position 2 (Mid): These areas are low but are not expected to flood. However, they are likely to have saturated soils for extended periods.

[c]Landscape Position 3 (High): These areas are generally on well-drained slopes adjacent to stormwater BMPs. Soils typically dry out between storm events.

[d]**Bolded species** have been observed in the city and are known to be suitable for the recommended landscape position.

[e]Existing vegetation is appropriate for the proposed bioretention areas however, a more drought tolerant option may be preferred.

7. Green Infrastructure Operations and Maintenance

Maintenance of stormwater BMPs should be incorporated into existing routine maintenance activities. Permeable pavement should be swept during the existing monthly street sweeping schedule and City of LA maintenance personnel should be trained to maintain stormwater BMPs located in the public right-of-way. Maintenance activities for the BMPs should be focused on the major system components, especially landscaped areas. Landscaped components should blend over time through plant and root growth, organic decomposition, and they should develop a natural soil horizon. The biological and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Irrigation might be needed, especially during plant establishment or in periods of extended drought. Irrigation frequency will depend on the season and type of vegetation. Drought tolerant plants require less irrigation than other plants.

Table 8, Table 9, and Table 10 outline the required maintenance tasks, their associated frequency, and notes to expand on the requirements of each task based on recommendations from researchers in the green infrastructure field.

Table 8. Inspection and maintenance tasks for underground infiltration basins.

Task	Frequency	Maintenance Notes
Dry season inspection	One time per year	Inspect once during the dry season to ensure volume capacity. Clean if required.
Wet season inspection	Monthly during wet season	Monthly during the wet season to ensure volume capacity. Inspect and confirm level of silt and sediment.
Vault cleaning	Dry season – 1 time Wet season – 1 times	Dry season cleaning to happen just before the start of the wet season.
Valve maintenance	As needed	

Table 9. Bioretention operations and maintenance considerations.

Task	Frequency	Maintenance notes
Monitor infiltration and drainage	1 time/year	Inspect drainage time (12–24 hours). Might have to determine the infiltration rate (every 2–3 years). Turning over or replacing the media (top 2–3 inches) might be necessary to improve infiltration (at least 0.5 in/hr).
Pruning	1 time/year	Nutrients in runoff often cause bioretention vegetation to flourish.
Mulching	1 time/year	Recommend maintaining 1-inch to 3-inch uniform mulch layer.
Mulch removal	1 time/3–4 years	Biodegraded mulch accumulation reduces available water storage volume. Removal of mulch also increases surface infiltration rate of fill soil.
Watering	1 time/2–3 days for first 1–2 months; sporadically after establishment	If drought conditions exist, watering after the initial year might be required.
Soil amendments	1 time initially	One-time spot soil amendments for first year vegetation.
Remove and replace dead plants	1 time/year	It is common for 10% of plants to die during first year. Survival rates tend to increase with time.
Inlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow into the retention area is as designed. Remove any accumulated sediment.
Outlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for erosion at the outlet and remove any accumulated mulch or sediment.
Miscellaneous upkeep	2 times/year	Tasks include trash collection, plant health, spot weeding, and removing mulch from the overflow device.

Table 10. Permeable pavement operations and maintenance considerations.

Task	Frequency	Maintenance notes
Impervious to pervious interface	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow onto the permeable pavement is not restricted. Remove any accumulated sediment. Stabilize any exposed soil.
Street sweeping	Weekly during routine mechanical sweeping and twice a year with vacuum sweeper (or as needed)	Portions of pavement should be swept with a vacuum street sweeper at least twice per year or as needed to maintain infiltration rates.
Replace void fill materials (applies to pervious pavers only)	1-2 times per year (and after any vacuum truck sweeping)	Fill materials will need to be replaced after each sweeping and as needed to keep interstitial bedding material even with the paver surface.
Miscellaneous upkeep	4 times per year or as needed for aesthetics	Tasks include trash collection, sweeping, and spot weeding. Ensure landscaping materials (soil, mulch, grass clippings, etc.) are not stockpiled on permeable pavement surfaces.

8. Cost Estimate

The estimated cost of the pump station upgrades are included in Table 11 and the costs of implementing each of the alternative described above are included in Table 12, Table 13, and Table 14. This cost estimate is a guide only and should be updated at the time of preliminary design to account for fluctuation in cost of material, labor, or components, or unforeseen contingencies.

Table 11. Pump plant upgrade costs.

Item No.	Description	Estimated Qty	Unit	Unit Cost	Total
1	Mobilization and Demobilization	1	LS	$175,000	$175,000
2	Demolition/Removal of Existing Pumps and Discharge Piping	1	LS	$50,000.00	$50,000
3	Furnish and Install 520 GPM Submersible Pump to BMP	2	EA	$60,000.00	$120,000
4	Furnish and Install 9,500 GPM Vertical Turbine Solids Handling Pump	2	EA	$300,000.00	$600,000
5	Furnish and Install 6-inch Outlet Piping to BMP	1	LS	$20,000.00	$20,00
6	Furnish and Install 18-inch Outlet Piping to Storm Drain	1	LS	$50,000.00	$50,000
7	Replace Chain-Link Fencing Around Site	60	LF	$20.00	$1,200
8	Sand Blast and Paint the Interior and Exterior of the Building	1	LS	$30,000.00	$30,000
9	Structural Upgrades to Building	1	LS	$10,000.00	$10,000
10	Replace the Ventilation System	1	LS	$30,000.00	$30,000
11	Upgrade the Interior and Exterior Lighting	1	LS	$10,000.00	$10,000
12	Furnish and Install 250 KW Natural Gas Generator, Tier 4F	1	LS	$400,000.00	$400,000
13	Furnish and Install MCC	1	LS	$200,000.00	$200,000
14	Furnish and Install SCADA/I&C	1	LS	$60,000.00	$60,000
Subtotal Cost					**$1,756,200**
17	Construction contingency (25% of subtotal)				$440,000
Total Cost					**$2,196,200**

Table 12. Alternative 1 scenario 1: Post-Pump Treatment 11 cfs Gravity Diversion Cost Estimate.

Item No.	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Temporary Construction Fence	1,072	LF	$2.50	$2,680
2	Silt Fence	1,072	LF	$3.00	$3,216
	Site Preparation				
3	Excavation and Removal	1,753	CY	$45.00	$78,899.92
	Structures				
4	Structural Layer (washed no 57 or no 2 stone)	195	CY	$50.00	$9,740
5	Utility Conflicts	1	LS	$10,000.00	$10,000
6	Connection to Underground Infiltration Basin	1	LS	$350.00	$350
7	Diversion Structure	1	EA	$8,000.00	$8,000
8	Gravity 18" RCP	100	LF	$130.00	$13,000
	Underground Storage				
9	Fine Grading	5,260	SF	$0.72	$3,787
10	Underground Infiltration Basin	779	CY	$378.00	$294,560
11	Maintenance/Observation Access to the Underground Infiltration Basin	5		$5,000.00	$25,000
	Construction Subtotal				$449,230
12	Bond (5% of subtotal)				$22,460
13	Mobilization (10% of subtotal)				$44,920
14	Construction contingency (20% of subtotal)				$89,850
	Construction Total				$606,460
15	Design (40% of Construction Total)				$242,580
	Total Cost				**$849,040**

Table 13. Alternative 1 scenario 2: Post-Pump Treatment 1.2 cfs Direct Pumping Cost Estimate.

Item No	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Temporary Construction Fence	1,072	LF	$2.50	$2,680
2	Silt Fence	1,072	LF	$3.00	$3,216
	Site Preparation				
3	Excavation and Removal	1,169	CY	$45.00	$52,600
	Structures				
4	Structural Layer (washed no 57 or no 2 stone)	195	CY	$50.00	$9,740
5	Utility Conflicts	1	LS	$10,000.00	$10,000
6	Connection to Existing Wet-Well	1	LS	$350.00	$350
7	Force Main 6" DI	100	LF	$50.00	$5,000
	Underground Storage				
8	Fine Grading	5,260	SF	$0.72	$3,787
9	Underground Infiltration Basin	779	CY	$378.00	$294,560
10	Maintenance/Observation Access to the Underground Infiltration Basin	5		$5000.00	$25,000
	Construction Subtotal				$406,930
11	Bond (5% of subtotal)				$20,350
12	Mobilization (10% of subtotal)				$40,690
13	Construction contingency (20% of subtotal)				$81,390
	Construction Total				$549,360
14	Design (40% of Construction Total)				$219,740
	Total Cost				**$769,100**

Table 14. Alternative 2: Pre-Pump Green Infrastructure Treatment Cost Estimate.

Item No	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Traffic Control	40	Day	$1,000.00	$40,000
2	Temporary Construction Fence	2,696	LF	$2.50	$6,740
3	Silt Fence	2,696	LF	$3.00	$8,088
	Site Preparation				
4	Curb and Gutter Removal	1,330	LF	$3.30	$4,389
5	Saw Cut Existing Asphalt	1,150	LF	$5.12	$5,888
6	Asphalt Removal	8,050	SF	$3.36	$27,048
7	Sidewalk Removal	1,350	SF	$2.01	$2,714
8	Excavation and Removal	1,734	CY	$45.00	$78,021
	Structures				
9	Curb and Gutter	2,480	LF	$22.00	$54,560
10	Permeable Pavement	8,050	SF	$12.00	$96,600
11	Structural Layer (washed no 57 or no 2 stone)	870	CY	$50.00	$43,480
12	Concrete Transition Strip	1,150	LF	$4.00	$4,600
13	Utility Conflicts	1	LS	$10,000.00	$10,000
	Bioretention				
14	Fine Grading	2,660	SF	$0.72	$1,915
15	Drainage Stone (washed no 57 stone)	271	CY	$50.00	$13,546
16	Hydraulic Restriction Layer (30 mil liner)	5,336	LF	$0.60	$3,202
17	Soil Media Barrier (washed sand)	16	CY	$40.00	$657
18	Soil Media Barrier (choking stone, washed no 8)	16	CY	$45.00	$739
19	Mortared Cobble Energy Dissipater	70	SF	$2.25	$158
20	Curb Opening with Grate	14	LS	$350.00	$4,900
	Landscaping				
21	Soil Media	197	CY	$45.00	$8,867
22	Vegetation	2,660	SF	$4.00	$10,640
23	Mulch	25	CY	$55.00	$1,355
	Construction Subtotal				$428,110
24	Bond (5% of subtotal)				$21,410
25	Mobilization (10% of subtotal)				$42,810
26	Construction contingency (20% of subtotal)				$85,620
	Construction Total				$577,950
27	Design (40% of Construction Total)				$231,180
	Total Cost				**$809,130**

9. Additional Considerations

9.1. Monitoring Plan

Performance monitoring of stormwater BMPs is an important component of a BMP implementation program. Monitoring provides the BMP's designer a mechanism to validate certain design assumptions and to quantify compliance with pollutant-removal performance objectives. Specific monitoring objectives should be considered early in the design process to ensure that BMPs are adequately configured for monitoring. Detailed monitoring guidance is provided by the EPA (USEPA 2012). The instrumentation and monitoring configuration will vary from site to site, but a monitoring approach using an inlet/outlet sample location setup is recommended for this site.

9.1.1. Monitoring Hydrology

An inlet/outlet sampling setup is suggested as the most effective monitoring approach to quantify flow and volume in stormwater BMPs. The runoff source and type of BMP will dictate the configuration of inflow monitoring. A weir or flume (Figure 29) is typically installed at the inlet of a BMP. Outflow can be monitored using similar techniques as inflow by installing a weir or ADV at the point of overflow/outfall (Figure 30). Outlet samples can also be collected from systems configured with underdrains utilizing specially designed v-notch weirs such as the one shown in Figure 31. Figure 32 shows an example of potential monitoring points.

Figure 29. Inlet curb cut with an H-flume.

Figure 30. Outlet of a roadside bioretention equipped with a V-notch weir for flow monitoring.

Figure 31. Typical weir for monitoring flow in an underdrain.

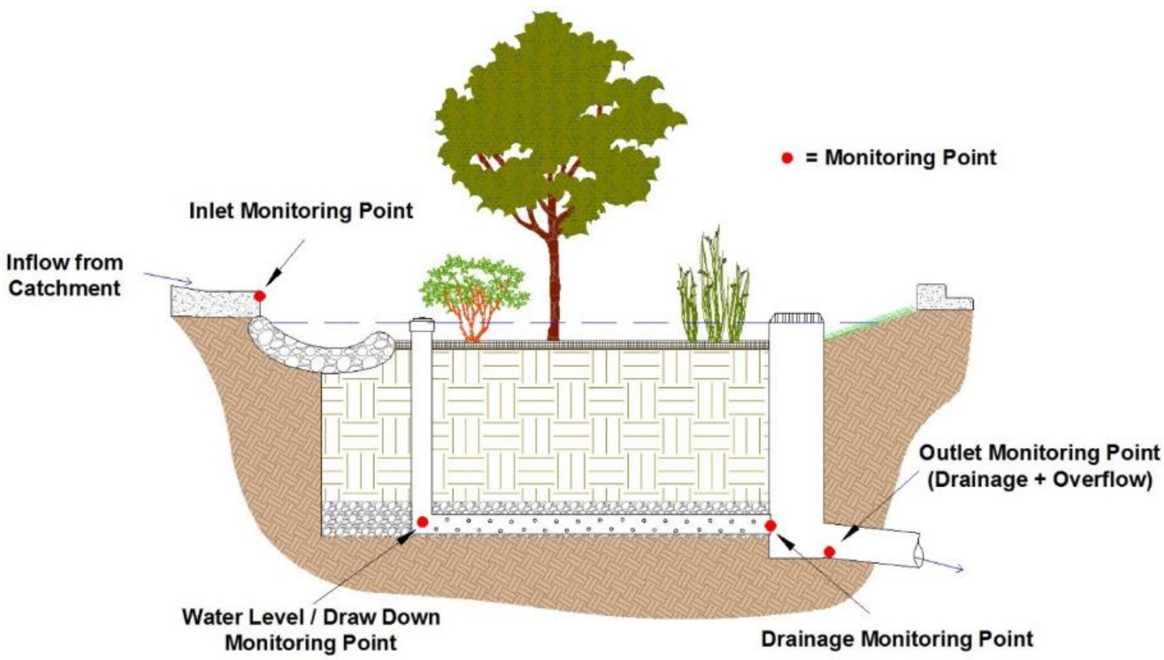


Figure 32. Typical monitoring points.

In addition to monitoring inflow and outflow, rainfall should be recorded on-site. Rainfall data can also be used to estimate inflow to BMPs that receive runoff only by sheet flow or direct rainfall (e.g., permeable pavement or green roofs). The type of rain gauge depends on monitoring goals and frequency of site visits. An automatic recording rain gauge (e.g., tipping bucket rain gauge), used to measure rainfall intensity and depth, is often paired with a manual rain gauge for data validation (Figure 33). For more advanced monitoring, weather stations can be installed to simultaneously monitor relative humidity, air temperature, solar radiation, and wind speed; these parameters can be used to estimate evapotranspiration.

Figure 33. Example of manual (left) and tipping bucket (right) rain gauges.

Water level (and drawdown rate) is another useful hydrologic parameter. Depending on project goals, perforated wells or piezometers can be installed to measure infiltration rate and drainage. Care should be taken when installing wells to ensure that runoff cannot enter the well at the surface and *short circuit* directly to subsurface layers; short circuiting can result in the discharge of untreated runoff that has bypassed the intended treatment mechanisms. It might be useful to pair soil moisture sensors with water level loggers in instances where highly detailed monitoring performance data are required (such as for calibration and validation of models).

9.1.2. Monitoring Water Quality

Although hydrologic monitoring can occur as a standalone practice, water quality data must be paired with flow data to calculate meaningful results. Flow-weighted automatic sampling is the recommended method for collecting samples that are representative of the runoff event and can be used to calculate pollutant loads (total mass of pollutants entering and leaving the system). Simply measuring the reduction in pollutant concentrations (mass per unit volume of water) from inlet to outlet can provide misleading results because it does not account for load reductions associated with infiltration, evapotranspiration, and storage.

Influent water quality samples are typically collected just upstream of the inlet monitoring device (e.g., weir box, flume) just before the runoff enters the BMP. The downstream sampler should be at the outlet control device just before the overflow enters the existing storm drain infrastructure. A strainer is usually installed at collecting end of the sampler tubing to prevent large debris and solids from entering and clogging the sampler. Automatic samplers should be programmed to collect single-event, composite samples according to the expected range of storm flows. Depending on the power requirements, a solar panel or backup power supply might be needed.

In addition to collecting composite samples, some water quality constituents can be monitored in real-time. Some examples include dissolved oxygen, turbidity, conductivity, and temperature.

9.1.3. Sample Collection and Handling

Quality assurance and quality control protocols for sample collection are necessary to ensure that samples are representative and reliable. The entire sample collection and delivery procedure should be well documented, including chain of custody (list of personnel handling water quality samples) and notes regarding site condition, time of sampling, and rainfall depth in the manual rain gauge. Holding times for water quality samples vary by constituent, but all samples should be collected, placed on ice, and delivered to the laboratory as soon as possible (typically 6 to 24 hours) after a rainfall event. Some water quality constituents require special treatment upon

collection, such as acidification, to preserve the sample for delivery. Appropriate health and safety protocols should always be followed when on-site, including using personal protective equipment such as safety vests, nitrile gloves, and goggles.

9.2. Public Education and Outreach

The green infrastructure BMPs will provide learning opportunities for community residents who frequent the area. A demonstration project will provide an example of how BMPs can be implemented in existing infrastructure and will serve as a consistent reminder of their impact on stormwater quality. When the project is completed, educational signage describing the BMPs and indicating the BMPs role in maintaining healthy water quality should remain on-site.

9.3. Future Retrofit Opportunities

The 10 acre drainage area containing portions of SWS 667349 and SWS 685049 was the focus of these wet weather treatment conceptual designs because of the required upgrade of Pump Plant 621. If more extensive, watershed-wide retrofits will be planned for future implementation, optimization analysis should consider the entire 1513-acre area of SWS 667349 and 685049 in order to generate a cost effective solution for controlling the quality of runoff draining storm drain system and ultimately to the LA River. During EWMP formulation, BMP opportunities throughout the entire subwatersheds were identified. These results can be used to guide future stormwater retrofit projects in the area.

10. References

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Appendix A - Fact Sheets

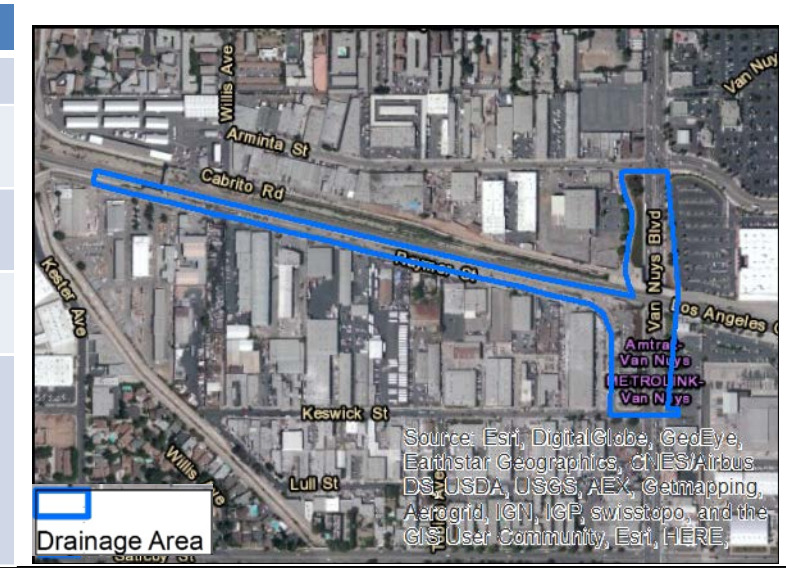
Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–EXHIBIT A.1
SITE: Pumping Plant No. 621

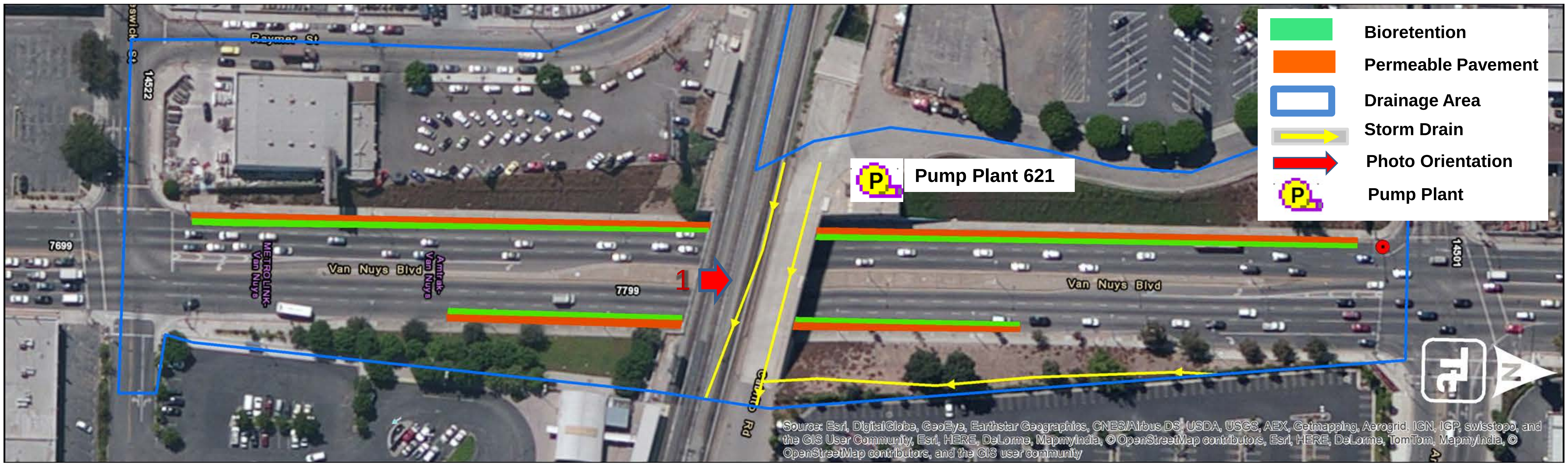
Site Location			
Landowner	City of Los Angeles	Latitude	34°12'43.30"N
Date of Field Visit	03/05/2015	Longitude	118°26'55.65"W
Field Visit Personnel	TJ, LT, RM	Street Address	7805 Van Nuys Blvd Van Nuys, CA 91402
Major Watershed	Upper Los Angeles River		

Existing Site Description: The conceptual design centers around the existing Pump Plant 621 near the intersection of Van Nuys Boulevard and Cabrito Road. The pump plant is intended to provide flood protection to an area roughly bounded by Arminta Street, Van Nuys Boulevard, Keswick Street, and the Pacoima Wash in the Van Nuys area of the City. Storm water flows from underground storm drain pipes in Van Nuys Blvd. are pumped up to a box culvert storm drain that flows to the southeast.

Watershed Characteristics		Retrofit Characteristics		
Drainage Area, acres	10	Proposed Retrofit	Green Street	
Soil Type	Hanford Series	BMP footprint, ft^2	Bioretention Permeable Pavement	2660 8050
Total Impervious, %	85	Ponding Depth, ft	Bioretention Permeable Pavement	1.5 0.01
Design Storm Event, in	85th	Media Depth, ft	Bioretention Permeable Pavement	4.75 3.75

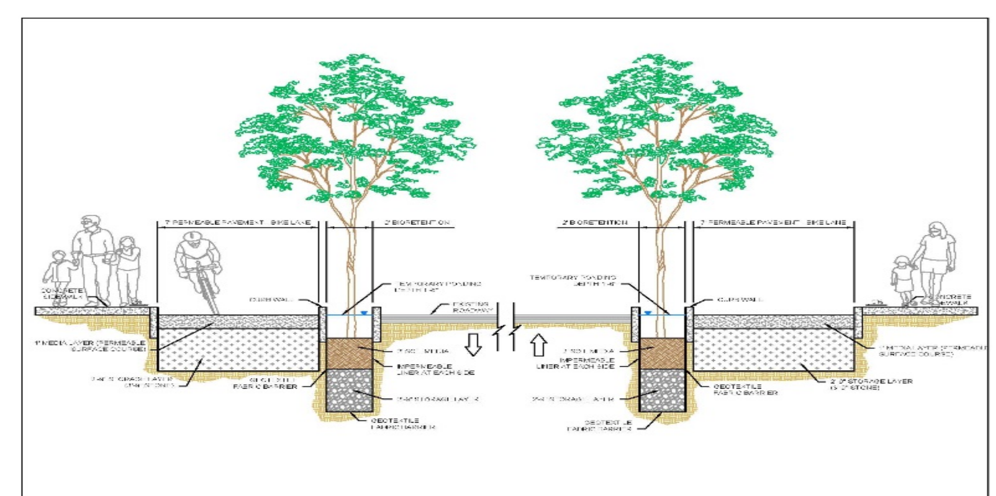
Proposed Retrofit Description: The proposed retrofit would involve installation of curb cuts to convey runoff to bioretention areas in the right-of-way along Van Nuys Blvd. to provide stormwater treatment and traffic calming benefits. A protected bike lane will increase safety for bicyclists and pedestrians while protecting permeable pavement in the bike lane from vehicular traffic. Treating the 85th percentile storm will reduce the amount of time that the main pumps have to operate by approximately 65%.





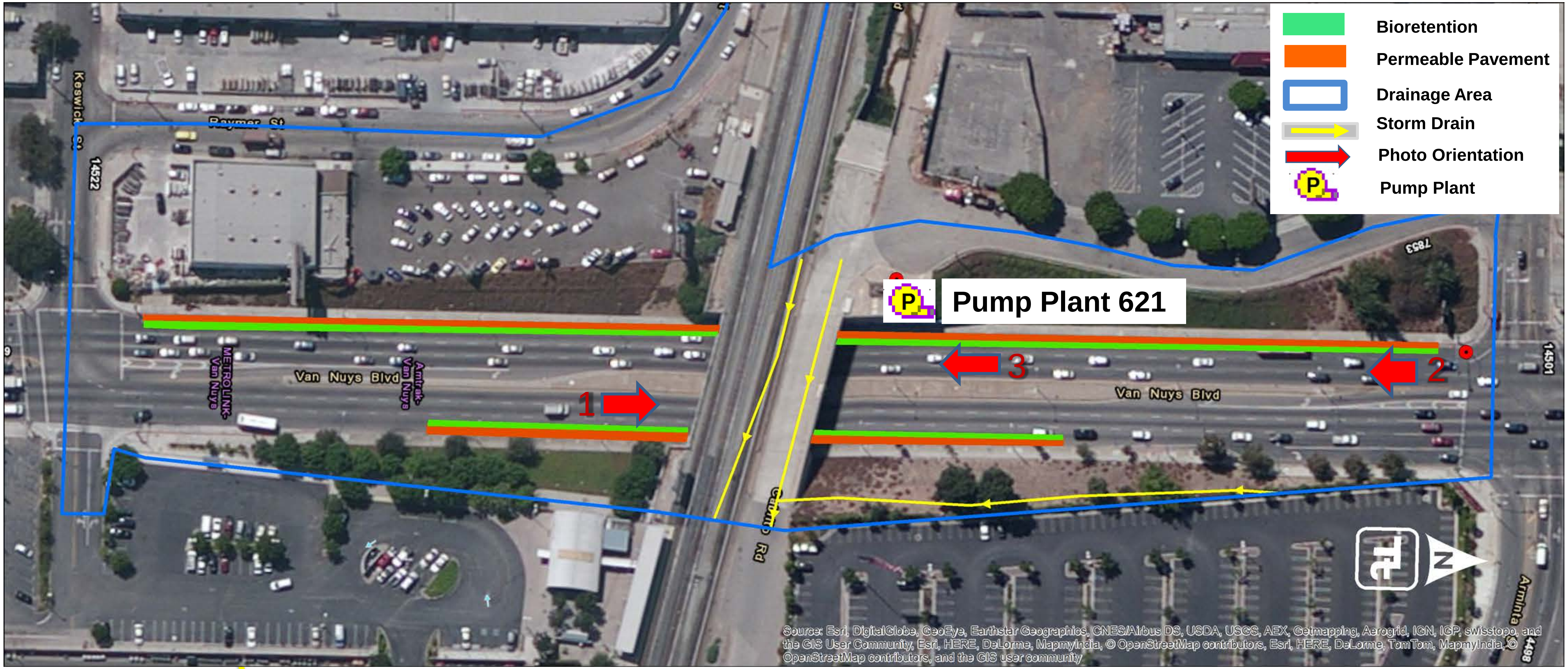
Current Street View

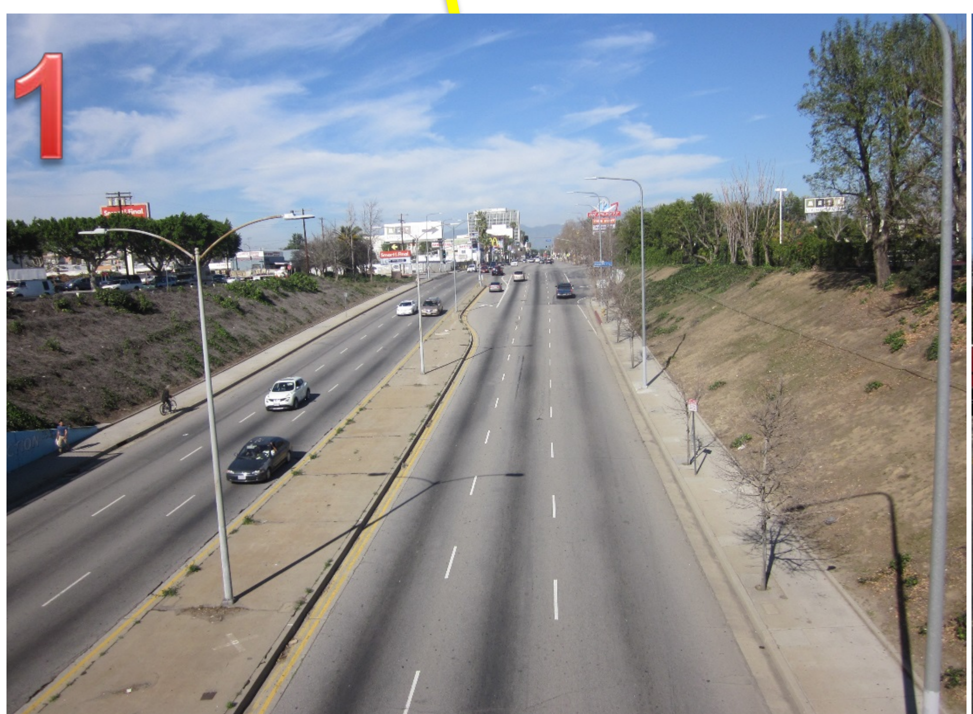

Rendered Street Improvement


Example Cross Section

LA Sanitation environment, City of Los Angeles

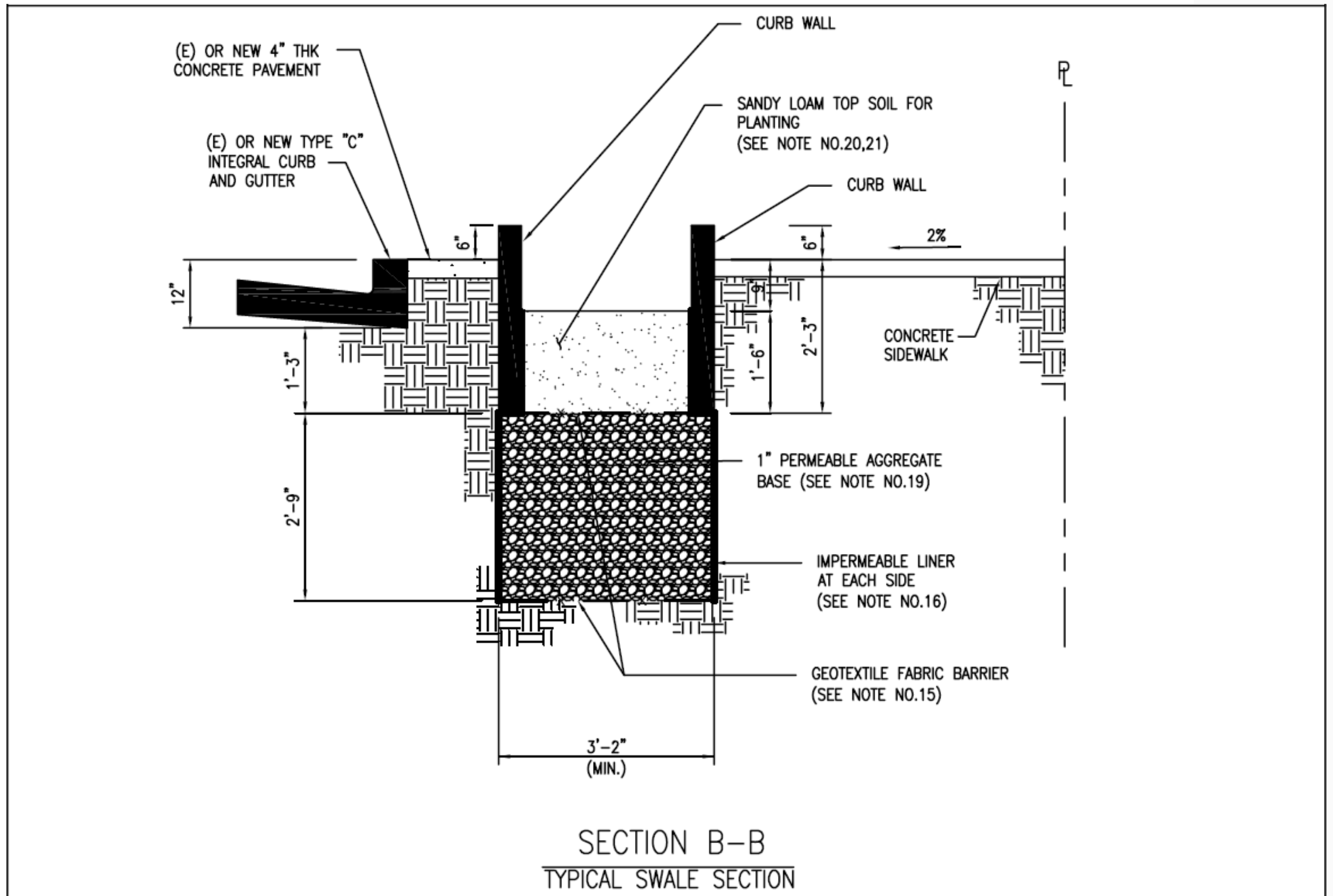
Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–Appendix A.2
SITE: Pumping Plant No. 621



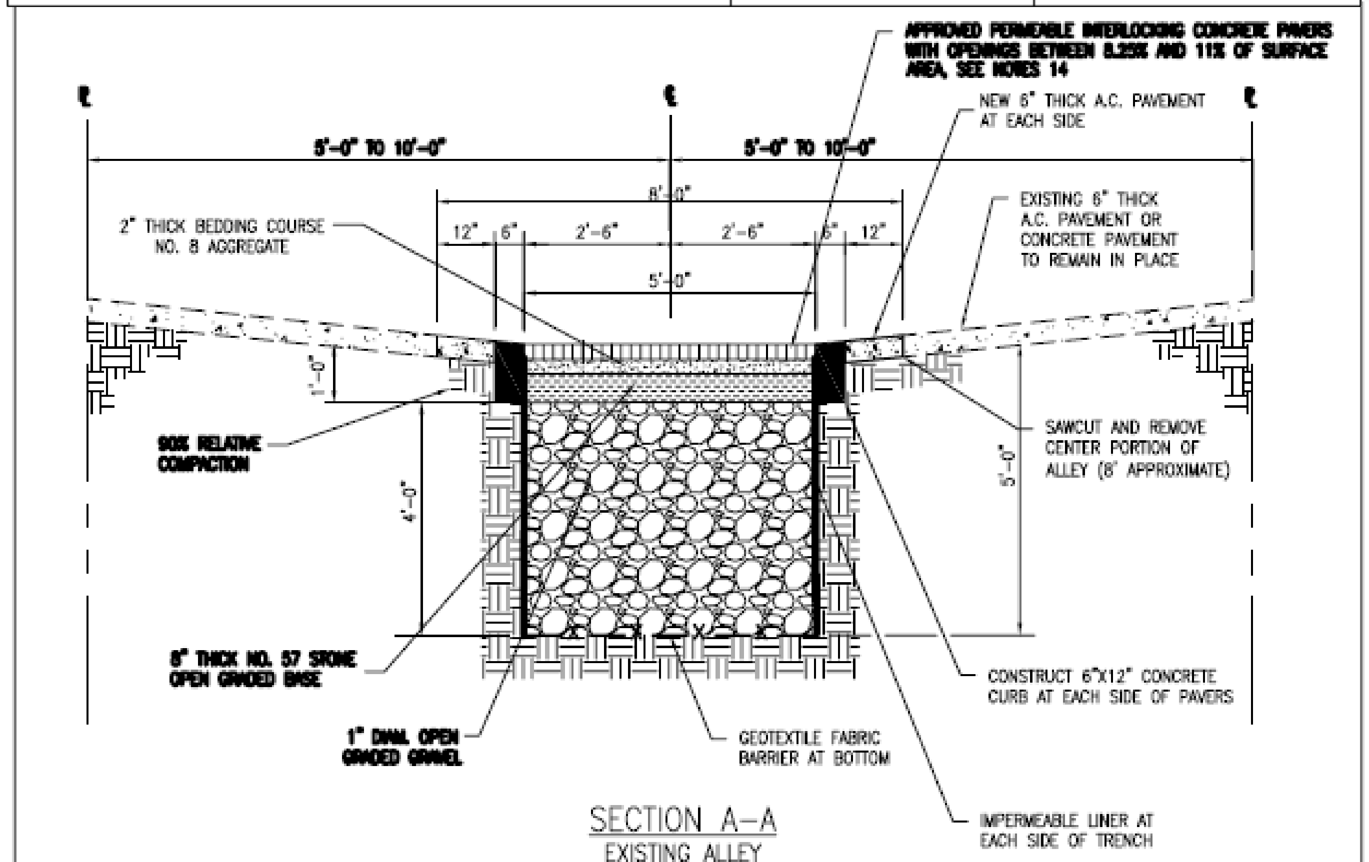


environment
LA SANITATION
CITY OF LOS ANGELES

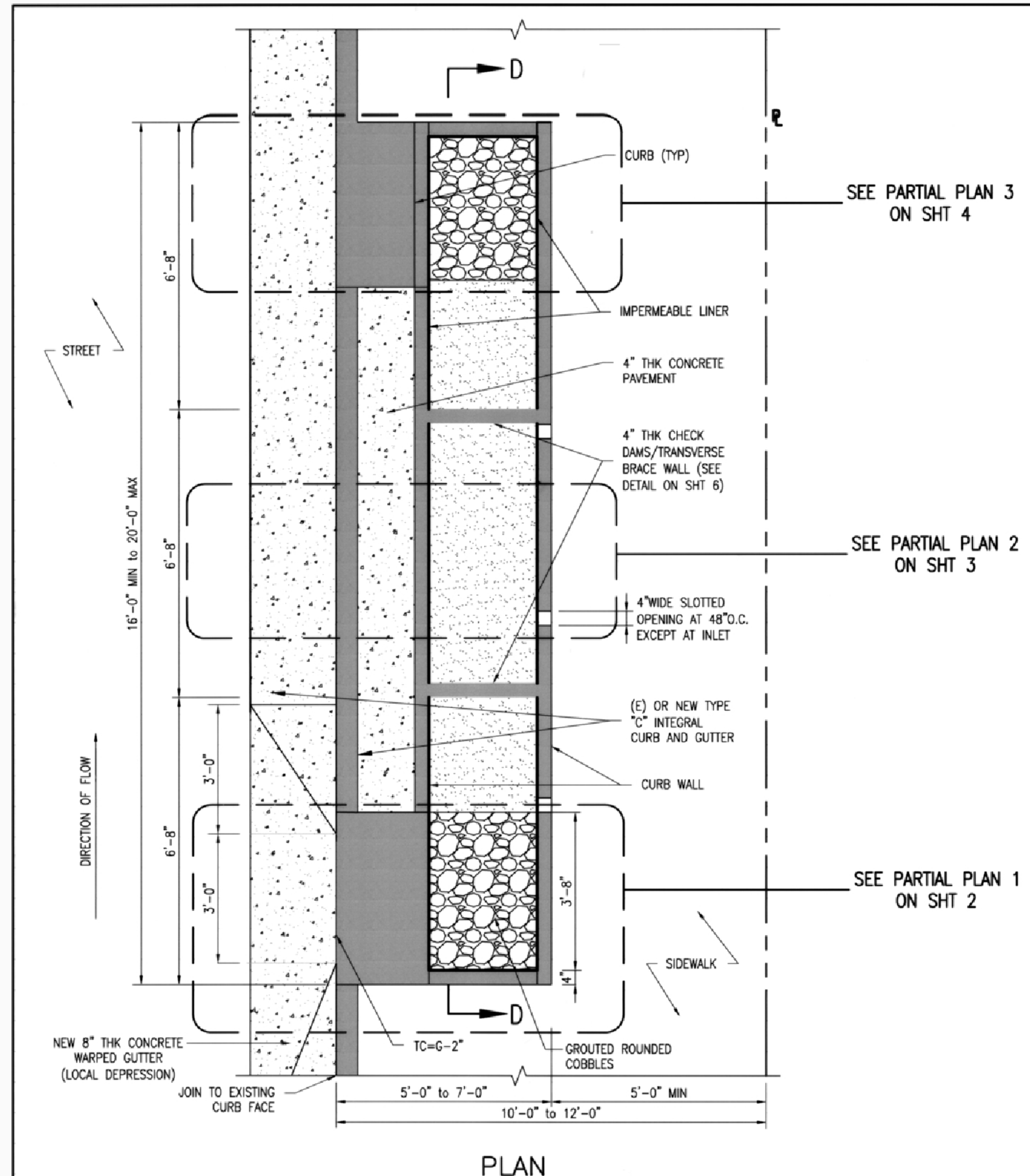
Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN-EXHIBIT A.3
SITE: Pumping Plant No. 621



STANDARD PLAN NO. S-481-0 | SHEET 3 OF 8 SHEETS



STANDARD PLAN NO. S-485-0 | SHEET 2 OF 3 SHEETS



BUREAU OF ENGINEERING	DEPARTMENT OF PUBLIC WORKS		CITY OF LOS ANGELES
PARKWAY SWALE IN MAJOR/SECONDARY HIGHWAYS			STANDARD PLAN S-481-0
PREPARED: ALICE GONG, CE49107, BUREAU OF SANITATION, ENRIQUE C. ZALDIVAR, P.E., DIRECTOR	SUBMITTED: JEONG PARK, S.E., ENGINEER OF DESIGN, BUREAU OF ENGINEERING, 6/28/10	APPROVED: GARY LEE MOORE, P.E., CITY ENGINEER, 6-29-10	SUPERSEDES / REFERENCES: S-410, S-480, S-484
CHECKED: PATRICK LEE, CE42448, BUREAU OF ENGINEERING	KEN REDD, P.E., ACTING DEPUTY CITY ENGINEER, 6/29/10		VAULT INDEX NUMBER:
			SHEET 1 OF 8 SHEETS

REGISTERED PROFESSIONAL ENGINEER GARY LEE MOORE No. C-49446 Exp. 9/30/10 CIVIL STATE OF CALIFORNIA

LA SANITATION environment CITY OF LOS ANGELES

Appendix B - Hydrocalcs

Peak Flow Hydrologic Analysis

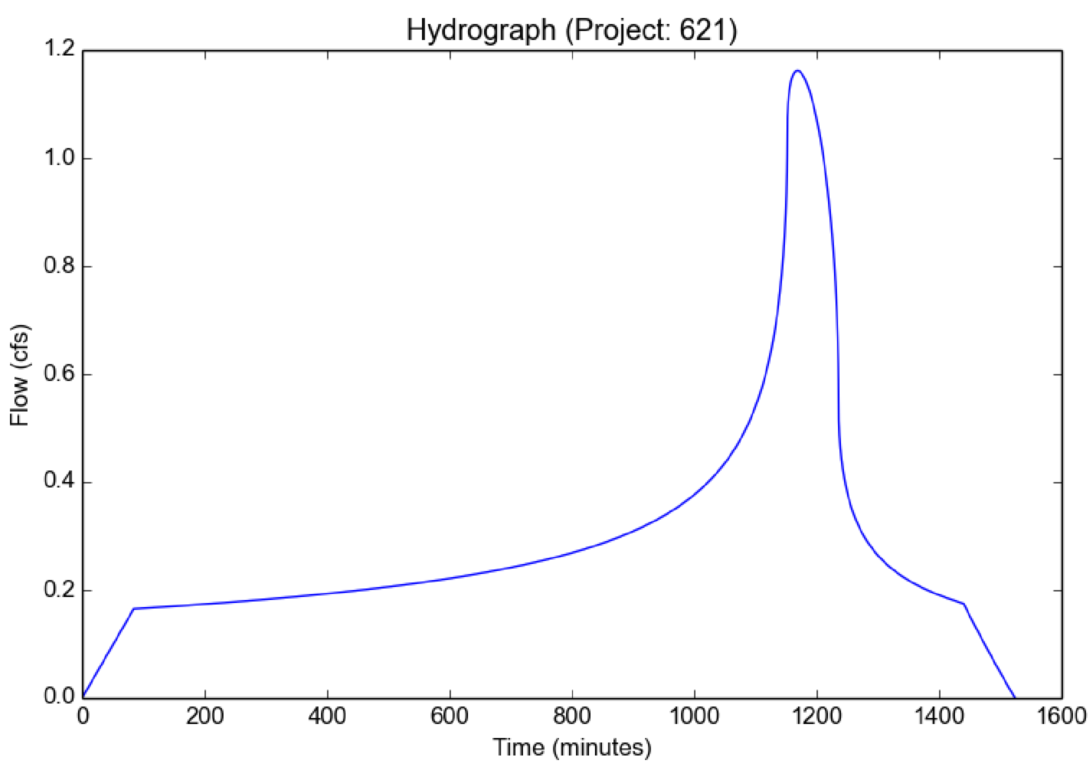
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Pump_621/621-85thYear.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	621
Area (ac)	10.0
Flow Path Length (ft)	3600.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	0.94
Percent Impervious	0.85
Soil Type	8
Design Storm Frequency	85th percentile storm
Fire Factor	0.71
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.94
Peak Intensity (in/hr)	0.1489
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.78
Time of Concentration (min)	84.0
Clear Peak Flow Rate (cfs)	1.1615
Burned Peak Flow Rate (cfs)	1.2029
24-Hr Clear Runoff Volume (ac-ft)	0.606
24-Hr Clear Runoff Volume (cu-ft)	26397.6626



Peak Flow Hydrologic Analysis

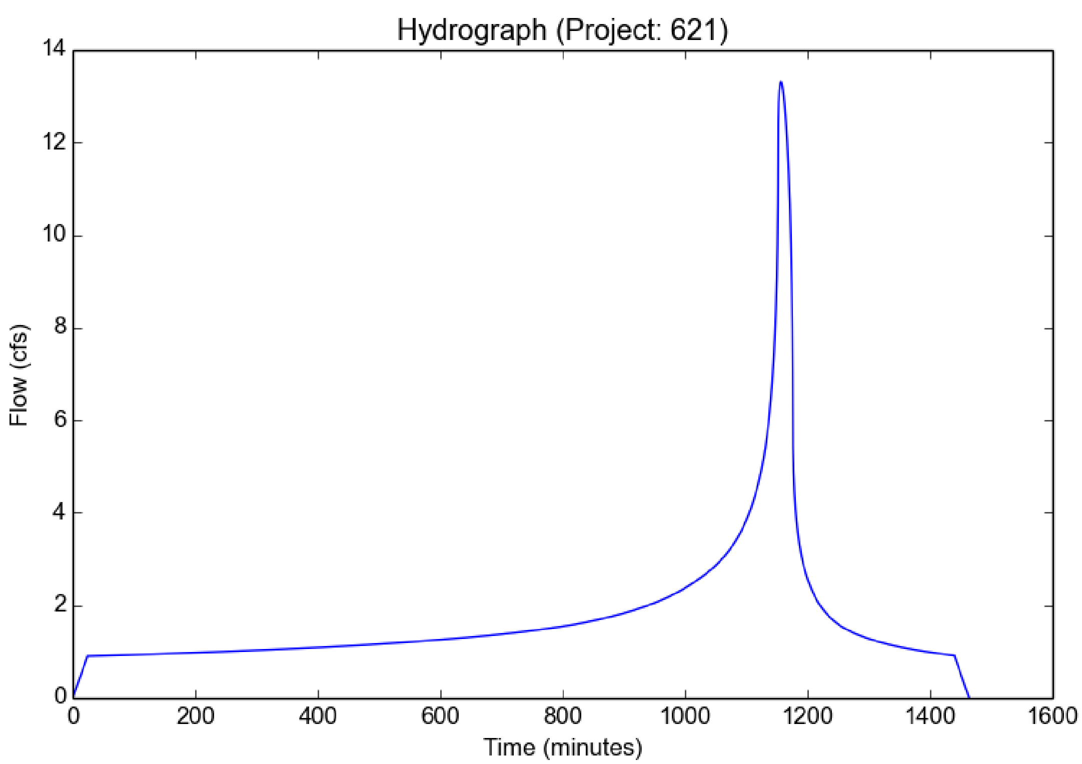
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Pump_621/621-10Year.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	621
Area (ac)	10.0
Flow Path Length (ft)	3600.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.3
Percent Impervious	0.85
Soil Type	8
Design Storm Frequency	10-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	5.2122
Peak Intensity (in/hr)	1.4878
Undeveloped Runoff Coefficient (Cu)	0.8638
Developed Runoff Coefficient (Cd)	0.8946
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	13.3094
Burned Peak Flow Rate (cfs)	13.699
24-Hr Clear Runoff Volume (ac-ft)	3.5033
24-Hr Clear Runoff Volume (cu-ft)	152605.8844



Peak Flow Hydrologic Analysis

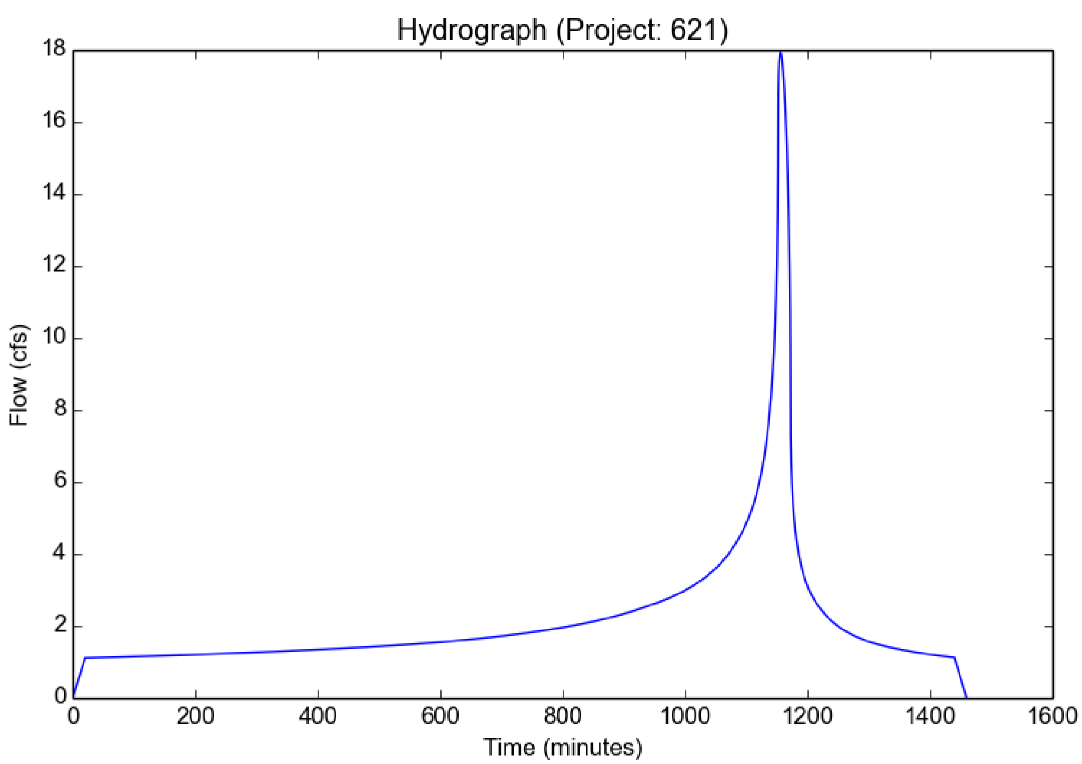
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Pump_621/621-25Year.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	621
Area (ac)	10.0
Flow Path Length (ft)	3600.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.3
Percent Impervious	0.85
Soil Type	8
Design Storm Frequency	25-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	6.4094
Peak Intensity (in/hr)	1.9932
Undeveloped Runoff Coefficient (Cu)	0.8984
Developed Runoff Coefficient (Cd)	0.8998
Time of Concentration (min)	20.0
Clear Peak Flow Rate (cfs)	17.9342
Burned Peak Flow Rate (cfs)	18.4576
24-Hr Clear Runoff Volume (ac-ft)	4.3547
24-Hr Clear Runoff Volume (cu-ft)	189691.3009



Peak Flow Hydrologic Analysis

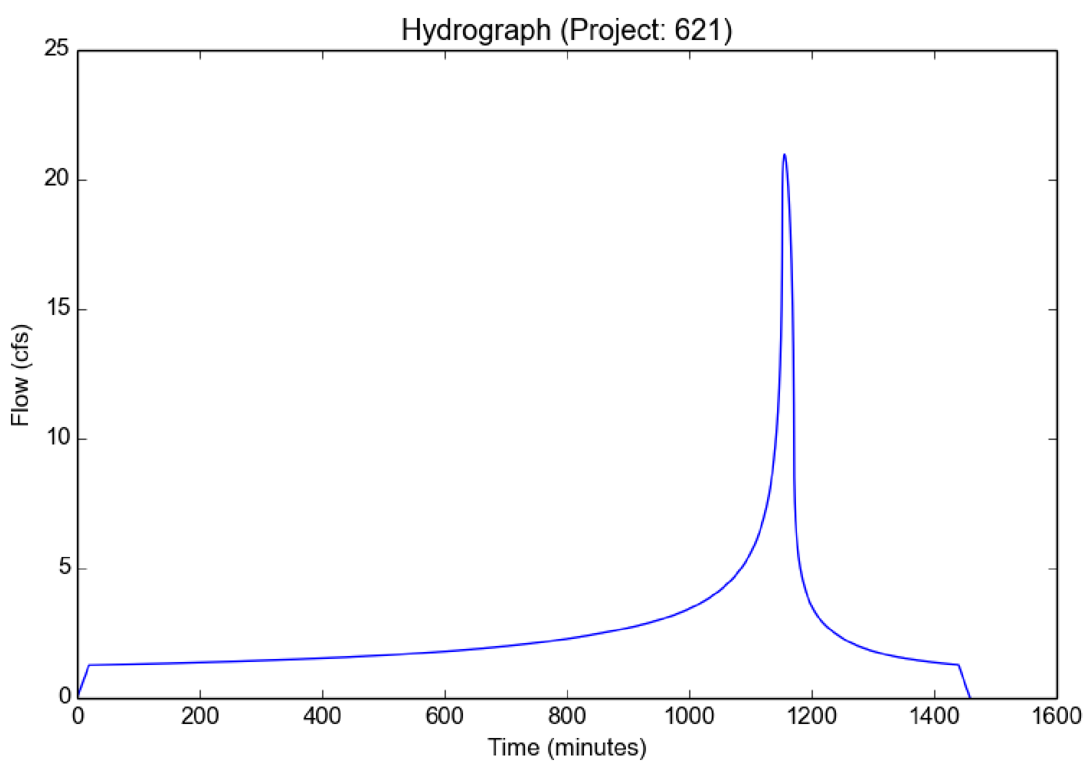
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Pump_621/621-50Year.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	621
Area (ac)	10.0
Flow Path Length (ft)	3600.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.3
Percent Impervious	0.85
Soil Type	8
Design Storm Frequency	50-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	7.3
Peak Intensity (in/hr)	2.3256
Undeveloped Runoff Coefficient (Cu)	0.9103
Developed Runoff Coefficient (Cd)	0.9015
Time of Concentration (min)	19.0
Clear Peak Flow Rate (cfs)	20.9659
Burned Peak Flow Rate (cfs)	21.5818
24-Hr Clear Runoff Volume (ac-ft)	5.0
24-Hr Clear Runoff Volume (cu-ft)	217799.0675



Appendix C – Pump Calculations

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #621 Storm Water PS BMP pumps

Givens: 1. 85th Percentile flow is 1.16 CFS (520 gpm)
2. Assume 50 LF of 6" pipe to BMP Summit manhole

e
Assumptions: 1. The Hazen-Williams C-factors are assumed to be as follows:
Aged Ductile Iron Pipe = 100
2. The pump suction grade line is based on the water levels in the Plant #622 wet well
LWL = 738.41 HWL = 743.41
5. The pump discharge is pumping to the summit manhole.
Elev = 773

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: h_L=10.44*L(ft)*$Q^{1.85}$(gpm)/$C^{1.85}$*$D^{4.87}$(inches)

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
6	50	DIP	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
6	90 Deg	0.25	2	0.5
6	Ent Loss	0.8	1	0.8
6	Exit Loss	1	1	1
Total Minor Losses				**2.3**

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift	
Summit MH	773
Low Water Level	738.41
$H_{(static-max)}$=	34.59

Minimum Static Lift	
Summit MH	773
High Water Level	743.41
$H_{(static-min)}$=	29.59

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Step 4 ***Determine System Curve***

Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	34.6	29.6	32.1	0.00
50	0.0	0.0	34.6	29.6	32.1	0.57
100	0.1	0.0	34.7	29.7	32.2	1.14
150	0.2	0.1	34.9	29.9	32.4	1.70
200	0.3	0.2	35.1	30.1	32.6	2.27
250	0.5	0.3	35.3	30.3	32.8	2.84
300	0.6	0.4	35.7	30.7	33.2	3.41
350	0.9	0.6	36.0	31.0	33.5	3.97
400	1.1	0.7	36.4	31.4	33.9	4.54
450	1.4	0.9	36.9	31.9	34.4	5.11
500	1.7	1.2	37.4	32.4	34.9	5.68
520	1.8	1.2	37.6	32.6	35.1	5.90
550	2.0	1.4	38.0	33.0	35.5	6.24
600	2.3	1.7	38.6	33.6	36.1	6.81
650	2.7	1.9	39.2	34.2	36.7	7.38
700	3.1	2.3	39.9	34.9	37.4	7.95
750	3.5	2.6	40.7	35.7	38.2	8.52
800	4.0	2.9	41.5	36.5	39.0	9.08
850	4.4	3.3	42.4	37.4	39.9	9.65
900	4.9	3.7	43.3	38.3	40.8	10.22

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

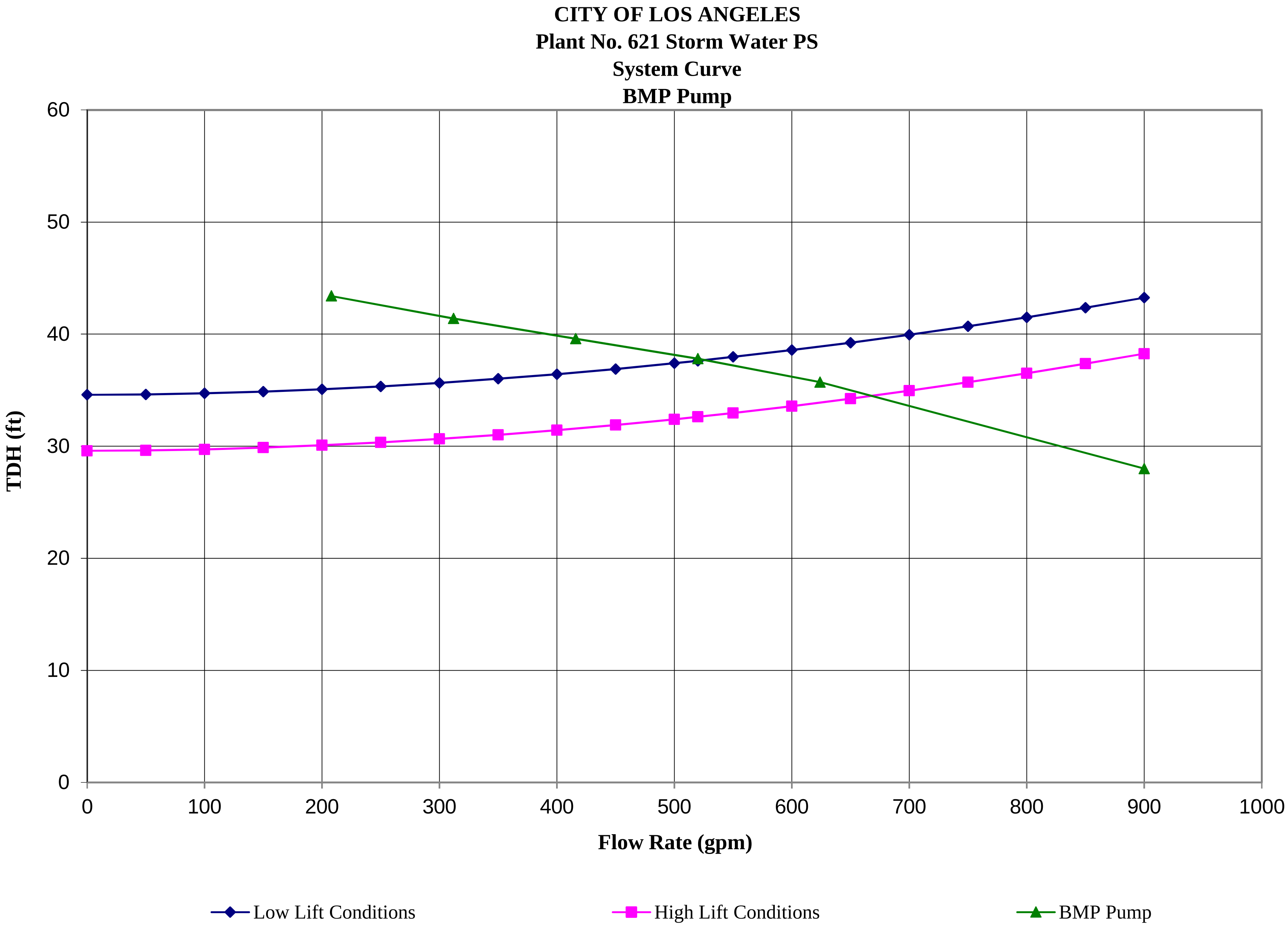
System Curve Calculations

Step 5 ***New Pump Curve***

Fairbanks
4" 5434

7 hp

Q (gpm)	TDH (ft)
900	28
624	35.7
520	37.8
416	39.6
312	41.4
208	43.4


CITY OF LOS ANGELES
Plant No. 621 Storm Water PS
System Curve
BMP Pump
TDH (ft)
0
10
20
30
40
50
60
0
100
200
300
400
500
600
700
800
900
1000
Flow Rate (gpm)
Low Lift Conditions
High Lift Conditions
BMP Pump

Pump Data Sheet - Fairbanks Morse Pump, 60 Hz

PENTAIR

FAIRBANKS NIJHUIS™

Company:
Name:
Date: 4/24/2015

Pump:

Size: 4"5434M&W

Type: 5430-SOLIDS HANDLING
Synch speed: 720 rpm

Speed: 705 rpm
Dia: 16 in

Curve: 340410B

Impeller: T4D1B

Specific Speeds:

Ns: 1305
Nss: 5818

Dimensions:

Suction: 5 in
Discharge: 4 in

Pump Limits:

Temperature: 104 °F
Pressure: 100 psi g
Sphere size: 3 in

Power: ---
Eye area: ---

Search Criteria:

Flow: 520 US gpm

Head: 37.6 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP

NPSHa: ---

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Consult Fairbanks Morse Pump, 60 Hz to select a motor for this pump.

---- Data Point ----

Flow:	520 US gpm
Head:	37.8 ft
Eff:	71%
Power:	6.98 hp
NPSHr:	4.03 ft

---- Design Curve ----

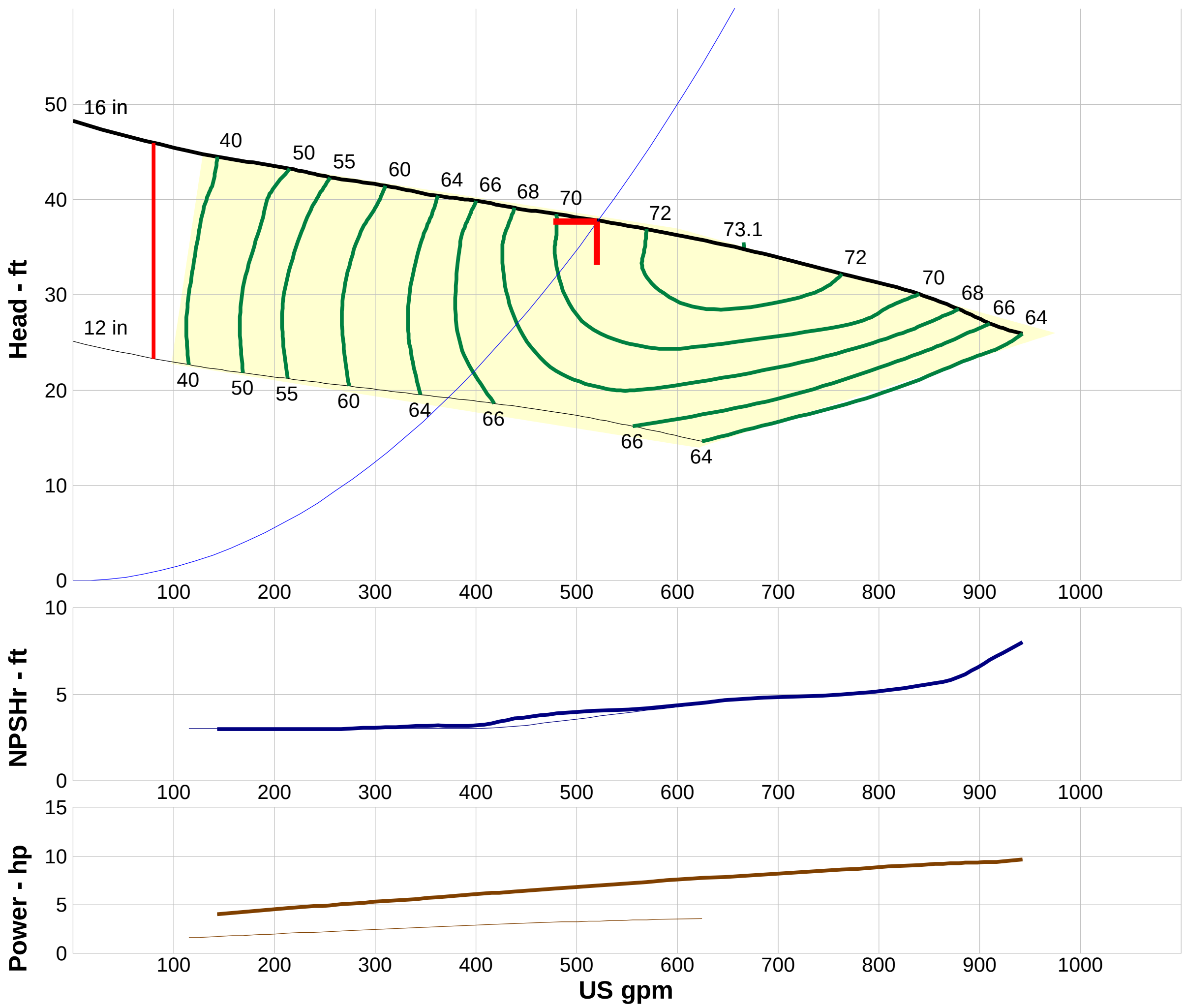
Shutoff head:	48.3 ft
Shutoff dP:	20.9 psi
Min flow:	80 US gpm

BEP: 73% @ 666 US gpm

NOL power:
9.63 hp @ 942 US gpm

-- Max Curve --

Max power:
9.63 hp @ 942 US gpm



Curve efficiencies are typical. For guaranteed values, contact Fairbanks Morse or your local distributor. Las eficiencias en curvas son típicas. Para valores garantizados contacte a Fairbanks Morse o a su distribuidor local.

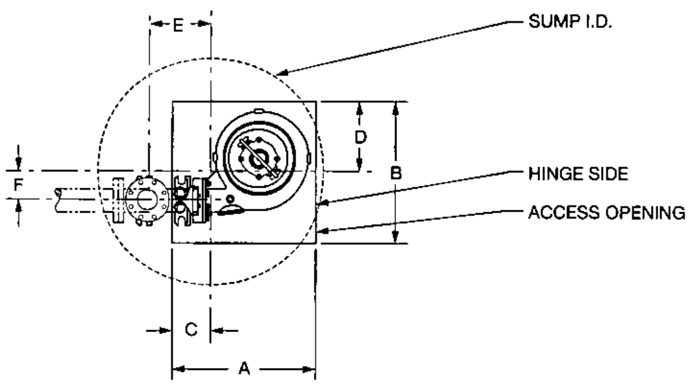
Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
624	705	35.7	73	7.73	4.51
520	705	37.8	71	6.98	4.03
416	705	39.6	67	6.21	3.37
312	705	41.4	60	5.42	3.1
208	705	43.4	49	4.63	3

Selected from catalog: Fairbanks Morse Submersible.60 Vers: 3

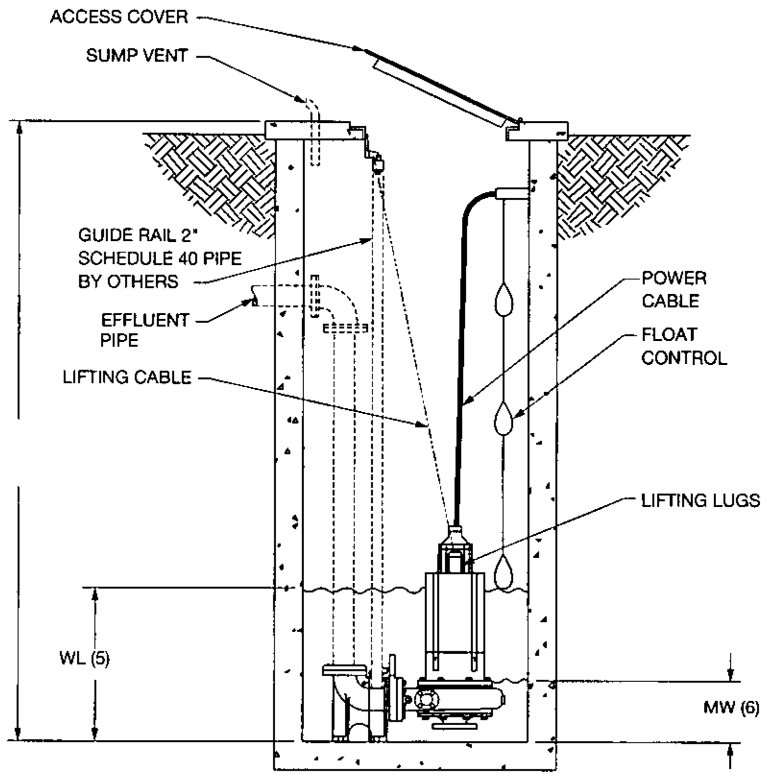
	D5434 M & W					D5435 M & W			D5436 M & W				
Pump Size (Discharge Size)	4	5	6	8S	8L	4	8	10	5	6	6L	8	8S
Suction Size (Standard)	5	5	6	8	8	4	8	10	8	10	10	12	10
Nominal Wear Ring (Axial) Clearance:	.020	.020	.025	.025	.025	.015	.025	.030	.020	.025	.025	.025	.025
Impeller Fastener:													
Size	3/4-10	3/4-10	3/4-10	3/4-10	3/4-10	7/8-9	7/8-9	7/8-9	7/8-9	1 1/4-7	1 1/4-7	7/8-9	1 1/4-7
Tightening Torque (lbs.-ft.)	200	200	200	200	200	240	240	240	240	240	240	240	240
Impeller:													
Weight (lbs.)	103.0	89.3	169.3	102.1	102.1	103.0	302.0	380.0	89.3	133.0	125	342.0	125
Inlet Area (sq. inches)	47.01	58.39	(2)	62.99	(3)	35.65	(4)	127.43	52.05	59.32	93.3	93.22	93.3
Sphere Size (Maximum)	3	4	(2)	3 1/2	(3)	3	5	6	3	3	3	5	3
Max. Hydrostatic Test, PSI	160	80	80	80	80	190	115	115	190	225	225	150	225
Max. Casing Working, PSI	100	75	75	75	75	125	75	75	1125	150	150	100	150
Nominal Casing Thickness	9/16	1/2	1/2	1/2	1/2	11/16	3/4	3/4	11/16	7/8	7/8	3/4	7/8
Max. Operating Temperature, °F (5)	104	104	104	104	104	104	104	104	104	104	104	104	104
Anchor Bolt Size, recommended	7/8	7/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8	7/8	7/8
Dry Pit Submersible Options													
Suction Size (Optional)	6	6	8	10	10	6	10	12	10	—	—	—	—
Vent/Priming Tap	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Volute Cleanout Diameter	2 7/8	4 1/4	4 1/4	4 7/8	4 7/8	2 7/8	5 1/8	4 7/8	3 7/8	5 1/8	5 1/8	5 1/8	5 1/8
Suction Elbow Cleanout Diameter (6)	5	5	6	6	6	3	6	6	6	6	6	6	6
Min. Round Opening to Install Pump	46	48	50	52	52	46	68	70	48	58	58	68	58
Weights													
Pump & Motor (7)													
210T	640	860	1075	1085	1135	850	—	—	1070	—	—	—	—
250T	1140	1095	1300	1280	1350	1590	—	—	1145	1500	—	—	—
320T	1660	1695	1750	1800	1850	1750	2550	—	1845	2000	2000	—	2100
360T	2100	2145	2200	2250	2300	—	3000	3200	2150	2450	2450	3050	2400
365T	2300	2250	2400	—	—	—	3200	3350	2350	2650	2650	3250	2750
400T	—	—	—	—	—	—	—	—	—	—	—	—	—
440T	—	—	—	—	—	—		5900	—	5295	5295	5700	5000
MV or MT Base/Elbow Adder													
4" Elbow	80	—	—	—	—	80	—	—	—	—	—	—	—
6" Elbow	—	150	150	—	—	150	—	—	150	150	150	150	—
8" Elbow	—	230	230	230	230	—	230	—	230	230	230	230	230
10" Elbow	—	—	—	970	970	—	970	970	—	—	—	970	970
WD Base & Elbow Adder	200	230	245	305	315	200	285	375	265	410	410	410	410

(1) All dimensions are in inches.
(2) TAJC5BH impeller has an inlet area of 60.58 sq. in. and can pass a 3" sphere; TAJC5DC impeller has an inlet area of 70.85 sq. in. and can pass a 4" sphere; TAJC5BJ impeller has a inlet area of 64.55 sq. in. and can pass a 3" sphere.
(3) T8D1A impeller has an inlet area of 62.99 sq. in. and can pass a 3 1/2" sphere; TAKC5W impeller has an inlet area of 99.93 sq. in and can pass a 5" sphere; T8D1D impeller has an inlet area of 72.94 sq. in. and can pass a 4" sphere.
(4) TAKE5N impeller has an inlet area of 130.29 sq. in.; TAKE5U impeller has an inlet area of 108.36 sq.in.
(5) For UL Listing only.
(6) Suction elbow available on WD units only.
(7) For water jacketed motors add the appropriate following weight:
250 Frame = 85 lbs., 320 Frame = 230 lbs, 360 Frame = 245 lbs.,
365 Frame = 245 lbs., 400 Frame = 355 lbs, 440 Frame = 460 lbs.



PLAN VIEW

PUMP	SUMP I.D.	A	B	C
2" A5431MT	48	30	30	8
3" A5431MT	48	30	30	8
4" A5431MT	48	30	30	8
2" A5432MT	48	30	30	8
3" A5432MT	48	30	30	8
4" A5432MT	48	30	30	9
3" A5433MT	48	30	30	9
4" A5433MT	48	36	30	8
5" A5433MT	60	36	36	10¾
6" A5433MT	60	36	36	10¾



ELEVATION

PUMP	D	E	F
2" A5431MT	15	12	3
3" A5431MT	15	12	3
4" A5431MT	15	12	3¼
2" A5432MT	15	12	3
3" A5432MT	15	12	3½
4" A5432MT	15	13	4
3" A5433MT	15	13	4
4" A5433MT	15	12	6
5" A5433MT	18	16	6
6" A5433MT	18	16	5

NOTES:

(1) ALL DIMENSIONS ARE IN INCHES UNLESS NOTED.
(2) FOR USE WITH IMPELLER DESIGN T8D1A
(3) FOR USE WITH IMPELLER DESIGNS T8D1A AND TAKC5W
(4) 5400'S AND 5400K'S ARE DIMENSIONALLY IDENTICAL
(5) RECOMMENDED LOW WATER LEVEL FOR CONTINUOUS OPERATION. OPTIONAL CONTINUOUS IN AIR MODIFICATION AVAILABLE.
(6) WATER LEVEL MAY BE DRAWN DOWN TO THIS LEVEL FOR SHORT TIME DUTY IN AIR MOTOR RATINGS DRAW DOWN CAN OCCUR OVER A PERIOD OF 15 MINUTES.
(7) CLOCKWISE ROTATION SHOWN COUNTERCLOCKWISE IS AVAILABLE.
(8) BASES ARE DESIGNED TO HAVE FULL CONTACT WITH GROUT OR A SOLE PLATE GROUTED IN PLACE.
(9) NOT FOR CONSTRUCTION, INSTALLATION, OR APPLICATION PURPOSES UNLESS CERTIFIED DIMENSIONS SHOWN MAY VARY DUE TO NORMAL MANUFACTURING TOLERANCES.
(10) REFER TO BASIC PUMP DIMENSION DRAWING FOR WL AND MW DIMENSIONS.

SIMPLEX, A5430MT, SUBMERSIBLE PULL-UP
SINGLE DOOR ACCESS COVER

Fairbanks Morse Pump

DWG NO 543MS171 REV NO 2

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #621 Storm Water PS 50 yr storm pump

Givens: 1. 50yr storm flow is 21 CFS = 9,425 gpm

Assumptions: 1. The Hazen-Williams C-factors are assumed to be as follows:
Aged Concrete Pipe = 100
2. The pump suction grade line is based on the water levels in the Plant #621 wet well
LWL = 738.41 HWL = 748.5
5. The pump discharge is pumping to the summit manhole.
Elev = 776.75

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: h_L=10.44*L(ft)*$Q^{1.85}$(gpm)/$C^{1.85}$*$D^{4.87}$(inches)

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
18	24	Concrete	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
18	Ent loss	0.8	1	0.8
18	90 Deg	0.25	1	0.25
18	45 deg	0.2	2	0.4
18	Ret Bend	0.4	1	0.4
10	Exit Loss	1	1	1
Total assumed minor losses				**2.85**

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift	
Summit MH	776.75
Low Water Level	738.41
$H_{(static-max)}$=	38.34

Minimum Static Lift	
Summit MH	776.75
High Water Level	748.5
$H_{(static-min)}$=	28.25

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Step 4 ***Determine System Curve***

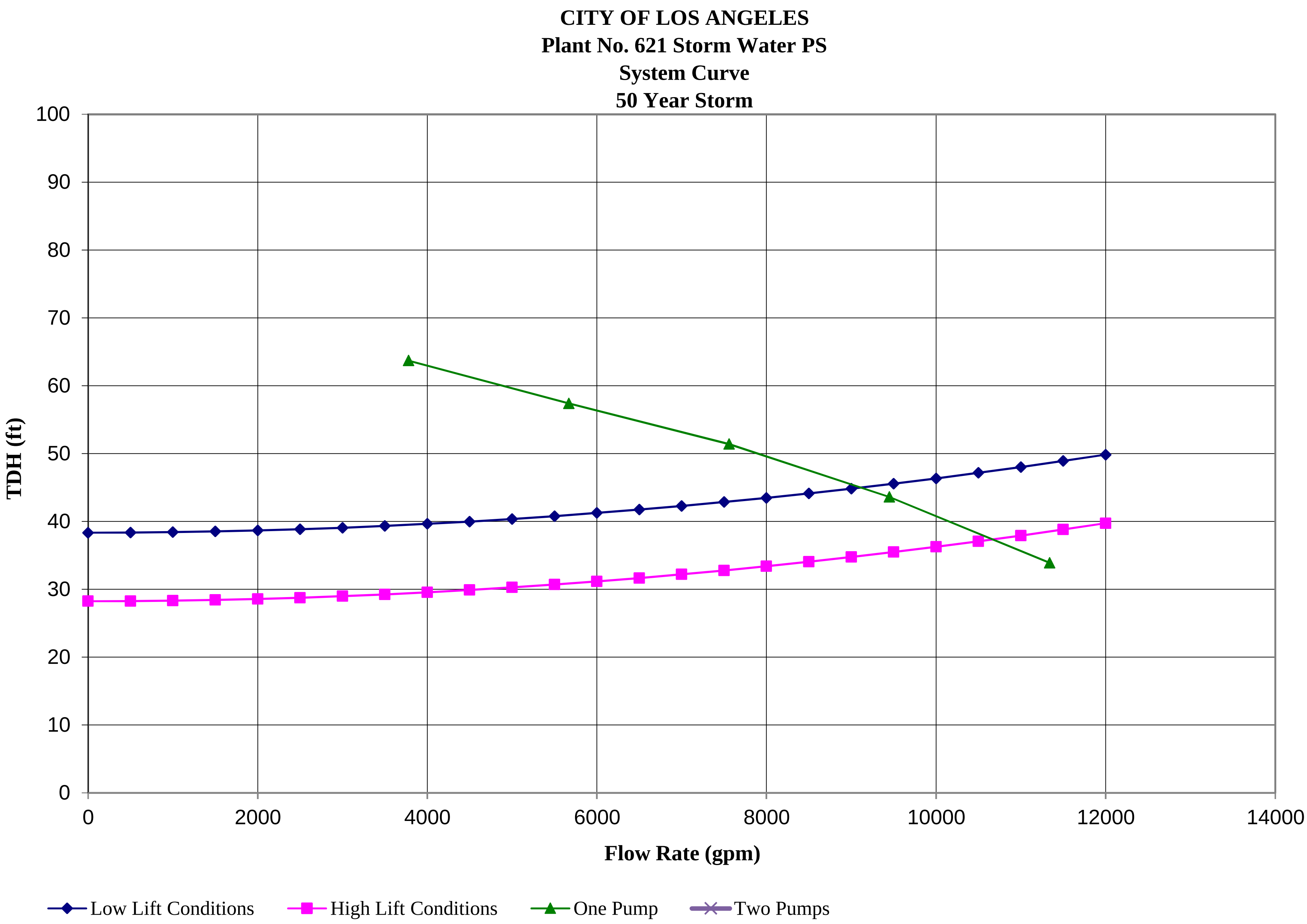
Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	38.3	28.3	33.3	0.00
500	0.0	0.0	38.4	28.3	33.3	0.63
1000	0.0	0.1	38.4	28.3	33.4	1.26
1500	0.0	0.2	38.5	28.4	33.5	1.89
2000	0.0	0.3	38.7	28.6	33.6	2.52
2500	0.1	0.4	38.9	28.8	33.8	3.15
3000	0.1	0.6	39.1	29.0	34.0	3.78
3500	0.1	0.9	39.3	29.3	34.3	4.42
4000	0.2	1.1	39.6	29.6	34.6	5.05
4500	0.2	1.4	40.0	29.9	34.9	5.68
5000	0.3	1.8	40.4	30.3	35.3	6.31
5500	0.3	2.1	40.8	30.7	35.7	6.94
6000	0.4	2.5	41.3	31.2	36.2	7.57
6500	0.4	3.0	41.8	31.7	36.7	8.20
7000	0.5	3.5	42.3	32.2	37.2	8.83
7500	0.6	4.0	42.9	32.8	37.8	9.46
8000	0.6	4.5	43.5	33.4	38.4	10.09
8500	0.7	5.1	44.1	34.1	39.1	10.72
9000	0.8	5.7	44.8	34.8	39.8	11.35
9500	0.9	6.4	45.6	35.5	40.5	11.98
10000	1.0	7.0	46.4	36.3	41.3	12.62
10500	1.1	7.8	47.2	37.1	42.1	13.25
11000	1.2	8.5	48.0	37.9	43.0	13.88
11500	1.3	9.3	48.9	38.8	43.9	14.51
12000	1.4	10.1	49.8	39.7	44.8	15.14

CITY OF LOS ANGELES
Plant No. 621 Storm Water PS

System Curve Calculations

Step 5 ***New Pump Curve***

Firbanks Morse	
20" VTSH	
150 hp	
Q (gpm)	**TDH (ft)**
3780	63.7
5670	57.4
7560	51.4
9450	43.6
11340	33.9


CITY OF LOS ANGELES
Plant No. 621 Storm Water PS
System Curve
50 Year Storm
TDH (ft)
100
90
80
70
60
50
40
30
20
10
0
0
2000
4000
6000
8000
10000
12000
14000
Flow Rate (gpm)
Low Lift Conditions
High Lift Conditions
One Pump
Two Pumps

Pump Data Sheet - Fairbanks Morse Pump, 60 Hz

PENTAIR

FAIRBANKS NIJHUIS™

Company:

Name:

Date: 4/23/2015

Pump:

Size: 20"VTSH

Type: VTSH
Synch speed: 720 rpm

Speed: 705 rpm
Dia: 20.55 in

Curve:

Impeller: V20B1A

Specific Speeds:

Ns: ---
Nss: ---

Dimensions:

Suction: 20 in
Discharge: ---

Pump Limits:

Temperature: ---
Pressure: ---
Sphere size: 5 in

Power: ---
Eye area: 186 in²

Search Criteria:

Flow: 9450 US gpm

Head: 43.3 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: ---

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA
Enclosure: TEFC

Speed: ---
Frame: ---

Sizing criteria: Max Power on Design Curve

---- Data Point ----

Flow:	9450 US gpm
Head:	43.6 ft
Eff:	86%
Power:	121 hp
NPSHr:	21.4 ft

---- Design Curve ----

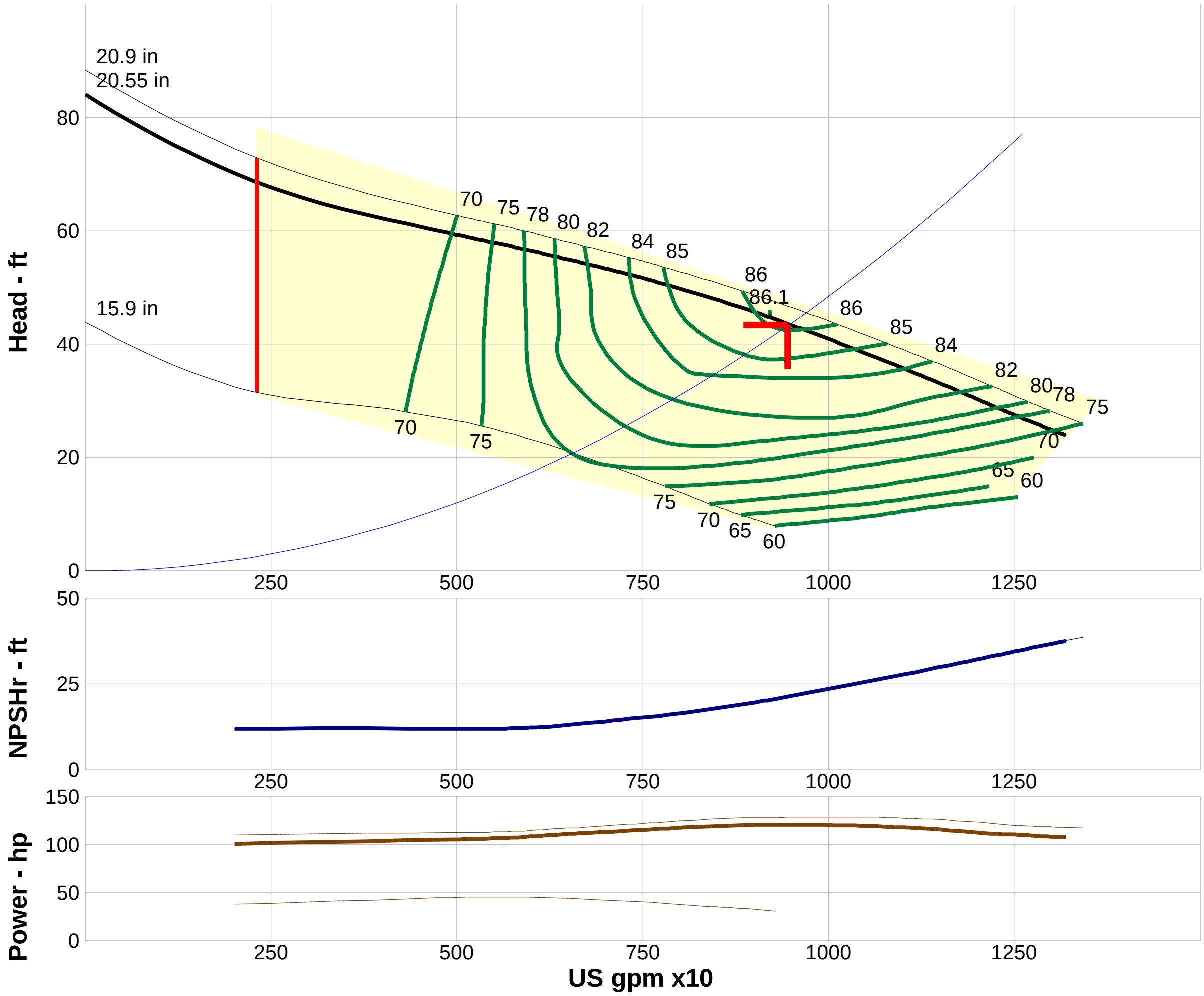
Shutoff head:	84 ft
Shutoff dP:	36.4 psi
Min flow:	2300 US gpm

BEP: 86% @ 9210 US gpm

NOL power:
121 hp @ 9210 US gpm

-- Max Curve --

Max power:
129 hp @ 10115 US gpm



Refer to factory for maximum working pressure and temperature limit. Curve efficiencies are typical. For guaranteed values, contact Fairbanks Morse or your local distributor. Las eficiencias en curvas son típicas. Para valores garantizados contacte a Fairbanks Morse o a su distribuidor local.

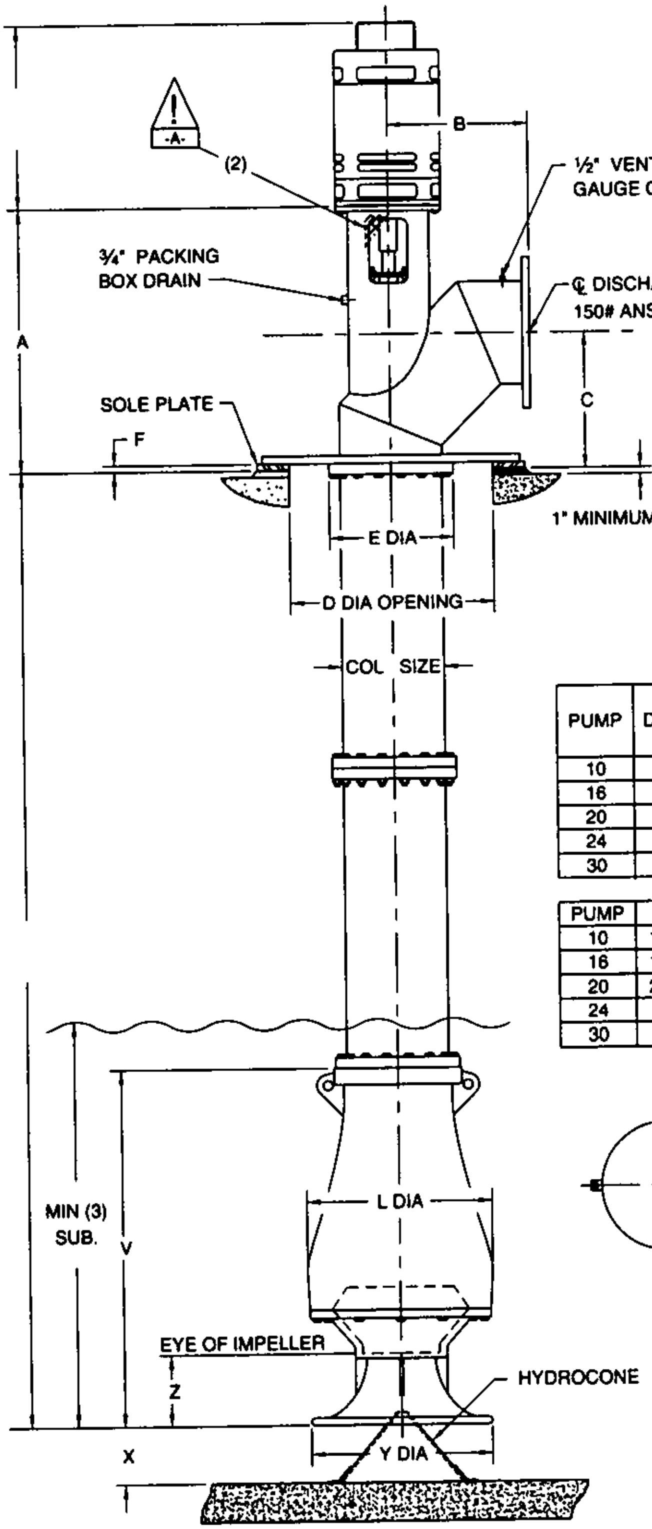
Performance Evaluation:

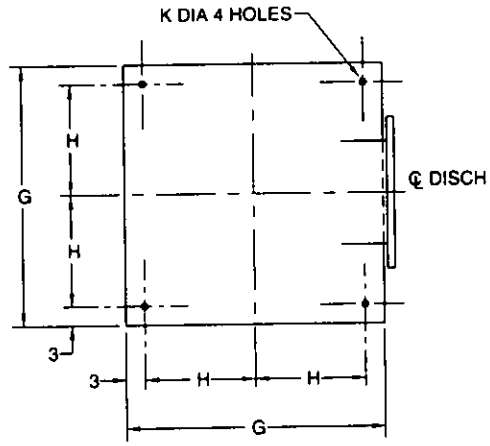
Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
11340	705	33.9	83	116	29.3
9450	705	43.6	86	121	21.4
7560	705	51.4	84	116	15.5
5670	705	57.4	76	107	12.1
3780	705	63.7	56	104	12.1

⚠ WARNING

DO NOT OPERATE THIS MACHINE WITHOUT PROTECTIVE GUARD IN PLACE. ANY OPERATION OF THIS MACHINE WITHOUT PROTECTIVE GUARD CAN RESULT IN SEVERE BODILY INJURY.

-A- SUPPLIED BY FMPC -B- SUPPLIED BY OTHERS

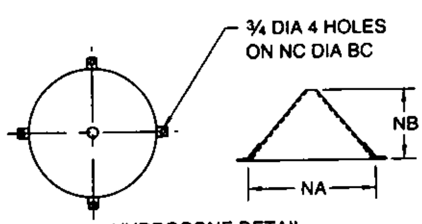




SOLE PLATE ANCHORING DIMENSIONS

PUMP	DISCH	COL.	A					B	C	D
			MOTOR BASE DIAMETER							
			10-12	16½	20	24½	30½			
10	10	10	33⅞	33⅞	- - -	- - -	- - -	17	12⅞	22
16	16	16	39⅞	40⅞	45⅞	- - -	- - -	22	20⅞	32
20	20	20	- - -	43⅞	49⅞	50⅞	- - -	27	24⅞	42
24	24	24	- - -	47⅞	53⅞	54⅞	62⅞	34	29⅞	52
30	30	30	- - -	CONSULT FACTORY						

PUMP	E	F	G	H	K	L	V	X	Y	Z
10	13¾	1	32	13	1	19⅛	37	6½	19	8
16	19½	1	42	18	1	29⅛	55½	9	28⅜	13
20	23¾	1	52	23	1	37¾	73⅝	12	37⅝	16
24	28	1	62	28	1¼	48⅛	83¼	15¼	47⅞	16
30	CONSULT FACTORY									



HYDROCONE DETAIL

PUMP	NA	NB	NC
10	14	7	16
16	20	11	22
20	28	15	30
24	34	18	36
30	RTF		

NOTES:
(1) ALL DIMENSIONS ARE IN INCHES UNLESS NOTED.
(2) GUARD FURNISHED WHEN FLANGED COUPLING IS USED
(3) REFER TO SUBMERGENCE CHART FOR MIN SUBMERGENCE.
(4) SOLEPLATE TO HAVE FULL CONTACT WITH GROUT.
(5) NOT FOR CONSTRUCTION, INSTALLATION, OR APPLICATION PURPOSES UNLESS CERTIFIED. DIMENSIONS SHOWN MAY VARY DUE TO NORMAL MANUFACTURING TOLERANCES.

CUSTOMER | P O NO
JOB NAME | TAG NAME
PUMP SIZE AND MODEL | GPM | TDH | RPM | ROTATION
MOTOR | HP | FRAME | PHASE | HERTZ | VOLTS | ENCLOSURE
CERTIFIED FOR | CERTIFIED BY | DATE

Fairbanks Morse Pump Corporation

SETTING PLAN
VERTICAL TURBINE
SOLIDS HANDLING
ABOVE GROUND DISCH

DWG NO VTSHS001 REV NO 0

1/1/92

Appendix D – BOE “D” Plans

INDEX TO PLANS

PLAN NO.	SHEET NO.	
D-18493		SOUTHERN PACIFIC COMPANY RAILROAD BRIDGE
	1	INDEX TO PLANS
	2	KEY MAP
	3	FOUNDATION PLAN
	4	LOG OF TEST BORINGS
	5	EXISTING UTILITIES
	6-8	RELOCATED UTILITIES AND DEMOLITION PLAN
	9	GENERAL PLAN
	10	PIER
	11	EAST ABUTMENT
	12	WEST ABUTMENT
	13	DECK PLAN
	14-16	MISCELLANEOUS DETAILS
	17	BULKHEAD DETAILS
D-18494		L.A.C.F.C.D. STORM DRAIN BRIDGE
	1-8	SAME AS D-18493
	9	GENERAL PLAN
	10	PIER
	11	WEST ABUTMENT
	12	EAST ABUTMENT
	13	DECK PLAN
	14-15	MISCELLANEOUS DETAILS
D-18495		RETAINING WALLS, BRIDGE RAILING DETAILS, RAILROAD EMBANKMENT GRADING
	1	INDEX TO PLANS
	2	S.E. AND S.W. RETAINING WALLS
	3	S.E. AND S.W. RETAINING WALL DETAILS
	4	N.W. RETAINING WALL
	5	N.W. RETAINING WALL DETAILS
	6	N.E. RETAINING WALL
	7	RAILING PLANS
	8	RAILING DETAILS
	9	SHOOFLY
D-18496		STORM DRAINS
	1	INDEX TO PLANS
	2	GENERAL NOTES
	3-4	PLAN AND PROFILE OF STORM DRAINS
	5	PROFILE OF CONNECTOR PIPES
	6	TRAFFIC DETOUR PLAN
	7-11	STRUCTURAL DETAILS
D-18497		PUMP PLANT — CIVIL, MECHANICAL, AND ELECTRICAL
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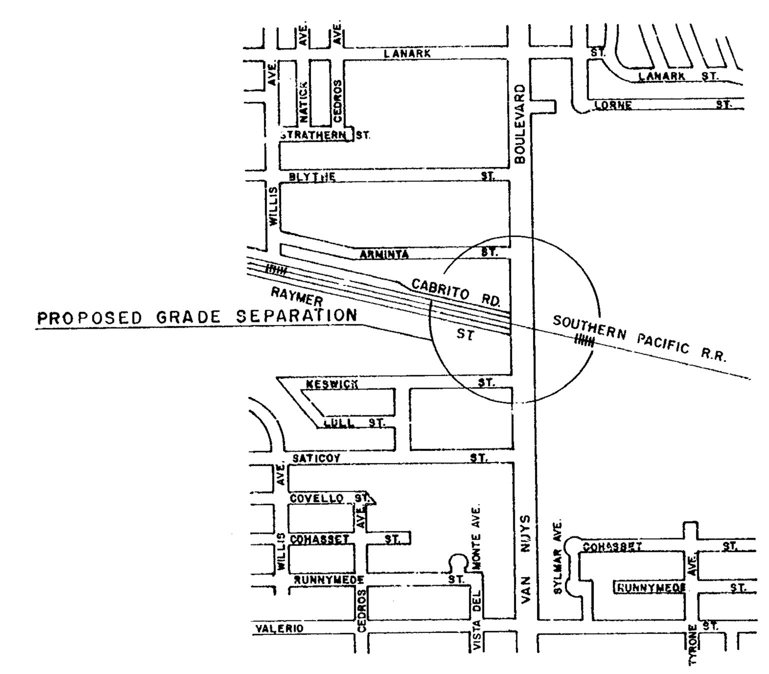
	2	GENERAL PLAN
	3	PLAN OF ROOF AND MOTOR ROOM FLOOR AND SECTIONS
	4	PLANS OF STORAGE CHAMBER, BAR SCREEN ROOM, AND SECTIONS
	5-8	MISCELLANEOUS DETAILS
	9	DETAILS OF PUMP DISCHARGE PIPES
	10-11	VENTILATION SYSTEM AND DETAILS
	12-13	PLANS AND SECTIONS OF WIRING LAYOUT
	14	SWITCHBOARD DETAILS
	15	PLOT PLAN AND WIRING DIAGRAM
D-18498		PUMP PLANT - STRUCTURAL, ARCHITECTURAL
	1	INDEX TO PLANS
	2	PLANS AND STRUCTURAL NOTES
	3	SECTIONS
	4-5	ELEVATIONS AND DETAILS
	6	BEAM DETAILS
	7-8	MISCELLANEOUS DETAILS
	9-10	ARCHITECTURAL DETAILS
D-18499		STREET LIGHTING AND TRAFFIC
	1	INDEX TO PLANS
	2	TITLE SHEET
	3	DETOUR LIGHTING
	4	FINAL LIGHTING
	5-8	TRAFFIC SIGNAL SYSTEM
	9	ADVANCE SIGNING
	10-13	TRAFFIC CHANNELIZATION
D-18500		EROSION CONTROL
	1	INDEX TO PLANS
	2	PLAN
	3	PLAN
	4	SKINNER LINE-TYPICAL DETAIL
D-18457		SEWERS
	1	TITLE SHEET
	2	SEWER PLAN AND PROFILE
P-22103		STREET PLANS
	1	TITLE SHEET
	2-4	CROSS SECTION DETAILS
	5-6	PLAN AND PROFILE OF VAN NUYS BLVD. FROM BLYTHE ST. TO SATICOY ST.
	7-8	PLAN AND PROFILE OF DETOUR RD. FROM STA. 48+00 TO STA. 68+00
	9	PLANS AND PROFILES OF RAYMER ST. AND CABRITO RD.
	10-13	PLAN OF VAN NUYS BLVD. FROM BLYTHE ST. TO SATICOY ST.
	14-16	PLAN OF DETOUR RD. FROM 152' N/O ARMINTA ST. TO 152' S/O KESWICK ST.
	17	PLAN OF RAYMER ST. AND KESWICK ST.
	18	PLAN OF CABRITO RD. AND ARMINTA ST.
	19	PLAN AND PROFILE OF ACCESS RD.
	20	INDEX TO PLANS

DESIGN	T.P. KAMACHI
DETAILS	M. RASHOFF
QUANTITIES	
SUPERVISED	E. ROSENKJAR
CHECKED	M. RASHOFF
CHECKED	T. P. KAMACHI
ARCHITECTURE	L.M. WRUBELLE
REVIEWED	P.H. SKARIN



VICINITY MAP
Scale: 1" = 1000'

VAN NUYS BOULEVARD GRADE SEPARATION AT RAYMER STREET AND SOUTHERN PACIFIC COMPANY TRACKS

CITY OF LOS ANGELES
LYALL A. PARDEE CITY ENGINEER

DATUM NOTE

U. S. G. S. DATUM EFFECTIVE JULY 1, 1935 ORDINANCE NO. 52222 DEDUCT 5.779 FEET TO ADJUST TO DATUM PLANE IN USE PRIOR TO SAID DATE

REFERENCES

FIELD BOOK NO. 27873 PAGES 1-10 & 27831 PAGES 1-4
DATE OF SURVEY AUGUST 10, 1962
DISTRICT MAP NO. 7496, 7497, 7500, 7501
ASSESSMENT MAP NO. ____ CITY 793, 794
DRAINAGE MAP NO. 398
SUPERSEDES PROFILE NO. ____

NOTICE TO CONTRACTORS

THIS IMPROVEMENT ALSO INCLUDES WORK CALLED FOR ON THE FOLLOWING SPECIAL PLANS AND PROFILES

STREET IMP. PROFILES P-22103
SEWER PLANS D-18457
STORM DRAIN PLANS D-18496
STRUCTURAL PLANS D-18493, D-18494, D-18495, D-18496, D-18498
ORNAMENTAL LIGHTING PLANS D-18499 SHEETS 2-4
EXISTING MANHOLES (TOTAL) STORM DRAIN ____ SEWER ____

[illegible] ALL WORK DETAILED ON THESE PLANS TO BE PERFORMED UNDER CONTRACT SHALL [illegible] AS OTHERWISE STATED OR PROVIDED FOR HEREIN [illegible] IN ACCORDANCE WITH THE STANDARD [illegible] AS AMENDED BY [illegible]

BENCH MARKS			
F.B.	Pg.	Elev.	Description
27873	4	780.960	Standard Survey Mon. ℄ Blythe St. on Transit Line 2' E/O ℄ Van Nuys Blvd.
27873	4	776.580	Standard Survey Mon. ℄ Arminta St. on Transit Line 2' E/O ℄ Van Nuys Blvd.
27873	6	770.830	Spk. West Curb Van Nuys Blvd. 10' S/O B.C. Return S/O Keswick St.
27873	8	778.735	Spk. North Conc. Headwall, S/S Cabrito Rd. 273'± W/O Van Nuys Blvd.
27873	9	764.990	Spk. W. Curb Van Nuys Blvd. 5' N/O B.C. Return N/O Saticoy St.

LOS ANGELES COUNTY FLOOD CONTROL DISTRICT
PERMIT NO. 63669-B

VAN NUYS BOULEVARD GRADE SEPARATION AT RAYMER STREET AND SOUTHERN PACIFIC COMPANY TRACKS W.O. 61682

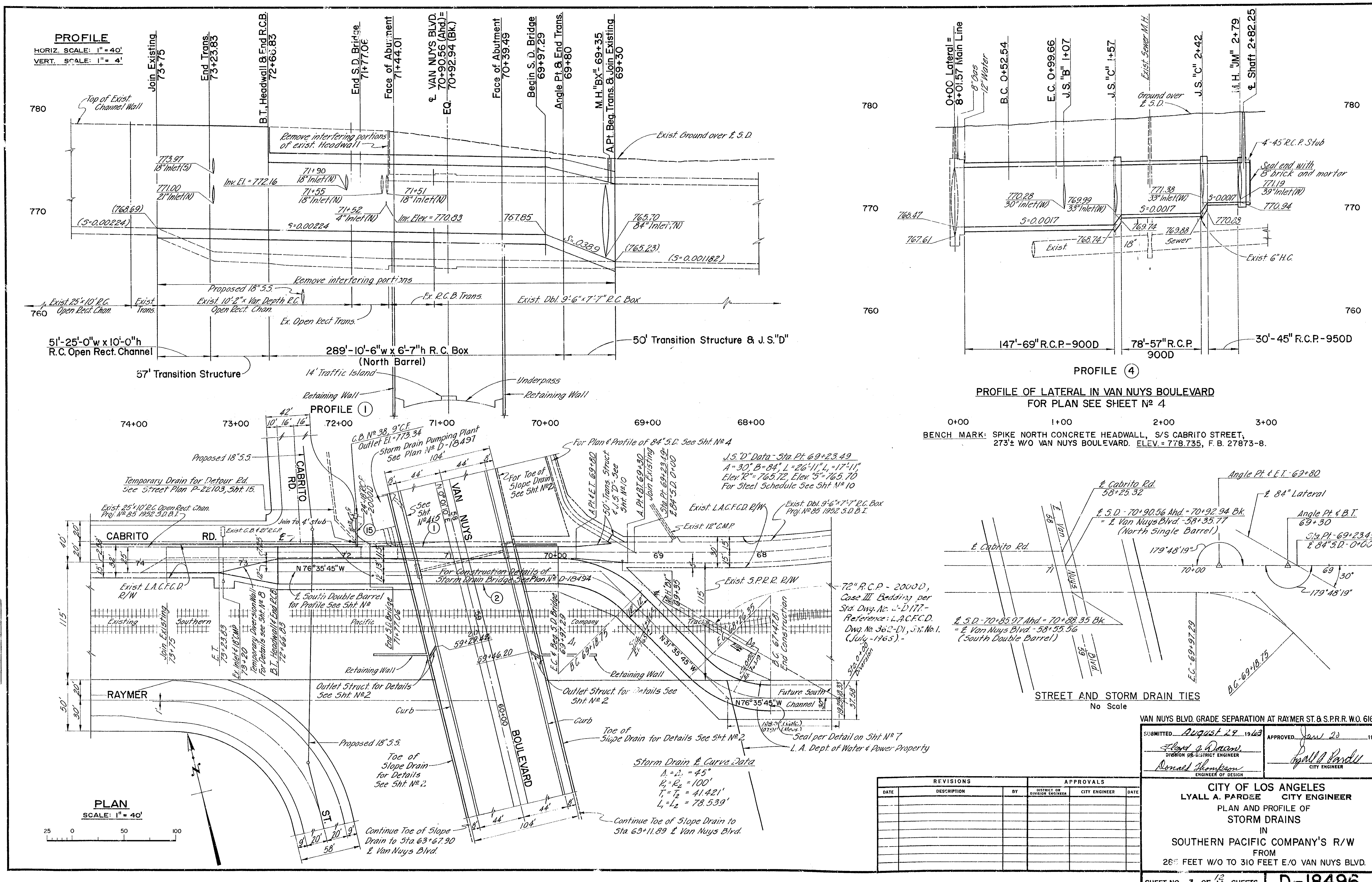
REVISIONS			APPROVALS	
DATE	DESCRIPTION	BY	DISTRICT OR DESIGN ENGINEER / CITY ENGINEER	DATE
[illegible]	CHANGED SIXTH ST. TO BLYTHE ST.	R.M.	[illegible]	[illegible]
[illegible]	Sheets 2, 4, 7, 8 & 10 Revised	R.M.	[illegible]	[illegible]

APPROVALS		
DIVISION OR DEPT.	ENGINEER	DATE
STREET OPENING	[illegible]	1-14-64
STREET AND FREEWAY	[illegible]	1-14-64
SANITARY SEWERS	[illegible]	1-14-64
STORM DRAIN	[illegible]	1-6-64
BRIDGE DESIGN	[illegible]	1-5-64
STREET LIGHTS	[illegible]	1-13-64
WATER DEPARTMENT		
TRAFFIC DEPARTMENT	[illegible]	

SUBMITTED Jan 14 1964
BY Floyd J. Dunn — DIVISION OR DISTRICT ENGINEER
Donald Thompson — DEPUTY ENGINEER (DESIGN)
APPROVED Jan 20 1964
Lyall A. Pardee — CITY ENGINEER

SHEET NO. 1 OF 11 SHEETS D-18496

D 18496



D18496

CERTIFICATE
I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles, and Section 34090.5 of the Government Code.
Date 7-16-[illegible] REX E. LAWTON, City Clerk

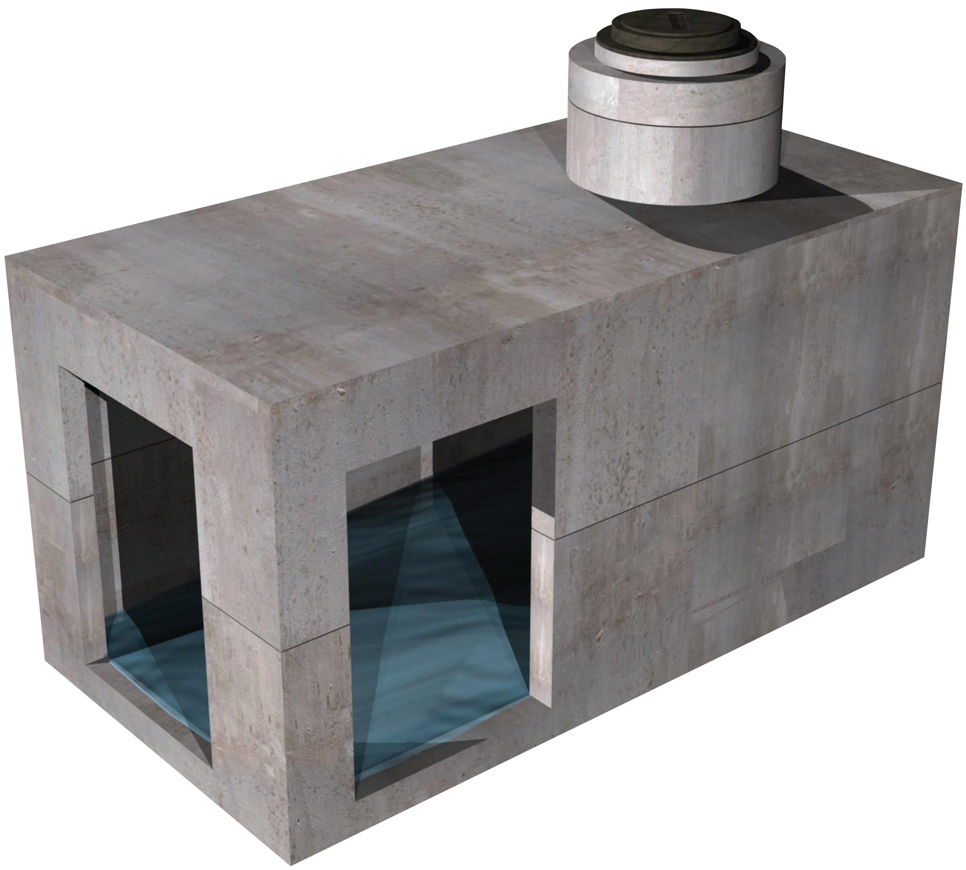
Appendix E – Product Information

STORM CAPTURE

Detention / Infiltration

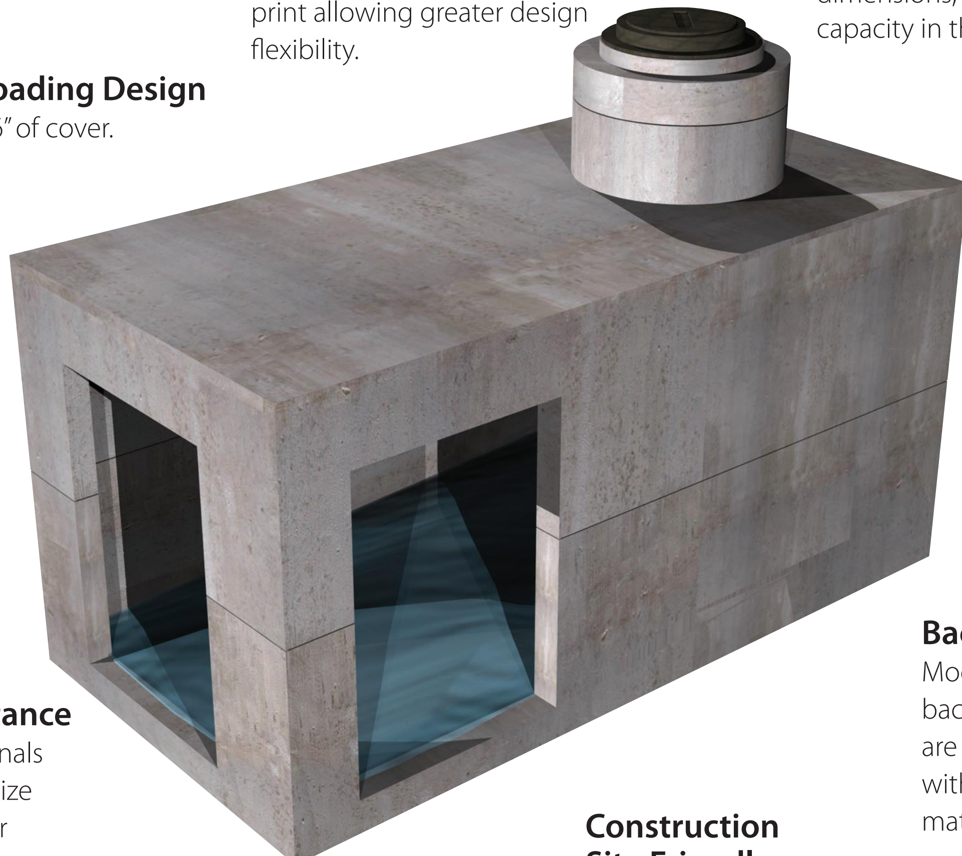
TOTAL STORMWATER MANAGEMENT SYSTEM

From Oldcastle Stormwater Solutions Comes Storm Capture, A Modular Stormwater Management System for Infiltration, Detention, Retention, and Treatment.



Oldcastle Stormwater Solutions™

Storm Capture Module



Description
7′ x 15′ with a 14′ maximum/ adjustable height inside dimensions, the largest capacity in the industry.

Large Storage Capacity
results in smaller system footprint allowing greater design flexibility.

Traffic Loading Design
with only 6″ of cover.

Easy to Install
modules for fast installation.

Flexible Heights
Available in heights from 2′ to 14′ to best-fit site needs.

Backfill
Modules do not rely on backfill for storage, and are typically backfilled with existing site materials.

Design Assistance
Let our professionals help you customize an application for your needs.

Construction Site Friendly
Contractor does not have to give up any of the site once the Storm Capture system is installed.

Treatment Train
Available with treatment train capability, pretreatment, post treatment, or both.

Same day staging and installation of StormCapture project.

StormCapture Project using Linkslab design.

StormCapture modules are designed for HS20 traffic loading.

StormCapture infiltration system.

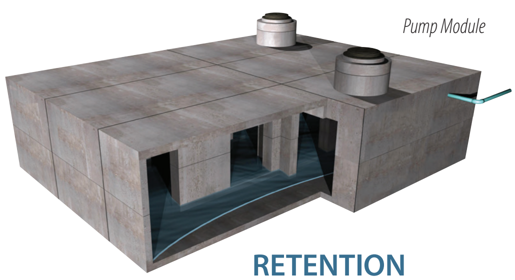
Storm Capture Benefits

- **Fast service** - Quick and easy project help by our national engineering team with layouts and specifications to meet each project's requirements.
- **Cost savings** - Highly competitive installed and life-cycle costs.
- **Manufactured** to the rigid standards of the Oldcastle quality control program at Oldcastle facilities around the country.
- **Codes** - Designed to the latest codes for HS-20-44 (full truck load plus impact).
- **Sustainability** - The system is maintainable for long-term sustainability.
- **LID** - Ideal for Low Impact Development (LID).
- **LEED** - Manufactured locally with recycled material for potential LEED credits. *LEED 2009 for New Construction & Major Renovation, US Green Building Council: Sustainable Sites (5.1, 5.2, 6.1, 6.2), Materials & Resources (4.1, 4.2, 5.1, 5.2), Water Efficiency (1.1, 1,2, 3.1, 3.2)*

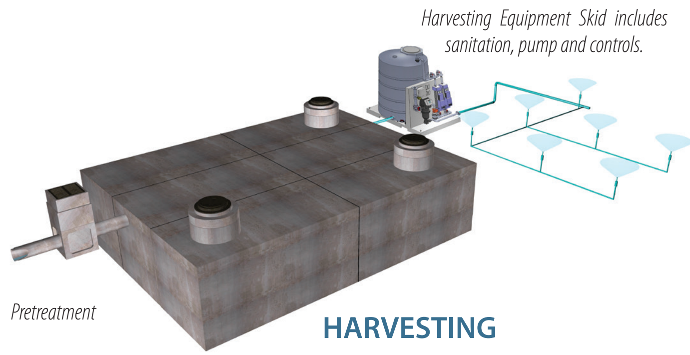
Applications

Storm Capture has many solutions for detention, retention, treatment, and harvesting that involve a combination of many parts designed to solve your stormwater management needs. Let us show you how we can design and customize a solution for you.

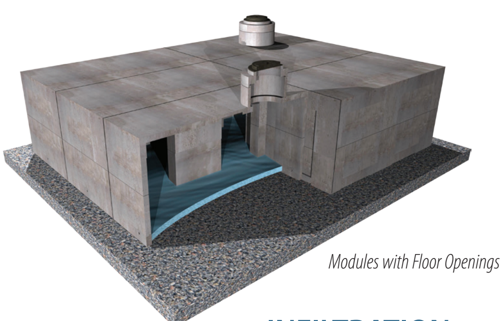
DETENTION



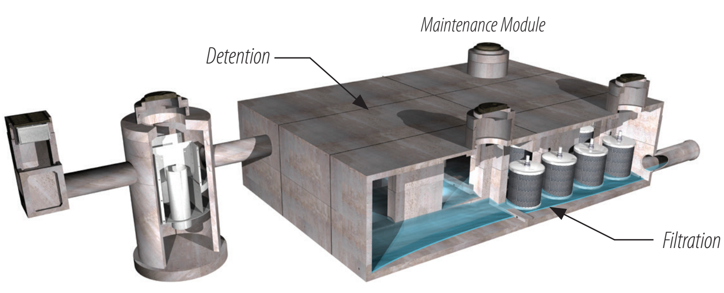
RETENTION



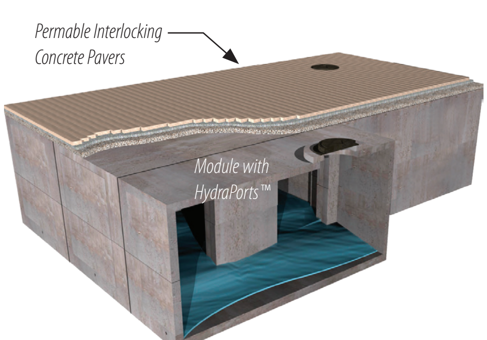
HARVESTING



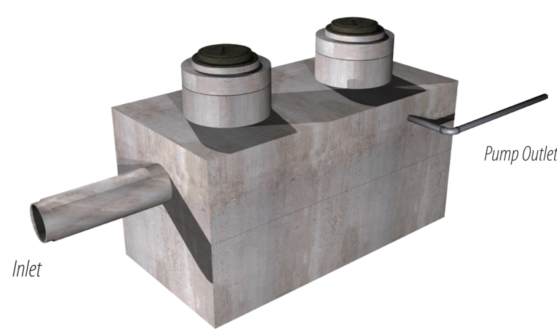
INFILTRATION



TREATMENT



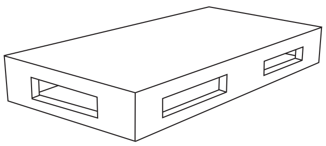
PERMECAPTURE



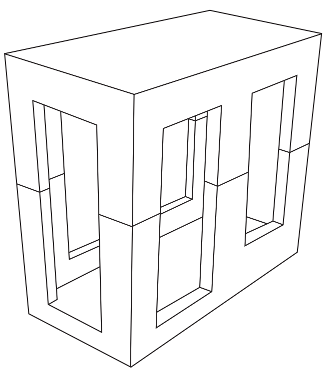
CISTERNS

INSTALLED IN ONE DAY

Module Sizes



SC1 – one piece modules can be used for applications from 2' to 7' tall. These are appropriate for cisterns, infiltration, detention, and retention systems. SC1 modules are typically installed on a minimal compacted gravel base, dependent on specific project requirements.

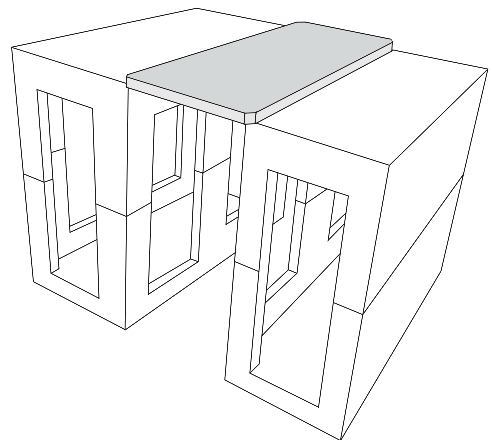


SC2 – two piece modules can be used for applications from 7' all the way up to 14' tall for maximum storage capacity in the smallest footprint. These are appropriate for cisterns, infiltration, detention, and retention systems. SC2 modules are typically installed on a compacted native subgrade.

Module Capacity

Size (ft.)	Capacity (ft^3.)	Size (ft.)	Capacity (ft^3.)
7x15x2	226	7x15x9	1027
7x15x3	343	7x15x10	1144
7x15x4	460	7x15x11	1257
7x15x5	577	7x15x12	1374
7x15x6	690	7x15x13*	1491
7x15x7	807	7x15x14*	1608
7x15x8	910		

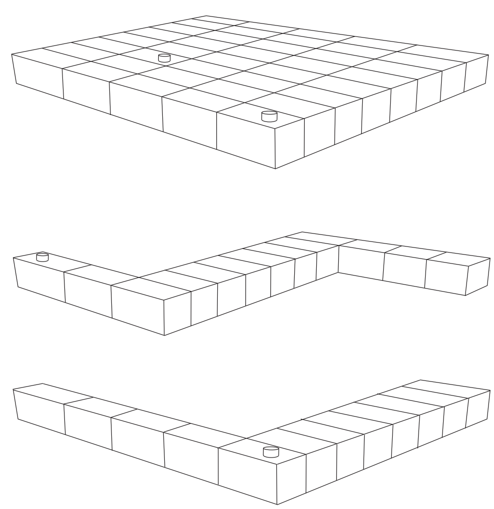
* Special design considerations required and limited availability
All dimensions are inside dimensions



Link Slab – for large storage assemblies, the unique link slab design allows significant reduction in the quantity of modules and associated costs, while providing the maximum in storage capacity.

Endless Configurations

Contact us today to start designing your system!



Humes
Water Solutions

Strength. Performance. Passion.

StormTrap® system Installation guide

SingleTrap™ model

Contents

The StormTrap® system

The StormTrap® system is a purpose-built stormwater detention and infiltration solution which provides a fully trafficable, below ground on-site detention system (OSD).

The system takes a unique design approach by connecting individual precast concrete modules into a single layer configuration that meets each project's requirements. This delivers a simple and flexible design solution without compromising above ground land use.

The growing popularity of the StormTrap® system is not only driven by its unique design and performance benefits, but by the significant installation economies it can provide. The modular design of the system means large detention volumes are delivered with the installation of each module. And because installers are able to use traditional construction processes, the installation can be completed in minimal time. Generally, it is expected that an individual StormTrap® module can be set in position in less than 10 minutes.

The StormTrap® system is available in two configurations to provide conventional detention, high early discharge or infiltration to ground water. The SingleTrap™ system and DoubleTrap™ system provide design solutions to meet volume requirements. This guide refers to the installation of the SingleTrap™ system.

The SingleTrap™ system is either founded on a strip footing to create a large infiltrative surface area, or founded on a conventional concrete slab for use as either a traditional detention basin or a basin with high early discharge.

The installation of the StormTrap® system is very simple:

1. Establish a suitable foundation.
2. Place modules row-by-row.
3. Apply StormWrap™ mastic tape across the top of the module joins.
4. Backfill.

There are a number of time-lapse videos available from humeswatersolutions.com.au which demonstrate the construction sequence and methodologies undertaken during the installation of a StormTrap® system. The library of videos includes a variety of project sizes and configurations.

As the system is made from precast concrete it is extremely strong and trafficable to AS 5100 traffic loadings (light duty designs are also available). Once the system has been installed there is no requirement for any further structural work in the trafficable pavement. The system will not deflect during construction loading, which allows rapid backfilling, and it won't suffer creep, as can be experienced with some lightweight systems.

Design and installation standards

The StormTrap® system is designed and installed in accordance with the requirements of the following Australian standards:

- AS 3600-2001 – Concrete Structures Code
- AS 5100-2004 – Bridge Design Code
- AS 5100.2-2004 – Bridge Design – Design Loads
- AS 1597.2-1996 – Precast Reinforced Concrete Box Culverts - Large Culverts
- AS/NZS 1170.1-2002 – Structural Design Actions – Part 1: Permanent, Imposed and other Actions.

Specifications

Module details

There are a number of different StormTrap® modules available and their use and placement will depend on design requirements and site layout (refer to Figure 1).

While the length and width of the modules remains constant, the height, and subsequently the mass, will vary according to the leg height for the system. The leg height varies from 600 mm to 1,500 mm, and is adjustable at 25 mm increments within this range.

Some modules will contain openings to allow for stormwater pipes or culverts and maintenance access points. Inlets and outlets may be placed at varying inverts and positions around the perimeter of the structure.

Depending on the overall size, each StormTrap® system will generally be designed with either 600 mm or 1,050 mm diameter openings for access through the roof at either end of the system. However, access openings may be in any location to fit in with specific site requirements. Designs can be modified to accommodate 900 mm x 900 mm grates.

Masses and dimensions

SingleTrap™ modules have a maximum internal leg height of 1,500 mm. The maximum mass of each module is shown in Table 1.

Table 1 – Masses and dimensions (1,500 mm height)

Module type	Mass (kg)	Length x width (mm)
I	6,730	4,000 x 2,350
II	4,320	2,000 x 2,350
III	7,660	4,000 x 2,350
IV	4,810	2,000 x 2,350
V	4,810	2,000 x 2,350
VI	8,590	4,000 x 2,350
VII	5,280	2,000 x 2,350
Light duty I	4,400	4,000 x 2,350

Figure 1 – A sample layout of a SingleTrap™ system

V	III	III	IV
II	I	I	II
II	I	I	II
IV	III	III	V

Standard type I

Standard type II

Standard type III

Standard type IV

Standard type V

Standard type VI

Standard type VII

Light duty type I

Handling and installation

Safety

Safety is a priority for Humes. It is important for all parties to observe safety requirements and regulations during transportation, handling, storage and installation, including wearing appropriate personal safety protection equipment.

It is the responsibility of the main contractor or installation contractor to produce a Safe work method statement; we recommend that this statement complies with both the National Code of Practice for Precast Tilt-up and Concrete Elements in Building Construction, and local and state codes (where they exist). Personnel should follow any safety advice provided by the main contractor/installation contractor.

The precast concrete component should only be lifted using the appropriate lifting clutches which are fitted into the designated lift points via the cast-in anchors. All lifting equipment must be certified to lift the specific mass and approved for lifting heavy components. The mass of the StormTrap® modules will vary depending on its geometry; weights will be clearly marked on the precast units and in the relevant project drawings.

All lifting and placement must proceed with caution and strictly in accordance with all relevant occupational health and safety standards. Bumping or impact of modules can cause damage and should be avoided.

The advice in this publication is of a general nature only. Where any doubt exists as to the safety of a particular lift or installation procedure, seek the guidance of a professional engineer or contact Humes for advice.

Pre-delivery

To ensure the safe and efficient installation of the StormTrap® system it is important to undertake sufficient planning prior to its arrival on site.

Equipment requirements

The following list of equipment is required for a safe and efficient installation:

- tape measure
- a can of marking spray
- chalk line/masonry string
- pinch/crowbar
- stanley knife
- two ladders
- broom
- level
- four chains
- four five-tonne Swiftlift® clutches
- Swiftlift® clutches for manhole covers or risers
- swivel for chains
- 20 mm spacers or gap gauge (available from Humes)
- safety harness for working at height
- StormMastic™ sealant
- StormWrap™ mastic tape.

Left:
Gap gauge

Site preparation

Before the StormTrap® system is installed, the concrete foundation must be poured (refer to the approval drawings supplied by Humes). The foundation details will depend on whether the system is required to provide stormwater detention or infiltration (refer to Figure 2 and Table 2 for an example).

Once the foundation is cured mark the outside edges of the system on the slab (as per the layout dimensions of the approval drawings).

Figure 2 – Example of a foundation plan

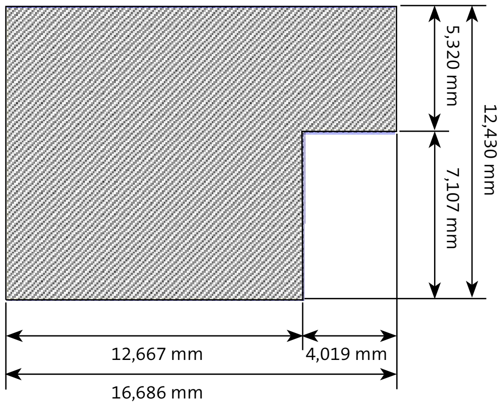
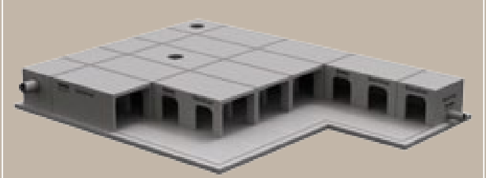
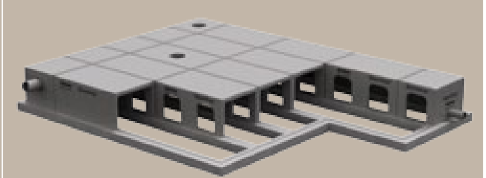
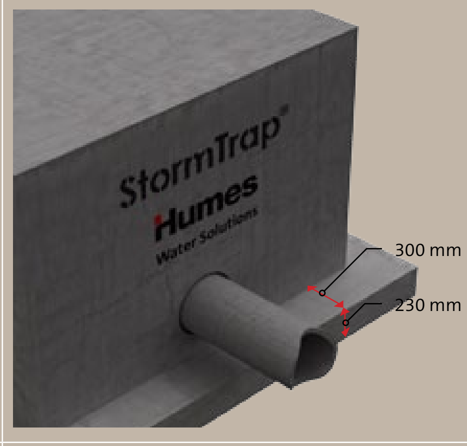
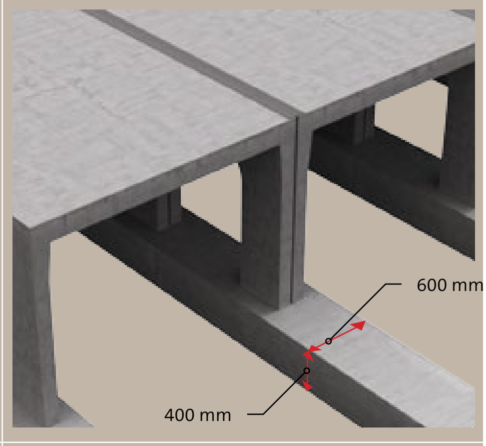


Table 2 – Foundation details

System type	Detention	Infiltration
		
Foundation	Continuous concrete slab	Strip footing
Dimensions	Slab is 230 mm thick* and extends 300 mm past outer edge of the system.  	Slab 'strips' are 400 mm thick and 600 mm wide running underneath the line of StormTrap® feet. 
Recommended cure period	7 days	7 days

Note:
*Slab design is based on in-situ material having a bearing capacity of 150 KPa; this may differ according to engineer's specifications.

Delivery

Prior to deliveries commencing, a pre-installation site meeting will occur with the contractor to finalise shipping plans including the sequencing of deliveries and the order of unloading and installing each of the modules.

The shipping plan will help to alleviate the double-handling of modules; save time and effort, make more efficient use of the crane, and reduce site congestion. The shipping plan will be provided to both the specifying engineer and contractor for sign off prior to commencing the delivery of modules to site (refer to Figure 3).

The StormTrap® modules will be delivered to site either on a semi-trailer or B-double depending on site access and the number of modules to be delivered. Each truck will typically contain 3-6 modules depending on the particular module type and mass. The first truck will typically take about 45 minutes to unload, the second truck about 30-45 minutes, and then each subsequent truck about 20-30 minutes.

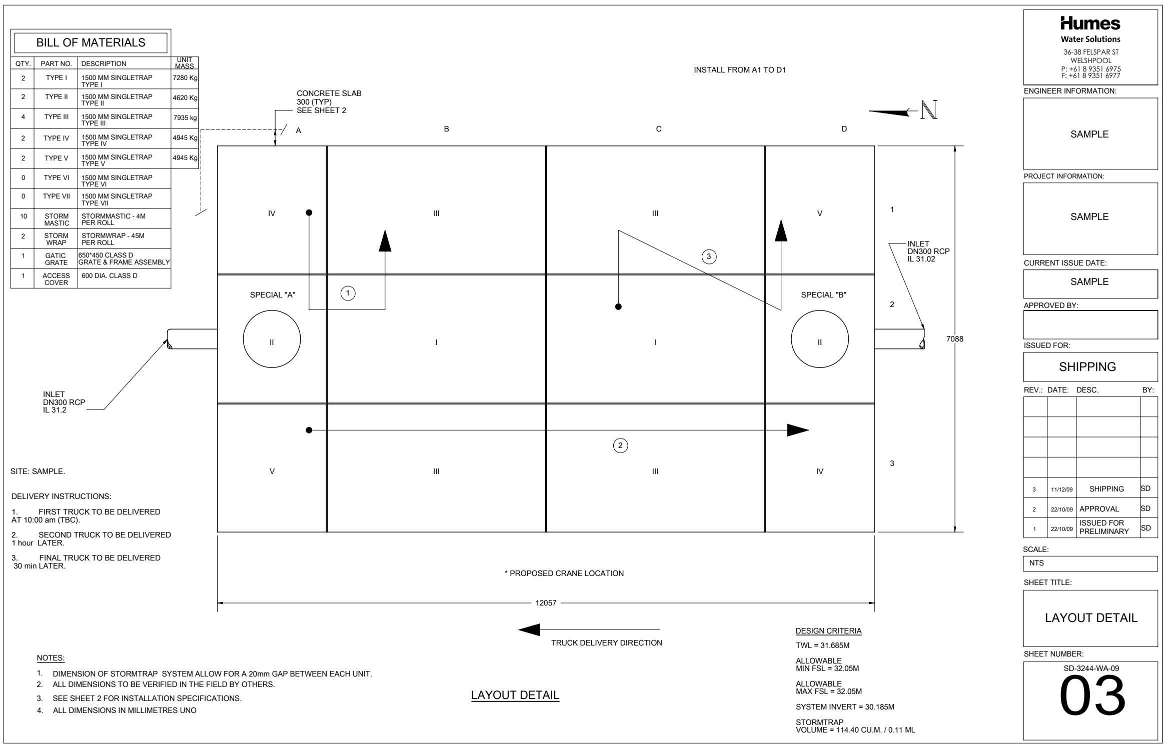
Lifting

All the precast units are supplied with cast-in lifting anchors to enable safe handling. To prevent stress and possible concrete cracking, all units must be handled using the cast-in lifting anchors and associated lifting clutches (lifting clutches can be obtained from the crane contractor or Humes). Installers should use tagged lifting equipment only. It is the installation contractor's responsibility to ensure the lifting clutches are available on site. The lifting points of anchors are clearly shown on the Humes drawings.

Wherever possible, all modular components should be lifted from the delivery truck and set directly onto the prepared substructure. Each module will take approximately 5-10 minutes to unload and set into position.

If for some reason temporary storage of the modules is required on site, they should be placed carefully on level, even ground, free of rocks and uniformly supported across the entire leg surface by using timbers. Modules should not be stacked on top of each other.

Figure 3 – Example of a shipping plan



Module installation

Top:
Step one

Middle:
Step two

Bottom:
Step three

A representative of Humes Water Solutions will be present on site at the commencement of the installation (as required) to provide support to the contractor and observe deliveries and installation.

The StormTrap® system is typically installed as follows:

1. Sweep the concrete slab/footings clean of dirt and debris.

2. Lay a bead of StormMastic™ sealant on the slab approximately 60 mm inside the perimeter line marking.

3. Secure the first module with four Swiftlift® anchors. Take care not to strike the modules together when you are unloading and lowering them. Be aware of pinch hazard at all times and don't walk or work under suspended loads.

4. When lowering the first module into position, pause 50 mm above the concrete slab, then gradually lower it into position once it is aligned with the perimeter markings. Ensure the unit is square and the bottom of the module is on the foundation before you remove the lifters.

Top:
Step four

Middle:
Step five

Bottom:
Step six

5. Align the next module with the edge markings and position it adjacent to, but no more than 20 mm from the first block (check with a gap gauge). Use a pinch or crowbar to assist with the finer adjustment of the modules.

6. Continue to install the modules row-by-row, in the order shown on the shipping plan.

Top:
Step seven

Bottom:
Step eight

7. Once two rows of modules have been laid and checked, apply StormWrap™ tape across the joins.

8. When four rows of modules have been laid, checked and sealed, backfilling can then occur (refer per note F. on page 2 of the approval drawings).

Note: During the installation check the overall dimensions of the system to make sure creep is not occurring. Adjust the laying gap when necessary to recover any discrepancies.

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ACPT

TechBrief
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THE ADVANCED CONCRETE PAVEMENT TECHNOLOGY (ACPT) Products Program is an integrated, national effort to improve the long-term performance and cost-effectiveness of the Nation's concrete highways. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, the goals of the ACPT Products Program are to reduce congestion, improve safety, lower costs, improve performance, and foster innovation.

The ACPT Products Program identifies, refines, and delivers for implementation available technologies from all sources that can enhance the design, construction, repair, and rehabilitation of concrete highway pavements. The ACPT Marketing Plan enables technology transfer, deployment, and delivery activities to ensure that agencies, academia, and industry partners can derive maximum benefit from promising ACPT products in the quest for long-lasting concrete pavements that provide a safe, smooth, and quiet ride.

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U.S. Department of Transportation
Federal Highway Administration

Pervious Concrete

This TechBrief presents an overview of pervious concrete and its use in pavement applications. General information on the composition of pervious concrete is provided, along with a summary of its benefits, limitations, and typical properties and characteristics. Important considerations in mix proportioning, hydrological design, structural design, construction, and maintenance are also described.

Introduction

Pervious concrete, sometimes referred to as no-fines, gap-graded, permeable, or enhanced porosity concrete, is an innovative approach to controlling, managing, and treating stormwater runoff. When used in pavement applications, pervious concrete can effectively capture and store stormwater runoff, thereby allowing the runoff to percolate into the ground and recharge groundwater supplies.

Pervious concrete contains little or no fine aggregate (sand) and carefully controlled amounts of water and cementitious materials. The paste coats and binds the aggregate particles together to create a system of highly permeable, interconnected voids that promote the rapid drainage of water (Tennis et al. 2004; ACI 2010). Typically, between 15 and 25 percent voids are achieved in the hardened concrete, and flow rates for water through the pervious concrete are generally in the range of 2 to 18 gal/min/ft^2 (81 to 730 L/min/m^2), or 192 to 1,724 inch/hr (488 to 4,379 cm/hr) (ACI 2010). Figure 1 shows a typical cross section of a pervious concrete pavement.

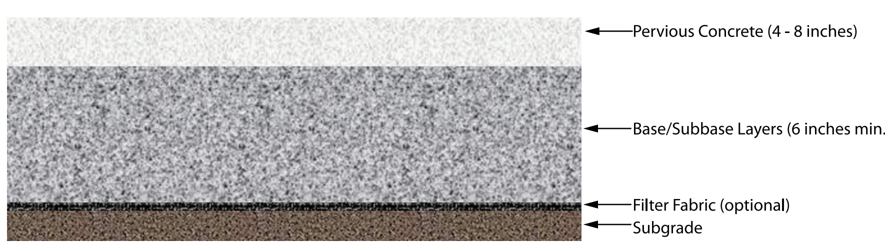

FIGURE 1. Typical pervious concrete pavement cross section (adapted from EPA 2010).

Benefits and Limitations

Table 1 summarizes some of the major benefits and limitations associated with pervious concrete. As described above, perhaps the most significant benefit provided by pervious concrete is in its use as a stormwater management tool. Stormwater runoff in developed areas (often the result of or exacerbated by the presence of conventional impervious pavement) has the potential to pollute surface and groundwater supplies, as well as contribute to flooding and erosion (Leming et al. 2007).

Pervious concrete can be used to reduce stormwater runoff, reduce contaminants in waterways, and renew groundwater supplies. With high levels of permeability, pervious concrete can effectively capture the "first flush" of rainfall (that part of the runoff with a higher contaminant concentration) and allow it to percolate into the ground where it is filtered and "treated" through soil chemistry and biology (Tennis et al. 2004; ACI 2010).

Other major benefits provided by pervious concrete include reduction in heat island effects (water percolating through the pavement can exert a cooling effect through evaporation, and convective airflow can also contribute to cooling (Cambridge 2005)), reductions in standing water on pavements (and associated hydroplaning and splash/spray potential), and reduced tire–pavement noise emissions (due to its open structure that helps absorb noise at the tire–pavement interface) (ACI 2010). In addition, pervious concrete can contribute toward credits in the LEED® (Leadership in Energy and Environmental Design) rating system for sustainable building construction (Ashley 2008).

Along with its many benefits, there are some limitations associated with the use of pervious concrete. First and foremost, pervious concrete has typically been used on lower trafficked roadways, although there are a number of installations on higher volume facilities, and research is being conducted on the structural behavior of pervious concrete slabs (see, for example, Suleiman et al. 2011; Vancura et al. 2011). In addition, pervious concrete exhibits material characteristics (primarily lower paste contents and higher void contents) and produces hardened properties (notably density and strength) that are significantly different from conventional concrete; as a result, the current established methods of quality control/quality assurance (e.g., slump, strength, air content) are in many

TABLE 1. Summary of Pervious Concrete Benefits and Limitations (Tennis et al. 2004; ACI 2010)

Benefits/Advantages	Limitations/Disadvantages
• Effective management of stormwater runoff, which may reduce the need for curbs and the number and sizes of storm sewers. • Reduced contamination in waterways. • Recharging of groundwater supplies. • More efficient land use by eliminating need for retention ponds and swales. • Reduced heat island effect (due to evaporative cooling effect of water and convective airflow). • Elimination of surface ponding of water and hydroplaning potential. • Reduced noise emissions caused by tire–pavement interaction. • Earned LEED® credits.	• Limited use in heavy vehicle traffic areas. • Specialized construction practices. • Extended curing time. • Sensitivity to water content and control in fresh concrete. • Lack of standardized test methods. • Special attention and care in design of some soil types such as expansive soils and frost-susceptible ones. • Special attention possibly required with high groundwater.

cases not applicable (ACI 2010). Moreover, a number of special practices, described later, are required for the construction of pervious concrete pavements. And, while there have been concerns about the use of pervious concrete in areas of the country subjected to severe freeze–thaw cycles, available field performance data from a number of projects indicate no signs of freeze–thaw damage (Delatte et al. 2007; ACI 2010).

Applications

Pervious concrete has been used in pavement applications ranging from driveways and parking lots to residential streets, alleys, and other low-volume roads (Tennis et al. 2004). Within these applications, pervious concrete has been used as the surface course, as a drainable base course (often in conjunction with edge drains to provide subsurface drainage), or as a drainable shoulder (to help provide lateral drainage to a pavement and prevent pumping). The focus in recent years has been on its use as a surface course as a means of providing stormwater management.

Typical Properties and Characteristics

As noted previously, many of the properties of pervious concrete are different from those of conventional concrete. These properties are primarily a function of the porosity (air void content) of the pervious concrete, which in turn depends on the cementitious content, the water-to-cementitious materials (w/cm) content, the compaction level, and the aggregate gradation and quality (ACI 2010). Table 2 summarizes some of the typical material properties associated with pervious concrete. These properties and characteristics must be considered during the structural design and pavement construction.

The cost of pervious concrete may be 15 to 25 percent higher than conventional concrete, but cost can vary significantly depending on the region, the type of application, the size of the project, and the inclusion of admixtures.

Mixture Proportioning

Like conventional concrete, pervious concrete is a mixture of cementitious materials, water, coarse aggregate, and possibly admixtures, but it contains little or no fines; however, note that a small amount of fine aggregate, typically 5 to 7 percent, is required for freeze–thaw durability (Schaefer et al. 2006; Kevern et al. 2008). Table 3 shows the typical range of materials proportions that have been used in pervious concrete. Commentary on the components of a pervious concrete is provided below (Tennis et al. 2004; Delatte et al. 2007; ACI 2010):

Cementitious materials. As with conventional concrete mixtures, conventional portland cements or blended cements are used as the primary binder in pervious concrete, although supplementary cementitious materials may also be used.

TABLE 2. Typical Pervious Concrete Properties (Tennis et al. 2004; Obla 2007)

Property	Common Value / Range
Plastic Concrete	
Slump	N/A
Unit weight	70% of conventional concrete
Working time	1 hour
Hardened Concrete	
In-place density	100 to 125 lb/ft^3
Compressive strength	500 to 4,000 lbf/in^2 (typ. 2,500 lbf/in^2)
Flexural strength	150 to 550 lbf/in^2
Permeability	2 to 18 gal/ft^2/min (384 to 3,456 ft/day)

1 in = 25.4 mm; 1 lb/ft^3 = 16 kg/m^3; 1 lbf/in^2 = 6.89 kPa; 1 gal/ft^2/min = 40.8 L/m^2/min

Coarse aggregate. Coarse aggregate is kept to a narrow gradation, with the most common gradings of coarse aggregate used in pervious concrete meeting the requirements of ASTM C33/C33M—aggregate sizes of 7, 8, 67, and 89. Coarse aggregate size 89 (top size 0.375 inch (9.5 mm)) has been used extensively for parking lot and pedestrian applications. Rounded and crushed aggregates, both normal and lightweight, have been used to make pervious concrete.

Water. The control of water is important in the development of pervious concrete mixtures, and the selection of an appropriate w/cm value is important for obtaining desired strength and void structure in the concrete. A high w/cm can result in the cement paste flowing off of aggregate and filling the void structure, whereas a low w/cm can result in mixing and placement difficulties and reduced durability. Commonly, w/cm values between 0.27 and 0.34 are used.

Admixtures. As with conventional concrete, chemical admixtures can be used in pervious concrete to obtain or enhance specific properties of the mixture. In particular, set retarders and hydration stabilizers are commonly used to help control the rapid setting associated with many pervious concrete mixtures. Air-entraining admixtures are required in freeze–thaw environments although no current method exists to quantify the amount of entrained air in the fresh paste. Air entrainment can be determined on hardened samples according to ASTM C457.

Mix proportioning for pervious concrete is based on striking a balance between voids, strength, paste content, and workability (ACI 2010). As such, the development of trial batches is essential to determining effective mix proportions using locally available materials. Detailed information on mix proportioning is available from ACI (2010).

Some limited work has been done investigating the freeze–thaw characteristics of pervious concrete and mix design for cold weather climates (NRMCA 2004; Schaefer et al. 2006). The freeze–thaw resistance of pervious concrete appears to be dependent on the saturation level of the voids; consequently a drainable base layer with a minimum thickness of 6 inches (150 mm) is recommended to help keep the pervious concrete layer from becoming saturated. Furthermore, as previously noted, the freeze–thaw resistance of pervious concrete has been shown to improve when sand is included in the pervious concrete mixture (Schaefer et al. 2006; Kevern et al. 2008).

Design of Pervious Pavements

Two primary considerations enter into the determination of the thickness of pervious concrete pavements: 1) hydrologic design to meet environmental requirements and 2) structural design to withstand the anticipated traffic loading applications (Leming et al. 2007; ACI 2010). These design considerations are briefly described below.

TABLE 3. Typical Pervious Concrete Materials Proportions (ACI 2010)

Mix Constituent or Design Parameter	Range
Coarse aggregate	2,000 to 2,500 lb/yd^3
Cementitious materials	450 to 700 lb/yd^3
Water-to-cementitious ratio	0.27 to 0.34
Aggregate-to-cementitious ratio (by mass)	4 to 4.5:1

1 lb/yd^3 = 0.59 kg/m^3

Hydrologic Design

In evaluating the hydrologic design capabilities of a pervious pavement, the approach is to determine whether the characteristics of the pervious concrete pavement system are sufficient to infiltrate, store, and release the expected inflow of water (which

includes direct rainfall and may also include excess runoff from adjacent impervious surfaces). As such, information required in a hydrologic analysis includes the precipitation intensity levels, the thickness and permeability characteristics of the pervious concrete pavement, cross slopes and geometrics, and permeability properties and characteristics of the underlying base, subbase, and subgrade materials.

Many hydrological design methods exist that can be used when designing pervious concrete pavement systems, including the Natural Resources Conservation Service Curve Number Method and the Rational Method (Leming et al. 2007). In essence, the hydrologic design of pervious concrete pavements should consider two possible conditions to ensure that excess surface runoff does not occur (Leming et al. 2007):

1. Low permeability of the pervious concrete material that is inadequate to capture the "first flush" of a rainfall event.

2. Inadequate retention provided in the pervious concrete structure (slab and subbase).

Often, the thickness of a pervious concrete pavement is first determined based on structural requirements and then analyzed to determine its suitability to meet the hydrologic needs of the project site. If the thickness is found to be insufficient, adjustments can be made to the thickness of the pervious pavement or the underlying base course. Details on hydrologic design are beyond the scope of this document but are available in the literature (Leming et al. 2007; Wanielista et al. 2007; Rodden et al. 2011).

Structural Pavement Design

Pervious concrete pavements can be designed using virtually any standard concrete pavement procedure (e.g., American Association of State Highway and Transportation Officials, Portland Cement Association, StreetPave) (Delatte 2007). The American Concrete Pavement Association has recently developed a comprehensive program, PerviousPave, that can be used to develop both structural and hydrological designs for pervious pavements (Rodden et al. 2011). Regardless of the procedure used, there are critical factors to consider in the design of pervious concrete pavements (ACI 2010):

Subgrade and subbase. In the design of pervious pavements, foundation support is typically characterized by a composite modulus of subgrade reaction, which should account for the effects of both the subgrade and the subbase. An open-graded subbase is commonly used beneath pervious concrete pavements not only to provide an avenue for vertical drainage of water to the subgrade, but also to provide storage capabilities. Special subgrade conditions (such as frost susceptibility or expansive soils) may require direct treatment.

Concrete flexural strength. The flexural strength of concrete is an important input in concrete pavement structural design. However, testing to determine the flexural strength of pervious concrete may be subject to high variability; therefore, it is common to measure compressive strengths and to use empirical relationships to estimate flexural strengths for use in design (Tennis et al. 2004).

Traffic loading applications. The anticipated traffic to be carried by a pervious pavement is commonly characterized in terms of equivalent 18,000-lb (80 kN) single-axle load repetitions, which many procedures compute directly based on assumed truck-traffic distributions. Most pervious concrete pavements are used in low-truck-traffic applications.

Currently there are no thickness standards for pervious concrete pavements, but many pervious pavements for parking lots are constructed 6 inches (150 mm) thick, whereas pervious pavements for low-volume streets have been

constructed between 6 and 12 inches (150 and 300 mm) thick (ACI 2010).

Construction Considerations

Because of its unique material characteristics, pervious concrete has a number of special construction requirements. Key aspects of pervious concrete construction include the following (Tennis et al. 2004; ACI 2010):

Placement and consolidation. Most pervious concrete is placed using fixed-form construction. For smaller projects, a hand-held straightedge or vibrating screed may be acceptable for placement, whereas for larger projects an A-frame, low-frequency, vibrating screed may be used. A few projects have used laser screeds and concrete slipform equipment. Consolidation is generally accomplished by rolling the concrete with a steel roller. Overall, the low water content and porous nature of pervious concrete require that delivery and placement be completed as quickly as possible.

Finishing. Pervious concrete pavements are not finished in the same manner as conventional pavements. In essence, the final surface finish is achieved as part of the consolidation process, which leaves an open surface. Normal concrete finishing procedures, such as with bull floats and trowels, should not be performed.

Jointing. Jointing is commonly done on pervious concrete to control random crack development. These joints are commonly formed (using a specially designed compacting roller-jointer) to a depth between one-fourth and one-third of the slab thickness.

Curing and protection. After the concrete has been jointed, it is important that the concrete be effectively cured; this is commonly achieved through the placement of thick (typically 6 mil (0.15mm)) plastic sheeting over all exposed surfaces. The plastic sheeting should be applied no later than 20 minutes following discharge of the concrete, and should remain in place for at least 7 days (longer times may be required under cold weather placement conditions or if supplementary cementitious materials are used in the mix). Liquid membrane curing compounds are not commonly used because they prevent surface moisture loss and do nothing to prevent evaporation from within the pervious concrete (Kevern et al. 2009).

Inspection and testing. The American Concrete Institute has prepared a summary of recommended inspection and testing activities that should be performed during construction of pervious concrete pavements (ACI 2010), as well as a specification for pervious concrete construction (ACI 2008). Acceptance testing for pervious concrete is typically limited to density (ASTM C1688) and thickness (ASTM C42). Test methods specific to pervious concrete are listed below:

- ASTM C1688, *Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.*
- ASTM C1701, *Standard Test Method for Infiltration Rate of In Place Pervious Concrete.*
- ASTM C1747, *Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion.*
- ASTM C1754, *Standard Test Method for Density and Void Content of Hardened Pervious Concrete.*

In recognition of the special construction requirements of pervious concrete, the National Ready Mixed Concrete Association has developed a program designed to educate, train, and certify contractors in pervious concrete placement (see http://nrmca.org/Education/Certifications/Pervious_Contractor.htm).

Maintenance

Over time, sand, dirt, vegetation, and other debris can collect in pervious concrete's voids and reduce its porosity, which can negatively affect

the functionality of the system. Thus, periodic maintenance may be needed to remove surface debris and restore infiltration capacity. Two common maintenance methods are pressure washing and power vacuuming (ACI 2010).

Performance

The performance of pervious concrete pavements may be assessed in a number of ways, including monitoring changes in the permeability/porosity of the system (which would indicate clogging of the void structure), the presence of distress (both structural and surficial), and resistance to freeze–thaw damage. Unfortunately, there are limited long-term performance data on pervious concrete, but generally performance is considered satisfactory. For example, a study in Florida indicated that pervious concrete pavements that were 10 to 15 years old were operating in a satisfactory manner without significant amounts of clogging (Wanielista et al. 2007). In another study, field inspections of 22 projects located in freeze areas were conducted, with reported good performance and no visual signs of freeze–thaw damage (although all projects were less than 4 years old at the time of inspection) (Delatte et al. 2007).

Where the performance of pervious concrete pavements has not been satisfactory, poor performance is often attributed to contractor inexperience, higher compaction of soil than specified, and improper site design (ACI 2010).

Summary and Future Needs

The use of pervious concrete has increased significantly in the last several years, perhaps largely because it is considered an environmentally friendly, sustainable product. The use of pervious concrete provides a number of benefits, most notably in the effective management of stormwater runoff. Other significant benefits include reducing contaminants in waterways, recharging groundwater supplies, reducing heat island effects, and reducing pavement–tire noise emissions.

Still, there are a number of areas that need additional developmental work to improve or enhance the capabilities of pervious concrete pavements. One area is the continued monitoring of the performance of pervious concrete so that long-term performance trends can be documented; this will also help in evaluating the suitability of pervious concrete for other applications, such as overlays. Tied in with this is the assessment of the suitability of current structural design approaches to provide competent designs, particularly regarding the fatigue behavior of pervious concrete. Finally, a third area is in the testing and evaluation of pervious concrete, as current test methods for conventional concrete are not generally applicable to pervious concrete.

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Sam Tyson, P.E.—sam.tyson@dot.gov

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Research—This TechBrief was developed by Kurt D. Smith, P.E., and James Krstulovich (Applied Pavement Technology, Inc.), as part of FHWA's ACPT product implementation activity. The TechBrief is based on research cited within the document. The ACPT Implementation Team acknowledges Dr. John Kevern of the University of Missouri–Kansas City for his technical review of this document.

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Key Words—concrete pavement construction, design, drainage, LEED® credit, maintenance, pavement design, pavement construction, permeability, pervious concrete, porous concrete, stormwater, sustainability

Eco-Priora™

Concrete Paver Environmental Systems

Eco-Priora™

Pavestone Eco-Priora™ is the sustainable solution for permeable pavements. Eco-Priora™ is produced in a 120mm x 240mm rectangular module that is 80mm in thickness with a patented interlocking joint and a micro-chamfered top edge profile. This ingenuity is singular to the Pavestone Eco-Priora™ product and insures optimum pavement performance unequaled in the permeable paver industry. The unique Eco-Priora™ joint profile allows surface water to infiltrate into the pavement and its sub-layers. With initial permeability average flow rates of over 100 inches per hour, the Eco-Priora™ product, even with a clogging factor, will still meet the majority of current storm water management plans (SWMP). The structural interlocking capability is achieved by the paving unit having interlocking joints with a minimum of two vertically aligned horizontal interlocking spacer bars on each of its sides. These spacer bars interlock throughout the depth of the block and nest adjacently with neighboring paving units. This interlocking function resists lateral and vertical displacement when the unit is exposed to load. The dynamics of pavement stress are better distributed providing a structurally superior permeable paving system.

The micro-chamfered top edge profile produces a horizontal edge to edge dimension that is nominally 7mm including installation gapping. This small joint complies dimensionally with current ADA requirements for walking surfaces with spaces no greater than 1/2 inch. This narrow jointed surface diminishes vibration for wheelchairs and shopping carts when compared to all other permeable paving products. Eco-Priora™ can assist in meeting current EPA storm water regulations and LEED certification. The Eco-Priora™ product best achieves the balance of aesthetic segmental paving and the function of permeable pavement.

APPLICATIONS

Parking Lots • Driveways • Patios • Entrance Areas • Sidewalks
Terraces Garden Pathways • Pool Decks • Pedestrian Malls • Roof Gardens • Streets

COMPOSITION AND MANUFACTURE

Eco-Priora™ is available in one size. Height = 80mm. Eco-Priora™ is made from a "no slump" concrete mix made under extreme pressure and high frequency vibrations. Eco-Priora™ has a compressive strength greater than 8000 psi, a water absorption maximum of 5% and will meet or exceed ASTM C-936. Note: Requires modifying the ASTM C 140 - Paver Annex A4 - "The test specimen shall be 60 ± 3 mm thick and, if necessary, cut to a specimen size having a Height/Thickness (width) [H/T] aspect ratio of 0.6 ± 0.1

INSTALLATION

1. Excavate unsuitable, unstable or unconsolidated subgrade material. Compact the area, which has been cleared as per the engineer's of record (EOR) requirements. Backfill and level with open graded aggregates as per the EOR's structural and hydraulic design.
2. Place bedding course of hard and angular material conforming to the grading requirements of ASTM No. 8 or No. 9 to a uniform minimum depth of 1 1/2" -2". (38mm) screeded to the grade and profile required.
3. Install Eco-Priora™ with joints approximately 1/4". (7mm).
4. Where required, cut pave stones with an approved cutting device to fit accurately, neatly and without damaged edges.
5. Tamp pave stones with a plate compactor, uniformly level, true to grade and free of movement.
6. Spread a thin layer of hard angular material conforming to the grading requirements of ASTM No. 8 or No. 9 aggregate over entire paving area.
7. Make one more pass with plate compactor to nest the aggregate and fill joints to the top.
8. Sweep and remove surplus joint material.

Complete installation & specification details are available by contacting your Pavestone Sales Representative.

Note: ✔ Permeable pavements require both civil and hydraulic engineering. All final pavements design shall be approved by a licensed engineer familiar with local site conditions, building codes and storm water management plans.

PRODUCT INFORMATION

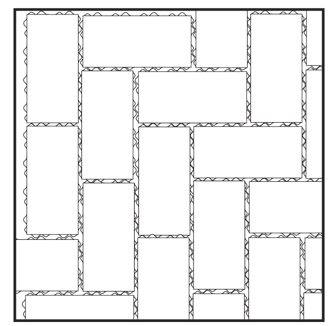
Eco-Priora™ is available in one size. Height = 80mm

ECO-PRIORA™
(120mm x 240mm)

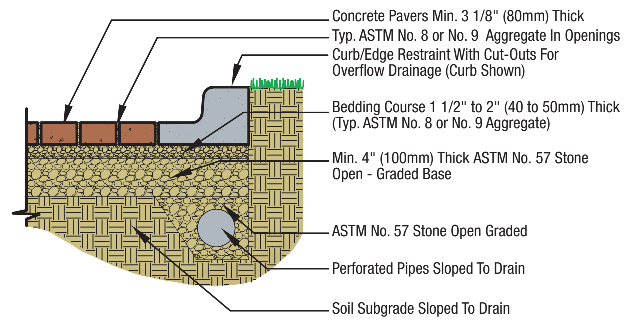
Eco-Priora™

Dimensions:	4 3/4" W x 9 7/16" L x 3 1/8" H
Wt./Stone:	11.5 lbs.
Stones/Pallet:	280
Approx. Wt./Pallet:	3,255 lbs.
Sq. Ft./Pallet:	88
Product Number:	699

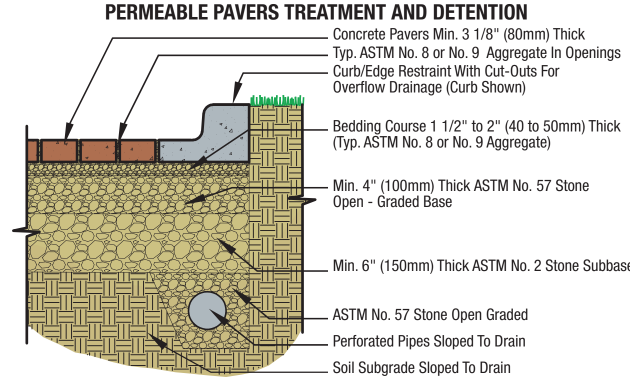
INSTALLATION PATTERN

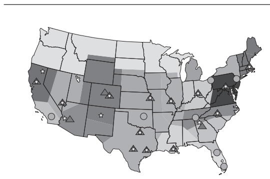


PERMEABLE PAVERS TREATMENT



PERMEABLE PAVERS TREATMENT AND DETENTION





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• Dallas/Ft. Worth, TX:	(817) 481-5802		
• Denver, CO:	(303) 287-3700		
• Hagerstown, MD:	(240) 420-3780		

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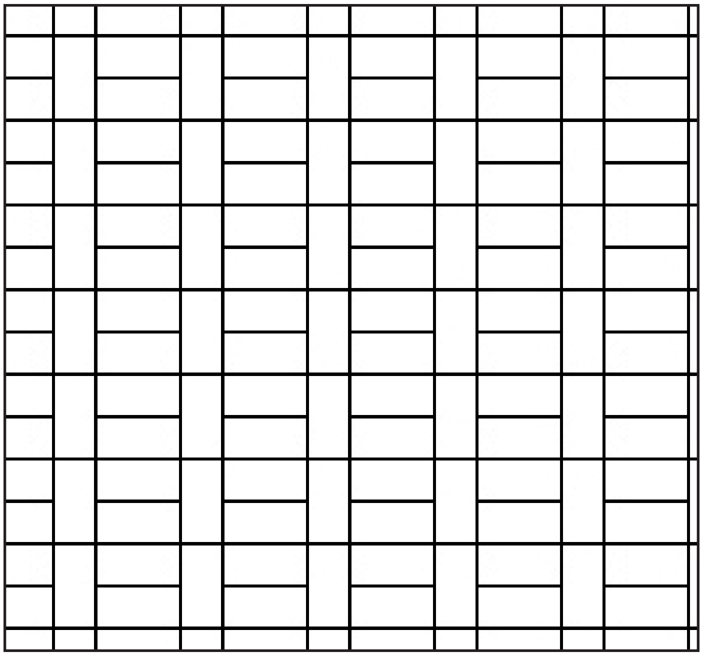
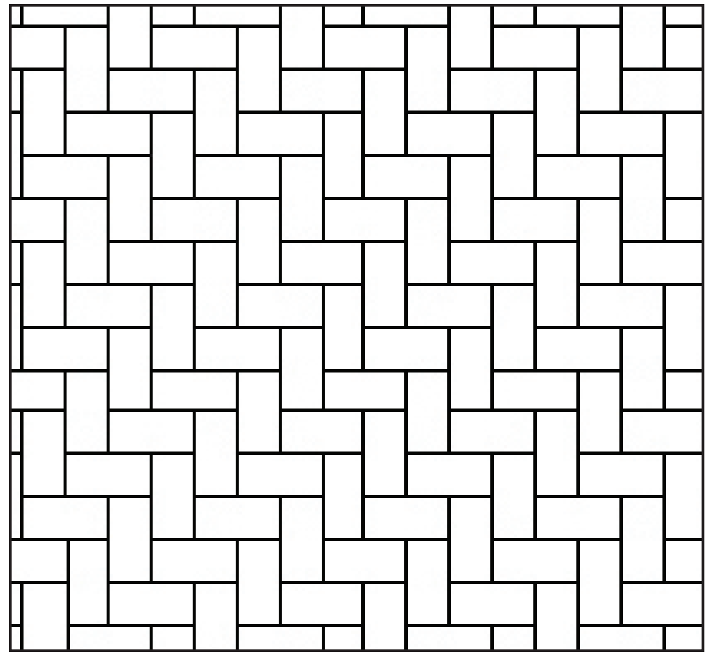
SKU# CDC 266V4 5/10

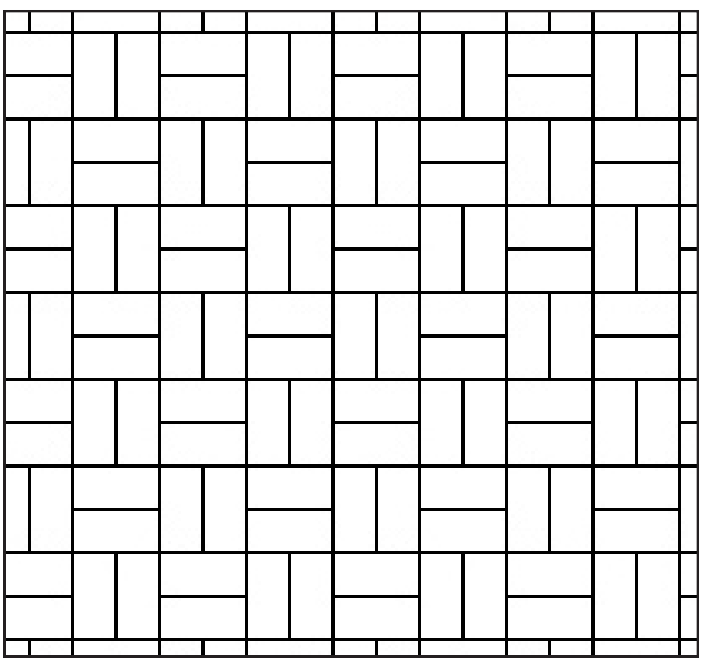
Eco-Priora™ 699 Installation Patterns



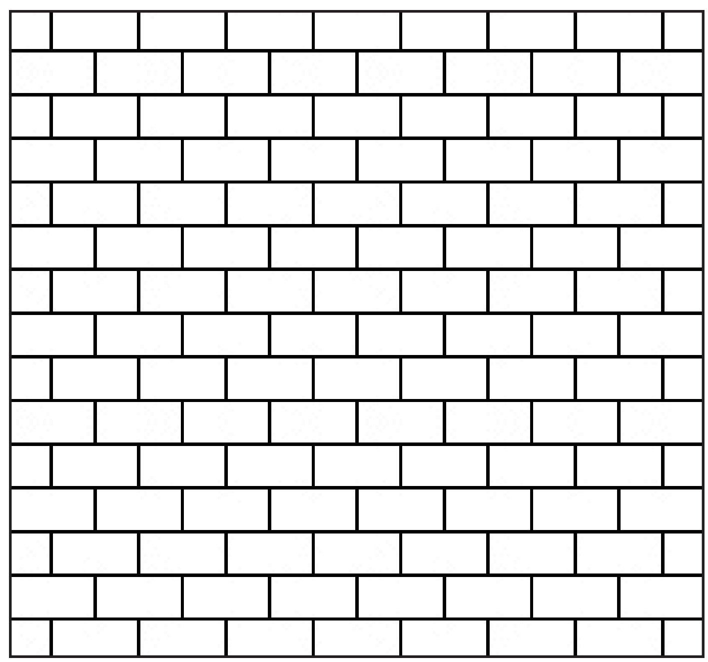
BASKETWEAVE (1)



HERRINGBONE (2)



PARQUET (5)

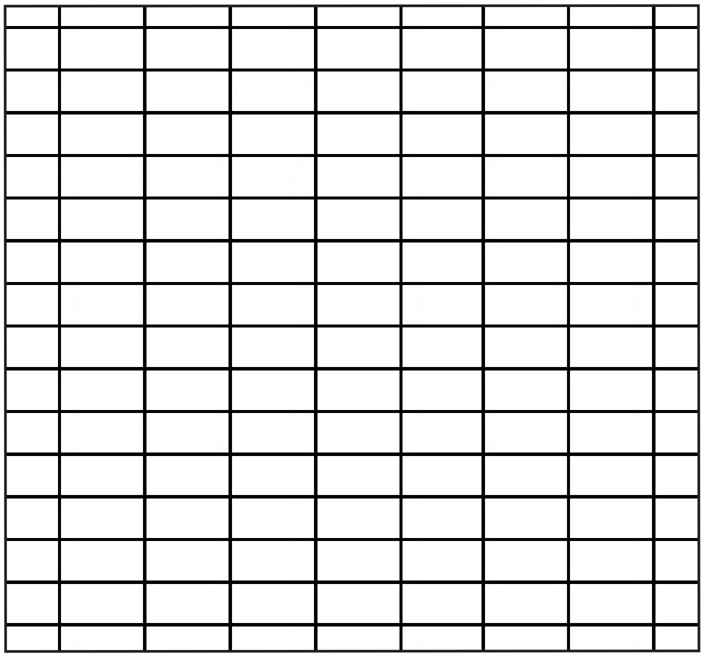


RUNNER BOND (7)

PAVESTONE®

CREATING BEAUTIFUL LANDSCAPES℠

Eco-Priora™ 699 Installation Patterns



STACK (8)

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CREATING BEAUTIFUL LANDSCAPES℠

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COMMERCIAL
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AquaLine™ L-stone Multi-Cobble
Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial AquaLine™ paver series, while the innovative design features of L-shape make it the perfect pavement choice for plazas, sidewalks, parking lots, alleys and small roadways. It is available in a variety of nationally offered colors, finishes and surface textures, including Texturgard™ - an ultra-durable wearing course that virtually eliminates the appearance of aging.

ADA COMPLIANT | HEAVY VEHICULAR—100MM | VEHICULAR—80MM | MECHANICAL INSTALLATION

Designed to provide an aesthetically pleasing large format permeable surface that is pedestrian friendly and functional for vehicular traffic. AquaLine combines structural joints and infiltrating voids to optimize system performance. Easier to install due to the additional interlock provided by the L-shape. It is the result of years of research on existing permeable paver products.

Benefits of AquaLine™ L-stone Multi-Cobble

STRENGTH
Manufactured to exceed the minimum standards specified in ASTM C936. Test results from an independent third party are available upon request.

ECOLOGICAL SOLUTIONS
Engineered to infiltrate up to 140 inches per hour which greatly exceeds even the heaviest storms. Where water quality improvements are required, select aggregates can be used in the voids to optimize contaminant removal.

ECONOMICAL
Permeable Pavement Systems serve as both the driving surface and stormwater management system, eliminating the need for traditional infrastructure, allowing more property to be used for revenue generation. Pavers have also been proven to last in excess of 50 years, greatly benefitting life cycle costs.

LOW MAINTENANCE
Maintenance is similar to what is commonly required for other pavement surfaces. If voids become plugged, aggregate and debris can be vacuum extracted and new aggregate material inserted, restoring the original infiltration rate.

AFFORDABILITY
Packaged for mechanical installation, resulting in a cost effective installed price.

COMFORT
ADA compliant walking surface that is high-heel and pedestrian friendly. Causes low-vibration for strollers, bikes, shopping carts and wheelchairs.

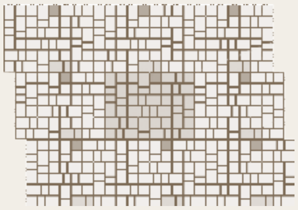
LEED POINTS
Can contribute to credits for stormwater quality and quantity, recycled materials, heat island effect, and innovation in design, among others.

AquaLine™ L-stone Multi-Cobble

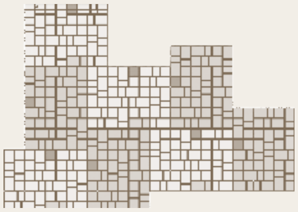
Size: 12" x 12" x 3 1/8" (or 12" x 12" x 4")
Colors: 9 national colors, local custom colors available upon request
Finishes: Smooth, Shot Blast, Ground Face
Processes: Colorgard, Texturgard
Chamfer: 2mm
Spacers: Dual positive-interlocking integrated bars
Joint/Void: Maximum 8 mm non-structural voids
Appearance: Random 3 size cobble

BELGARD AQUALINE™ L-SHAPE	
Dimensions	12" x 12" x 80mm
sold by	sf
sf/plt	96
lbs/plt	3380
layers/plt	8
lf/plt	96*
units/plt	128
sf/layer	12
sf/unit	0.75
lf/unit	0.75
lbs/unit	26.4

*Linear feet measured when used as 12" soldier course installed in pairs (see front photo).



Stitched Pattern



Non-Stitched Pattern

ICPI INTERLOCKING CONCRETE PAVEMENT INSTITUTE

CONTINUING EDUCATION AIA

NATIONAL CONCRETE MASONRY ASSOCIATION

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Eco Dublin™
Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial brand, and our Environmental Collection of permeable pavers is no exception. Belgard permeable pavers combine the best of Belgard with innovative stormwater management for a superior product line that provides sustainable solutions and aesthetically appealing designs.

ADA COMPLIANT | LT. VEHICULAR—80MM | MECHANICAL INSTALLATION

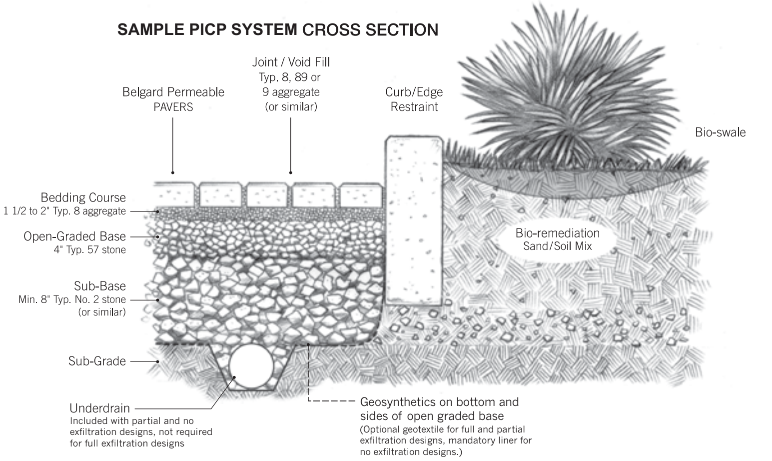
Eco Dublin™

Smart-looking style meets smart science. The classic look of cut stone and contemporary materials technology combine in Eco Dublin™, the latest addition to Belgard's Environmental Series of permeable pavers.

Benefits of Belgard® Permeable Paving Stone Systems

- On the US Environmental Protection Agency's (EPA) menu for structural Low Impact Development (LID) BMPs
- Can contribute toward several LEED NC-2009 points
- Reduces stormwater runoff by up to 100%
- Can be used to achieve total maximum daily load (TMDL) limits for a range of pollutants
- Certified SRI colors reduce heat island effect
- Can reduce or eliminate the need for traditional drainage and detention requirements, saving space and money
- Can be designed to accommodate all native soil types
- 50-year design life based on proven field performance

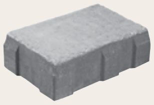
SAMPLE PICP SYSTEM CROSS SECTION



The availability of specific aggregate will often vary from region to region. In cases where it becomes necessary to substitute a similar size, your project engineer should always be consulted.

3 7/16" x 6 7/8" x 3 1/8"
(87.78mm x 174.57mm x 80mm)

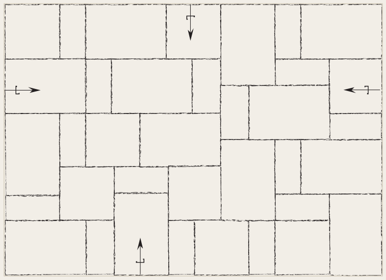
6 7/8" x 6 7/8" x 3 1/8"
(174.57mm x 174.57mm x 80mm)



Large Rectangle
6 7/8" x 10 1/4" x 3 1/8"
(174.57mm x 261.35mm x 80mm)

Shapes

(All three shapes come in each bundle.)



Mechanical Installation Laying Pattern

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Aqua Roc™
Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial brand, and our Environmental Collection of permeable pavers is no exception. Belgard permeable pavers combine the best of Belgard with innovative stormwater management for a superior product line that provides sustainable solutions and aesthetically appealing designs.

ADA COMPLIANT | VEHICULAR—80MM | LT. VEHICULAR—80MM | MECHANICAL INSTALLATION

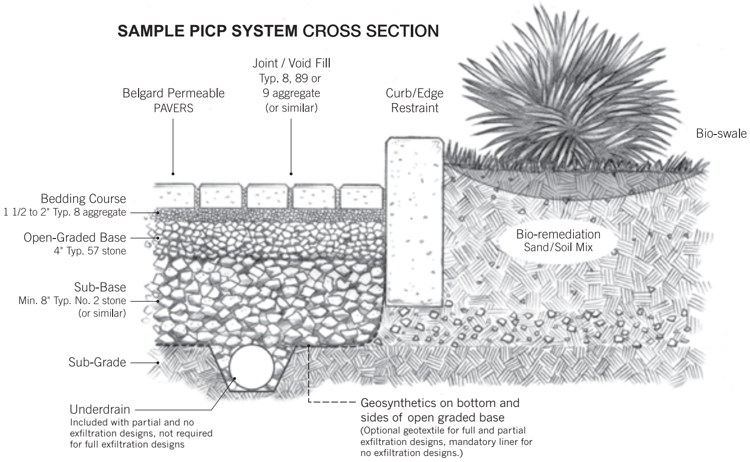
Aqua Roc™

Aqua Roc is a versatile paver featuring not only the environmentally-friendly benefits of a permeable paver, but also high visual appeal, low maintenance, and proven durability. Aqua Roc's versatile pattern range allows for flexible design options, making it an excellent choice for vehicular use.

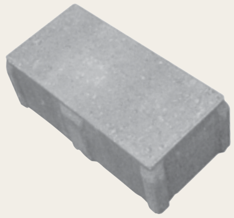
Benefits of Belgard® Permeable Paving Stone Systems

- On the US Environmental Protection Agency's (EPA) menu for structural Low Impact Development (LID) BMPs
- Can contribute toward several LEED NC-2009 points
- Reduces stormwater runoff by up to 100%
- Can be used to achieve total maximum daily load (TMDL) limits for a range of pollutants
- Certified SRI colors reduce heat island effect
- Can reduce or eliminate the need for traditional drainage and detention requirements, saving space and money
- Can be designed to accommodate all native soil types
- 50-year design life based on proven field performance

SAMPLE PICP SYSTEM CROSS SECTION

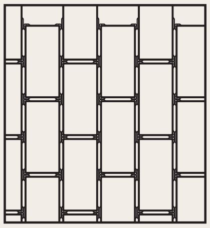


The availability of specific aggregate will often vary from region to region. In cases where it becomes necessary to substitute a similar size, your project engineer should always be consulted.

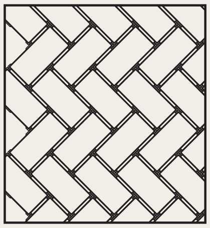


Shape

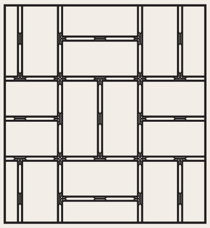
4 1/2" x 9" x 3 1/8"
(114.3mm x 228.6mm x 80mm)



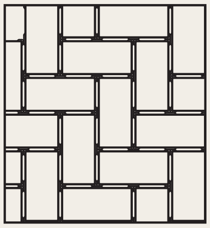
Running Bond



Herringbone 45 Degree



Basket Weave



Herringbone 90 Degree

Laying Patterns

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California Outdoor Living	Anaheim	CA
Marina Landscape, Inc.	Anaheim	CA
VERSAI Design and Development, Pavers Division	Beverly Hills	CA
Pacific Coast Pavers	Brea	CA
Peterson Brothers Construction	Brea	CA
AJ's Landscaping	Brentwood	CA
Paver Decor Masonry, Inc.	Calimesa	CA
System Pavers - San Diego	Carlsbad	CA
OLVERA MASONRY INC.	Carpinteria	CA
Landmark Site Contractors	Corona	CA
Stepping Stone Landscape	Coronado	CA
Castlelite Block, LLC	Dixon	CA
Paver Plus, Inc.	Downey	CA
Paving Stone of San Diego, Inc.	El Cajon	CA
Coyote Construction - Pavers	Escondido	CA
Claddagh Paving	Fallbrook	CA
Aloha Pavers, Inc.	Huntington Beach	CA
I.M. Masonry Construction, Inc.	Lancaster	CA
Precision Contractors, Inc.	Lancaster	CA
Earth Shelter Developers	Lodi	CA
Go Pavers	Los Angeles	CA
Stowe Contracting, Inc.	Marina	CA
Stowe General Construction	Modesto	CA
Sierra Madre Landscape	Monrovia	CA
Systems Paving - Dallas	Newport Beach	CA
System Pavers - Novato	Novato	CA
Haney Landscape Inc.	Ojai	CA
System Pavers - Inland Impire	Ontario	CA
Alan Smith Pools	Orange	CA
Farley Interlocking Paving	Palm Desert	CA
Sunshine Landscape	Palm Desert	CA
DMA Construction	Paso Robles	CA
Edsons Pavers, Inc.	Perris	CA
Viking Pavers Inc.	Point Richmond	CA
System Pavers - Sacramento	Rancho Cordova	CA
McEntire Landscaping, Inc.	Redding	CA
INSTALL IT DIRECT	San Diego	CA
Landscapes West	San Diego	CA
Pavers 4 Less	San Diego	CA
Bauman Landscape and Construction	San Francisco	CA
Black Diamond Paver Stone and Landscape, Inc	San Jose	CA
European Paving Designs, Inc.	San Jose	CA
JCMS Landscaping	Santee	CA
Prime Gardens, Inc.	Sherman Oaks	CA
Alford's English Gardens INC	Signal Hill	CA
JFK Pavestone, Inc.	Simi Valley	CA

Tahoe Outdoor Living DBA Tahoe Paving Stones	South Lake Tahoe	CA
Pacific Pavingstone, Inc.	Sun Valley	CA
Weiland & Associates, Inc.	Swall Meadows	CA
System Pavers - Northern California	Union City	CA
System Pavers - Northern California	Union City	CA
Scarlett's Landscape, Inc.	Ventura	CA
System Pavers - Ventura	Ventura	CA
Southwest Specialties of California, Inc.	Walnut	CA
Southwest Specialties of California, Inc.	Walnut	CA

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
Anthonie		Smith		T.B. Penick	San Diego	CA	92128	Pervious Concrete Craftsman	6/3/2016
Bill		Beeson		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Craftsman	2/5/2019
Danny		Stewart		T.B. Penick	San Diego	CA	92128	Pervious Concrete Craftsman	6/3/2016
David		Liguori		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Craftsman	11/14/2019
Dennis	M.	Collins		Enviro-Crete, Inc.	Orangevale	CA	95662	Pervious Concrete Craftsman	10/1/2017
Guy		Collignon		Enviro-Crete, Inc.	Orangevale	CA	95662	Pervious Concrete Craftsman	6/13/2016
Steven	J.	Carrera		S 7 J Carrera Construction, Inc.	Watsonville	CA	95076	Pervious Concrete Craftsman	2/24/2016
Wayne		Jenness		T.B. Penick	San Diego	CA	92120	Pervious Concrete Craftsman	6/3/2016

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
Alejandro		Ruiz Villalobos		Robert A. Bothman	Salinas	CA		Pervious Concrete Installer	10/26/2017
Alexander		Renteria		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Arturo		Rosas		Beeson Masonry	Lake Hughes	CA	93532	Pervious Concrete Installer	8/6/2019
Daniel		Rodriguez Avalos		Robert A. Bothman, Inc.	Salinas	CA		Pervious Concrete Installer	10/26/2017
Edward		Ramirez		GPF Concrete	Perris	CA	92574	Pervious Concrete Installer	1/16/2017
Hector		Vela Villagrana		Robert A. Bothman Inc.	Antioch	CA	94509	Pervious Concrete Installer	10/26/2017
Humberto		Tovalin		T.B. Penick	San Diego	CA	92128	Pervious Concrete Installer	6/3/2016
Isaias		Ruiz		Melo Concrete Construction	Gilroy	CA		Pervious Concrete Installer	10/26/2017
Jaime		Sanitillan		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Jaime		Villegas		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
James		Lamping		T.B. Penick	San Diego	CA	92128	Pervious Concrete Installer	6/3/2016
Joey		Lankford		Beeson Masonry	Lake Hughes	CA	93532	Pervious Concrete Installer	8/6/2019
Jose		Ceron		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Installer	11/8/2015
Juan		Munoz		Galvan's Place and Finish	Perris	CA	92574	Pervious Concrete Installer	1/16/2017
Luis		Castellanos		Robet A. Bothman Inc.	San Jose	CA		Pervious Concrete Installer	10/26/2017
Mario		Ortiz		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Michael		Orosz		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Mike		Beczak		T.B. Penick	San Diego	CA	92128	Pervious Concrete	6/3/2016

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
								Installer	
Piedad		Menchara Solorio		Robert A. Bothman Inc.	Salinas	CA	93905	Pervious Concrete Installer	10/26/2017
Ricardo	R.	Galvan		Galvan's Place and Finish	Perris	CA	92571	Pervious Concrete Installer	1/16/2017
Robert		Estrada		Bay Area Pervious Concrete	San Carlos	CA	95040	Pervious Concrete Installer	5/4/2017
Ron		Parietti			Pilot Hill	CA	95664	Pervious Concrete Installer	6/30/2015
Salvador		Rosas		Robert A. Bothman Inc.	San Jose	CA	95116	Pervious Concrete Installer	10/26/2017
Sergio		Grageda		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Installer	11/8/2015
Victor		Santana		Robert A. Bothman Inc.	Salinas	CA	93906	Pervious Concrete Installer	10/26/2017

Appendix F – Soil Report

99.0300004

BORING LOG

GeoSoils, Inc.

W.O. 4633A-VN

PROJECT: S & V VAN NUYS ASSOCIATES

BORING B- 4 SHEET 1 OF 1

DATE EXCAVATED 2-19-97

SAMPLE METHOD: 8" Hol/140lb/30" Drop

SPT ▇ Ring ▨ Water Seepage

Depth (feet)	Sample: Bulk	Sample: Undisturbed	Blows/6 in.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
0							**0 - 30' ALLUVIUM** @ 0 - 9', Dark brown, very silty, very fine SAND, slightly moist, loose, slightly porous.
		Ring	3/5	SM	101.7	17.2	
5		Ring	7/13	SM	104.0	16.3	
10		Ring	2/9	ML	99.8	14.2	@ 9 - 12', Brown, slightly sandy SILT, moist, slightly porous, moderately stiff.
		Ring	7/14	ML	101.8	18.2	@ 12 - 18', Brown, sandy SILT, moist, slightly stiff.
15							
		Ring	8/12	SM	97.9	19.5	@ 18 - 25', Brown, silty very fine SAND, moist, moderately dense.
20							
		Ring	7/10	CL	99.7	14.9	
25							@ 25 - 30', Dark brown, sandy CLAY, with silty SAND layers, moist, slightly stiff.
30		Ring	14/18	SM	97.0	17.4	@ 30-1/2', Red-brown, slightly silty very fine to fine SAND, moderately dense. Total Depth 30' No Groundwater
35							

GeoSoils, Inc.

PLATE A-4

BORING LOG

GeoSoils, Inc.

W.O. 4633A-VN

PROJECT: S & V VAN NUYS ASSOCIATES

BORING B-34 SHEET 1 OF 1

DATE EXCAVATED 2-24-97

SAMPLE METHOD: Rings/SPT Hammer

SPT ■ — Ring ▨ — Water Seepage

970830034

Depth (feet)	Sample: Bulk	Sample: Undisturbed	Blows/6 In.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
0–5							**0 - 11' ALLUVIUM** Sandy SILT, medium to large amounts and fine SAND, grey-brown, damp, firm, trace small rounded GRAVEL. Moist, loose to moderately firm with depth.
5		Ring	6/ 9	ML/ SM	107.6	11.1	
10		Ring	6/ 8	ML/ SM	112.3	12.9	
11							Total Depth @ 11' No Groundwater

PINNACLE
ENVIRONMENTAL TECHNOLOGIES
#2 Santa Maria, Foothill Ranch, CA
Tel: (949) 470-3691 Fax: (949) 595-0459

BORING LOG

99105 00H1

SITE: Former GM Assembly Plant
ADDRESS: Van Nuys Blvd. & Arminta Street
Van Nuys, California
DRILLING METHOD: GeoProbe Direct Push
DRILLING COMPANY: Vironex, Inc.

BORING No.: B-1
DATE: 12/3/99
GEOLOGIST: W. Malvey
REVIEWED: K. Thompson, R.G.
ELEVATION: Not Measured

Time	PID	LEL/H2S	Depth	Sample	DESCRIPTION	Graphic Log	Well Const
					Unpaved dirt at surface.		
1425	0	0/0			Silty Clay (CL), trace sand, dark brown, firm, damp, no odors		
1430	0	0/0	5		Silty Clay (CL), trace sand, dark brown, firm, damp, no odors		
1435	0	0/0	10		Sand (SP), some silt, grayish-tan, loose, damp, very fine-grained, no odors		
1445	0	0/0	15		Sand (SP), some silt, grayish-tan, loose, damp, very fine-grained, no odors		
1450	0	0/0	20		No Recovery		
1500	0	0/0	25		Silt (ML), trace sand, trace clay, dark brown, loose, damp, very fine-grained, no odors		
1515	0	0/0	30		Silt (ML), trace sand, trace clay, dark brown, loose, damp, very fine-grained, no odors		
					Boring terminated at 30 feet below ground surface		

9910500H2

BORING LOG

PINNACLE ENVIRONMENTAL TECHNOLOGIES
#2 Santa Maria, Foothill Ranch, CA
Tel: (949) 470-3691 Fax: (949) 595-0459

SITE: Former GM Assembly Plant
ADDRESS: Van Nuys Blvd. & Arminta Street, Van Nuys, California
DRILLING METHOD: GeoProbe Direct Push
DRILLING COMPANY: Vironex, Inc.

BORING No.: B-2
DATE: 12/3/99
GEOLOGIST: W. Malvey
REVIEWED: K. Thompson, R.G.
ELEVATION: Not Measured

Time	PID	LEL/H2S	Depth	Sample	DESCRIPTION	Graphic Log	Well Const
					Unpaved dirt at surface.		
0720	0	0/0			Silty Clay (CL), trace sand, dark brown, firm, damp, no odors		
0725	0	0/0	5		No Recovery		
0735	0	0/0	10		Sand (SP), some silt, grayish-tan, loose, damp, very fine-grained, no odors		
0740	0	0/0	15		Sand (SP), some silt, grayish-tan, loose, damp, very fine-grained, no odors		
0755	0	0/0	20		Silt (ML), trace sand, trace clay, dark brown, loose, damp, very fine-grained, no odors		
0800	0	0/0	25		Silt (ML), trace sand, trace clay, dark brown, loose, damp, very fine-grained, no odors		
0840	0	0/0	30		Silt (ML), trace sand, trace clay, dark brown, loose, damp, very fine-grained, no odors		
					Boring terminated at 30 feet below ground surface		

BORING LOG

GeoSoils, Inc.

W.O. 4633A-VN

PROJECT: S & V VAN NUYS ASSOCIATES

BORING B- 4 SHEET 1 OF 1

DATE EXCAVATED 2-19-97

SAMPLE METHOD: 8" Hol/140lb/30" Drop

■ SPT

▨ Ring

∿ Water Seepage

970830004

Depth (feet)	Sample: Bulk	Sample: Undisturbed	Blows/6 in.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
0							**0 - 30' ALLUVIUM** @ 0 - 9', Dark brown, very silty, very fine SAND, slightly moist, loose, slightly porous.
		▨	3/5	SM	101.7	17.2	
5		▨	7/13	SM	104.0	16.3	
10		▨	2/9	ML	99.8	14.2	@ 9 - 12', Brown, slightly sandy SILT, moist, slightly porous, moderately stiff.
		▨	7/14	ML	101.8	18.2	@ 12 - 18', Brown, sandy SILT, moist, slightly stiff.
15							
		▨	8/12	SM	97.9	19.5	@ 18 - 25', Brown, silty very fine SAND, moist, moderately dense.
20							
		▨	7/10	CL	99.7	14.9	
25							@ 25 - 30', Dark brown, sandy CLAY, with silty SAND layers, moist, slightly stiff.
30		▨	14/18	SM	97.0	17.4	@ 30-1/2', Red-brown, slightly silty very fine to fine SAND, moderately dense.
							Total Depth 30' No Groundwater
35							

Appendix 4.D.2

Upgrades to Pump Plants and Associated Stormwater Treatment Opportunities in the City of Los Angeles Upper Los Angeles River Watershed

Implementation Strategy for Pump Plant 622

Upgrades to Pump Plants and Associated Stormwater Treatment Opportunities in the City of Los Angeles Upper Los Angeles River Watershed

Implementation Strategy for Pump Plant 622

Jointly prepared by:

Tetra Tech
3475 East Foothill Boulevard
Pasadena, CA 91107

Black & Veatch Corporation
800 Wilshire Blvd, #600
Los Angeles, CA 90017

City of Los Angeles
LA Sanitation
Watershed Protection Division
1149 S Broadway, 10th Floor
Los Angeles, CA 90015-2213

June 11, 2015

Contents

1. Introduction

Multiple pollutants currently impair the beneficial uses of the Los Angeles River. To address these impairments, the City of Los Angeles (City) must comply with the water quality requirements presented in the Municipal Separate Storm Sewer System (MS4) Permit) and State-mandated total maximum daily loads (TMDLs). Recently prepared Enhanced Watershed Management Programs (EWMPs) prescribe collaborative and adaptive strategies for the City to attain compliance with these requirements; however, the scale of implementation is extraordinary.

The EWMPs currently forecast implementation of over 3,000 acre-feet of green infrastructure and regional control measures by the City (totaling $3.8 billion in capital cost) in the Upper Los Angeles River (ULAR) watershed alone. At this scale, cost-effective implementation will be challenging in many locations, particularly when the suitable opportunities for stormwater treatment are *not* located near runoff and pollutant sources. One solution is divert runoff to the highest efficiency opportunities using existing infrastructure.

EWMP Requirement:
Implement >3,000 acre-feet of BMPs in the ULAR basin before 2037

There are multiple aging pump plants located strategically throughout the City of Los Angeles – each intended to alleviate or prevent flooding in low lying areas where gravity flow is not feasible (Figure 1). If upgrades to these pumps can be leveraged to provide water quality benefits (Figure 2), the advantages are two-fold:

1. ***Creating* High-Efficiency Treatment Opportunities:** The efficiency (pollutant reduction per dollar) is maximized by routing runoff to areas with high treatment potential and maximizing the treated drainage area using existing infrastructure.
2. **Improving Resilience:** Control measures sited upstream from pumps can reduce pump cycle frequency, energy use, and maintenance burden by intercepting and retaining runoff volume from small storm events.

This conceptual design describes recommended upgrades to the aging infrastructure at Pump Plant 622 along with integrating multi-benefit stormwater treatment strategies into the plant upgrades. A cost-effective solution that addresses Permit water quality requirements in tandem with flood control functions will be recommended. These solutions would also provide multiple other benefits for residents and businesses in the area, and promote a greener, healthier, and more sustainable urban landscape. The concepts will justify incorporating water quality components into future infrastructure upgrades, and will have wider implications when considering leveraging existing infrastructure to support integrated water planning (One Water) in the Los Angeles region.

EXISTING CONDITIONS

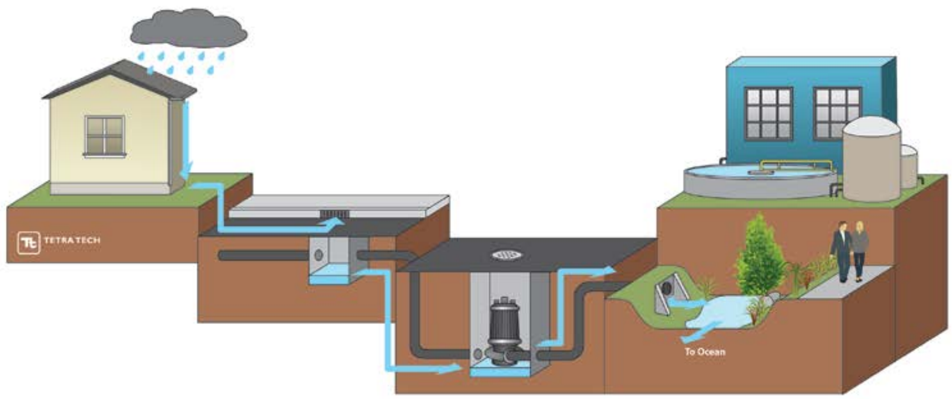

Figure 1. Conceptual diagram illustrating a typical infrastructure design. Pumps in low-lying areas use energy to convey runoff directly to the receiving water without treatment. In some instances, dry weather flows are diverted to the sanitary sewer for treatment.

PROPOSED SYNERGY: LEVERAGING INFRASTRUCTURE UPGRADES

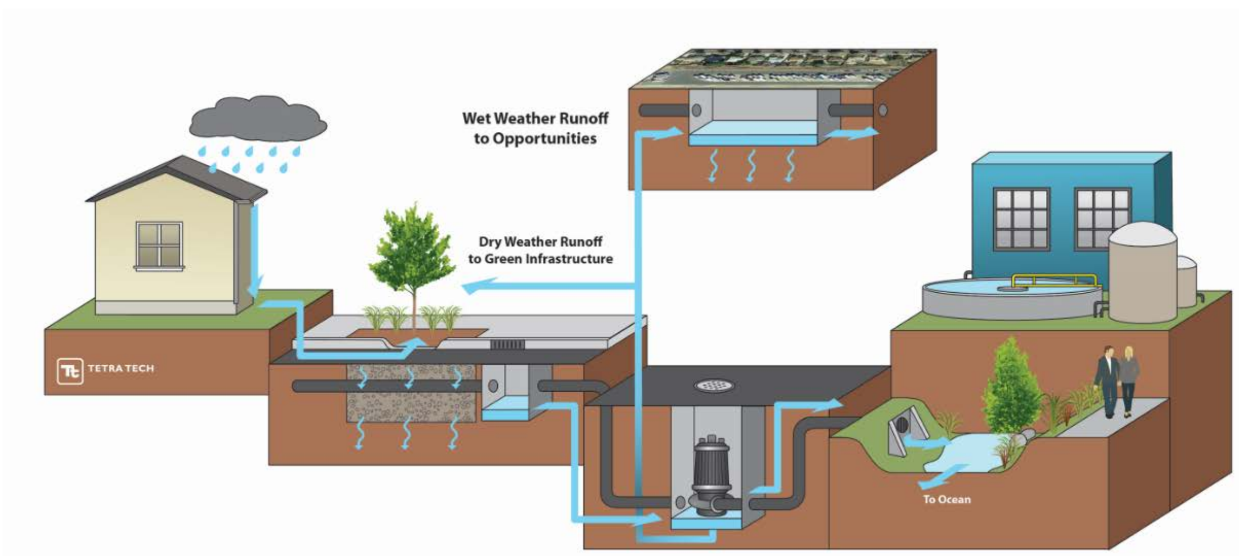

Figure 2. Conceptual diagram illustrating the potential benefits of integrating water quality design into future upgrades. Integrating water quality and flood control can lead to cost-effective treatment by taking advantage of existing facilities to move runoff to BMP opportunities. Upstream control measures can also reduce the burden on pumps by intercepting runoff near the source.

2. Background

This conceptual design focuses on the rehabilitation and green infrastructure modification of Pump Plant 622. Key background information, such as regulatory context and a description of the project site is provided in the following paragraphs.

2.1. Stormwater Regulations and Work to Date

The LA River is on the *Clean Water Act 303(d) List of Water Quality Limited Waterbodies* for ammonia, bacteria, zinc, copper, lead, algae, oil, and trash. To address these impairments, the State has developed TMDLs for metals, nitrogen, and trash, which contain compliance schedules for the City to reduce impacts from stormwater discharges. The LA River Metals TMDL has a final compliance date of 2028 for wet weather. The LA River Bacteria TMDL, perhaps the most challenging TMDL faced by the City, has a wet-weather compliance date of 2037. Moreover, compliance of these TMDLs would also address the pollutant reduction requirements of the 2012 MS4 (MS4) Permit (Order No. R4-2012-0175; NPDES Permit No. CAS004001). The stormwater project described herein would be a key component of the metals and bacteria Load Reduction Strategies for Segment D-Reach 4 of the LA River, and would address many other stormwater pollutants from the targeted subwatershed during wet weather.

2.2. Project Location and Site Description

The targeted subwatershed, SWS 685149 in the R4-LAR-Sepulveda subwatershed, is bordered by the 405 freeway to the west, Pacoima Wash to the east, Rayen Street to the north, and the Van Nuys Metrolink is immediately south of the pump station as shown in Figure 3. SWS 685149 is serviced by approximately 98 catch basins that drain to a network of both city and county storm drains that discharge to the Pacoima Wash and ultimately to the Los Angeles River (Figure 3 and Table 1). Pump Plant 622 dewaters the sag below a bridge and receives stormwater runoff from an approximately 13-acre subwatershed.

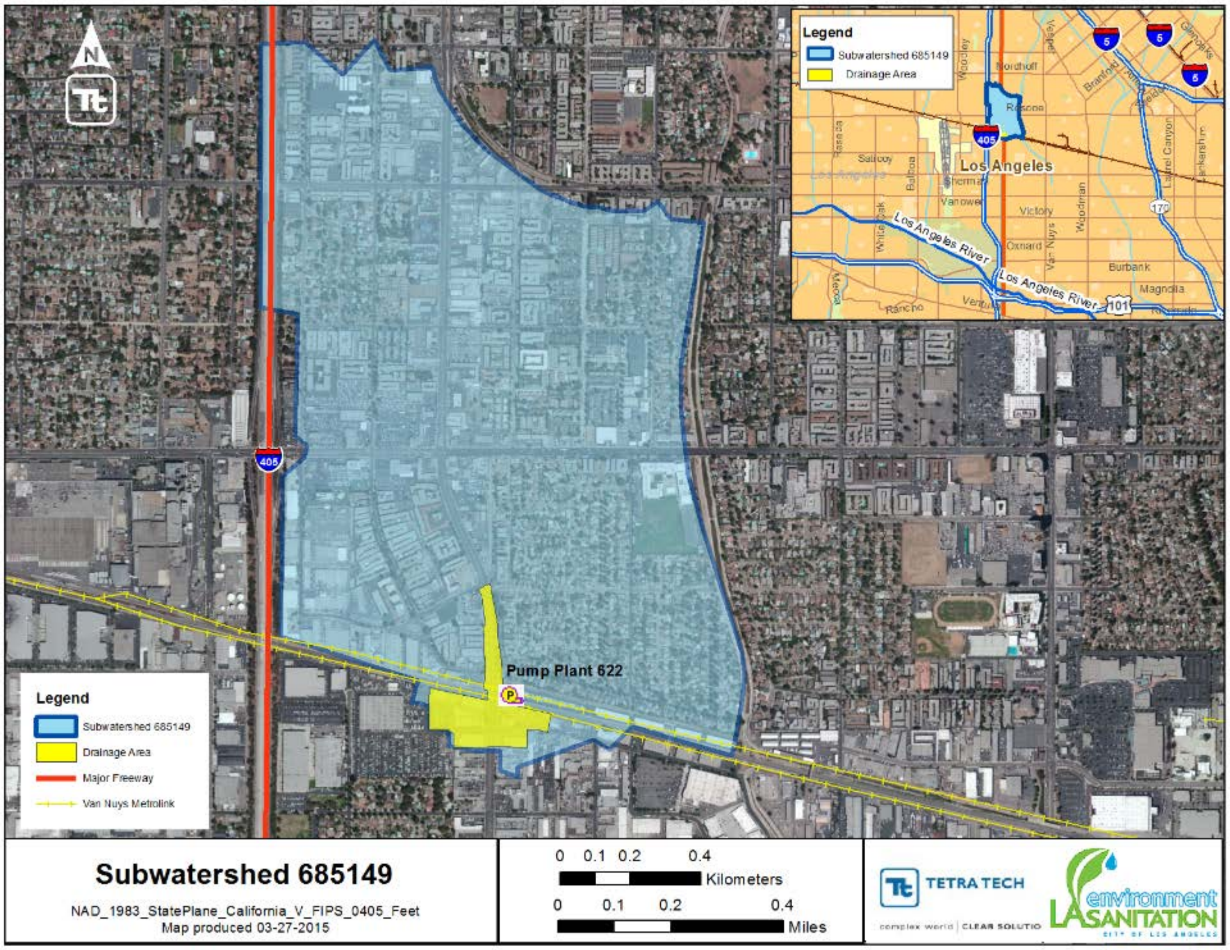

Figure 3. SWS 685149 in The R4-LAR-Sepulveda subwatershed.

Table 1. Site summary

Site attribute	Value
Watershed	Upper Los Angeles River
Subwatershed	SWS 685149
Total Pump Plant Drainage Area	12.7 acres

3.Proposed Pump Plant Upgrades

Pump Plant 622 is intended to provide flood protection to Sepulveda Boulevard south of Roscoe Boulevard in the Van Nuys area of the City. It does so by lifting storm water flows from the sump in Sepulveda Boulevard below the Metrolink railroad tracks up to a double box culvert storm drain located parallel and to the north of the Metrolink railroad tracks east of Sepulveda Boulevard. This double box culvert generally flows southeast and eventually ties into the Los Angeles County drainage system and the Los Angeles River. The current configuration of the pumping station is shown in Figure 4.

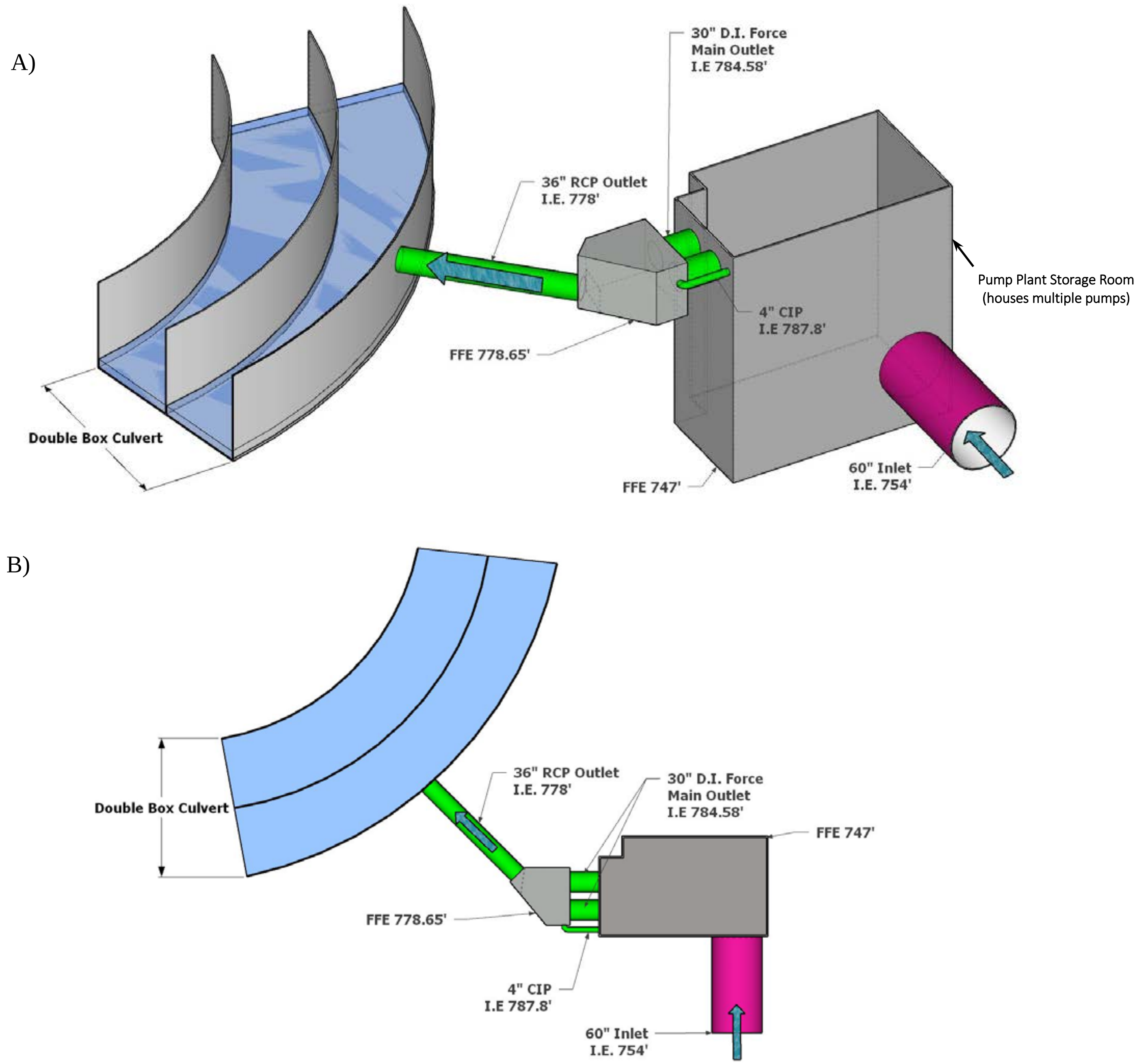

Figure 4. A) Isometric Configuration of Pump Plant 622. B) Plan Configuration of Pump Plant 622.

The characteristics of the Pump Plant 622 are summarized in the following sections. This information was obtained through a review of the as-built plans, a site visit to the plant, and other information obtained from LA Sanitation.

3.1. General Description of Pump Plant No. 622 (Sepulveda)

- Street address: 15266 Cabrito Road, Van Nuys, CA.
- Constructed in 1968.

- Underground reinforced concrete structure with three levels: a motor/electrical room level, a bar screen room level, and a storage room level.
- Reinforced concrete stairs provide access to the interior of the pump plant from the ground surface and between levels.
- Miscellaneous metal items are damaged including railings, ladders, bar screens, and ventilation louvers.
- Lighting is original and inadequate for many maintenance operations.
- The plant incorporates three pumps: two service pumps and one sump pump.
- The plant wet well storage is approximately 45,700 gallons.
- Inlet pipe is a 60" ID RCP with an invert elevation of 754.0.
- Main outlets are dual 30" DIP force mains (one for each pump) with an invert elevation of 784.58.
- Sump pump outlet is 4" CIP with an invert elevation of 787.2
- A 350 KW Onan trailer mounted portable backup generator is located on site. The original design included a permanent natural gas powered 150 KW backup generator located in the motor room of the pump plant. The original permanent generator has been removed.
- The fenced area around the plant is about 7,300 square feet.
- Security problems were noted at the site – the chain link fence has a large hole in it and there is evidence of intruders (graffiti, garbage, etc.).
- Based on discussions with maintenance staff, flooding on Sepulveda Boulevard, making it impassable to vehicles, occurred at least once in the last 30 years.

3.2. Existing Pumps and Proposed Upgrades

This section describes the existing and proposed pump types and capacities for Pump Plant 622.

3.2.1. Existing Duty Pumps

Based upon information provided by operations staff, the two duty pumps are Lane Bowler vertical turbine pumps each with a pumping capacity of 15,500 gpm (34.5 cfs) at a static head of 32'. These pumps are each powered by a single speed, 150 HP motor manufactured by US Motors. One pump operates at a time, providing 100% back-up redundancy.

Per the City of Los Angeles Storm Drain Design Manual, sump areas like this are to be sized for the 50-year storm. The 50-year storm for this this area was calculated to be approximately 40 cfs in Appendix B. The pump capacity of Plant 622 is 34.5 cfs, approximately 15% less than the 50-year storm.

The Pump # 2 motor was noted to leak oil and the breaker tripped when it was turned on during the site visit. A hole in the housing of Pump 2 appears to have been repaired with a sleeve wrap around the pump.

3.2.2. Existing Sump Pump

Based upon information provided by operations staff, the sump pump is a Yeomans submersible pump with a single speed 15 HP motor with a rated flow rate of 500 gpm. The purpose of this pump is to slowly drain the storage room from the low water level to the sump level after a storm is over. Based upon discussions with maintenance staff, this pump is not operational.

3.2.3. Proposed Duty Pumps

Due to the age, condition, and flow capacity, the two main duty pumps should be replaced and upgraded to meet the 50-year storm of 40 cfs. This would provide 100% redundancy for the station. Because of the flow requirements and available space within the existing station, vertical turbine solids handling pumps (similar to the existing ones) are considered.

The preliminary pumps selected for this application are Fairbanks Morse model 30" VTSH LH solids handling pump with 200 HP motors. To reduce the power load demand on motor start-up, solid state soft starters should be considered for the motor control center. The pump system curve for the duty pumps is included in Appendix C.

3.2.4. Proposed Sump Pump

The existing sump pump is rated at 500 gpm and has a 15 HP motor, but is not currently operational and should be replaced. To replace this pump, a submersible pump with integral motor is considered.

To meet the BMP 85th percentile flow of 2.5 cfs (as discussed in Section 4), the preliminary pump selected for this application is a Fairbanks Morse model 6" 5434 M&W submersible pump with 25 HP motor. The pump system curve for the sump pump is included in Appendix C.

3.2.5. Pump System Summary

The existing and proposed pump system for Pump Plant 622 is summarized in Table 2.

Table 2. Existing and proposed pump system components.

Existing Conditions				
Pump	Pump Type	Pump Capacity (gpm)	Static Head (feet)	Power (HP)
Duty Pump #1	Lane Bowler vertical turbine	15,500	32	150
Duty Pump #2	Lane Bowler vertical turbine	15,500	32	150
Sump Pump	Yeomans submersible	500	N/A	15
Proposed Conditions				
Duty Pump #1	Fairbanks Morse model 30" VTSH LH solids handling	17,900	32	200
Duty Pump #2	Fairbanks Morse model 30" VTSH LH solids handling	17,900	32	200
Sump Pump	Fairbanks Morse model 6" 5434 M&W	1,200	N/A	25

3.3. Structural Integrity

Based upon a cursory visual inspection of the pump plant, which was limited to those portions that were exposed to view (top of roof slab and pump plant interior), the structure appeared to generally be in good to very good condition. There are relatively minor concrete cracks in various locations throughout the structure, which is not uncommon for conventionally reinforced concrete. In the Motor Room, there is a damaged louvered vent at the ventilation and exhaust well. Also in the Motor Room, adjacent to the electrical panels, there are abandoned embedded metal items in the floor slab that are corroded. The current condition of the motor room is shown in Figure 5.

According to the Design Data on the General Plan of the as-built drawings, the Motor Room was designed for a lateral earth pressure of 143 pounds per cubic foot (PCF), while the Bar Screen Room and Storage

Room were designed for a uniform lateral earth pressure of 2000 pounds per square foot (PSF), equivalent to 143 PCF at 14 feet of depth. There are no seismic design parameters shown in the Design Data.

Figure 5. Pump Plant 622 Motor Room.

3.3.1. Proposed Structural Upgrades

The condition of the structure appears to be satisfactory. The replacement of the louvered vent and monitoring of the embedded metal items in the motor room for further corrosion should be considered. Additionally, a more detailed structural evaluation should be conducted during the pre-design phase of the project. If a current Code analysis/evaluation of the structure is desired, a geotechnical investigation should be performed to determine if the design lateral earth pressures are appropriate, and to determine if seismic earth pressure should be considered.

Due to the proposed modifications noted below, minor structural modifications may be required to accommodate the new equipment.

3.4. Miscellaneous Upgrades

Based upon site observations and discussions with maintenance staff, the following miscellaneous repairs and upgrades should be considered:

- Upgrade the Motor Control Center.
- Upgrade the SCADA / Instrumentation and Control Equipment.
- Replace pump discharge piping and valves.
- Install level control through ultrasonic sensors (primary) with float backup.
- Upgrade railings and ladders.
- Replace damaged bar screens.
- Replace the damaged louver in the motor room.
- Repair or replace the chain-link fence around the site.
- Sand blast and paint the interior and exterior of the building.

- Replace the ventilation system.
- Upgrade the interior and exterior lighting.
- Replace the on-site portable generator with new generator in plant (the original pump plant had an interior generator).
- Implement recommendations from the Arc Flash Study (to be determined).

3.4.1. Conceptual Layout and Design

The concept elements of the Pump Plant are as follows:

- Replace and upgrade the duty pumps, sized to convey the 50-year storm.
- Replace the existing sump pump with a new submersible pump.
- Perform miscellaneous upgrades.

3.4.2. Power Requirements

This section describes the power requirements needed to supply Pump Plant 622.

3.4.2.1. Electrical Supply

The pump plant has an existing 480V/500A service. A preliminary review indicates that if the replacement pumps include a solid state soft starter (instead of the existing magnetic starter) the existing service appears to be adequate for the upgraded pumps.

3.4.2.2. Backup Power Supply

The existing 350 KW backup generator is of sufficient size to power the replacement pumps. However, the generator is aging and it is not known if it is complies with current regulations. Additionally, since the generator is located outside, it is subject to damage from the elements and vandalism. As an alternate to this generator, a new 250 KW natural gas powered backup generator could be installed within the motor room of the existing pump plant building.

3.4.3. Operations and Maintenance

Operations and maintenance (O&M) procedures will be very similar to those currently conducted at Pump Plant 622. Major O&M items include monthly exercising of pumps and generator, as well as annual in-depth inspection, lubrication, and scheduled/worn-out part replacement.

3.5. Preliminary Opinion of Cost

Including a 25% contingency, the preliminary opinion of cost to complete the Pump Plant upgrades is approximately $2.0 million. A more detailed breakdown of costs is included in Section 8.

Due to the preliminary level of this study, this preliminary opinion of cost should be considered suitable for the early planning stage of the project. As the work becomes more defined in the subsequent project stages, it is expected that the opinion of cost will be revised.

4. Green Infrastructure Alternative Analysis Evaluation for Wet Weather Treatment

Integrating green infrastructure improvements into the rehabilitation of Pump Plant 622 can enhance the overall performance of the system and expand the benefit of the Pump Plant beyond its original function as a flood control mechanism. By linking the "gray infrastructure" (i.e. the physical pump plant) with the green infrastructure, multiple objectives can be achieved within a seamless system, reducing the overall cost to achieve each individual objective separately. In addition to the flood control function, this integration can help to achieve EWMP water quality improvement objectives while simultaneously providing the numerous advantages that green infrastructure brings to the City, such as an improvement to the community's overall well-being, increased property values, enhanced aesthetics, and recreational opportunities.

According to the ULAR EWMP, right-of-way along streets are the most extensive opportunity to implement BMPs on public land. In developed areas, curb and gutter in the road provide an opportunity to intercept both dry and wet weather runoff prior to entering the storm drain system and treat it within the extents of the public right-of-way. Green streets have been demonstrated to provide "complete streets" benefits in addition to stormwater management, including pedestrian safety and traffic calming, street tree canopy and heat island effect mitigation. The City of Los Angeles is planning to implement a Great Streets Initiative that seeks to enhance various areas of the City by making changes with temporary treatments such as plazas and parklets, and permanent changes to curbs, street lighting, and street trees (www.lamayor.org/greatstreets). The Great Streets Initiative is being implemented in aims of activating public spaces, providing economic revitalization, increasing public safety, and enhancing local culture. One setback for this area is narrow sidewalks, preventing the street from reaching its full potential. Because bicycle riding is permitted on sidewalks in the City of Los Angeles, a potential solution to narrow sidewalks would be to create a bicycle lane, decreasing sidewalk traffic In addition to the Great Streets initiative, the City of Los Angeles 2010 Bicycle Plan (LDCP 2010) proposes a bike lane for Sepulveda Boulevard from Rinaldi Street to Sherman Oaks Avenue. The plan notes that bicycle lanes along streets has been shown to have multiple economics, social, and environmental benefits such as, improvement to the businesses, increased number of riders, and enhanced safety. Utilizing permeable pavement in the bike lane can add an enhancement to water quality to the long list of benefits.

Localized flooding can result from insufficient capacity to drain a site and/or from excessive (and often unanticipated) offsite flows. Many causes of localized flooding can be remedied by repairing or replacing the existing infrastructure; however, it is often more practical to reduce the peak discharge and volume of runoff that are conveyed to the existing storm drainage network. As suggested in Alternative 2 below, retrofitting the study area with green infrastructure could provide a viable strategy to regulate runoff and alleviate localized flooding.

Implementing the green infrastructure concepts presented in the following sections provides an opportunity to integrate multiple initiatives currently proposed and in various stages of implementation across the City, the EWMP, Great Streets Initiative, and the 2010 Bicycle Plan. Combining all of these initiatives into one approach is a key component of the One Water plan approach.

There are two alternatives for incorporating treatment for wet weather flow into the pump station upgrades that could be implemented in tandem or independently. Water from the pump plant could be diverted into an underground infiltration basin (post-pump treatment) or stormwater flows could be treated before flowing into the pump plant (pre-pump treatment), using green infrastructure concepts suited for implementation in a protected bicycle lane and right-of-way, including permeable pavement and bioretention. Each alternative proposes incorporating treatment through green infrastructure in an attempt to improve the water quality of stormwater prior to discharge into the Los Angeles River (Segment D-Reach 4) and ultimately into the Pacific Ocean. Both alternatives incorporate diverting stormwater runoff from the street and the surrounding lands through a series of BMPs and allowing stormwater to infiltrate.

Alternative 1, referred to as "**Post-Pump Treatment**", includes two different scenarios that are designed to either pump or divert stormwater runoff into a underground infiltration basin underneath W. Cabrito Road on the east side of Sepulveda Blvd (Figure 6). Stormwater runoff is routed from two catch basins under the railroad bridge crossing Sepulveda Blvd into a wet well in the pump plant. The runoff will be pumped out of the wet well and into the City of LA owned culvert at a rate of approximately 40 cfs, once the pumps have been upgraded. There is also a sump pump that is allocated to slowly drain the storage room with the rate of 1.1 cfs from the low water level to the sump level after a storm is over. Scenario 1 proposes a gravity diversion structure sized to divert a portion of the flow from the bottom of the existing pump outfall junction structure into a proposed underground infiltration basin and scenario 2 proposes upgrading the existing sump pump to pump stormwater runoff directly from the existing wet well into the proposed underground infiltration basin.

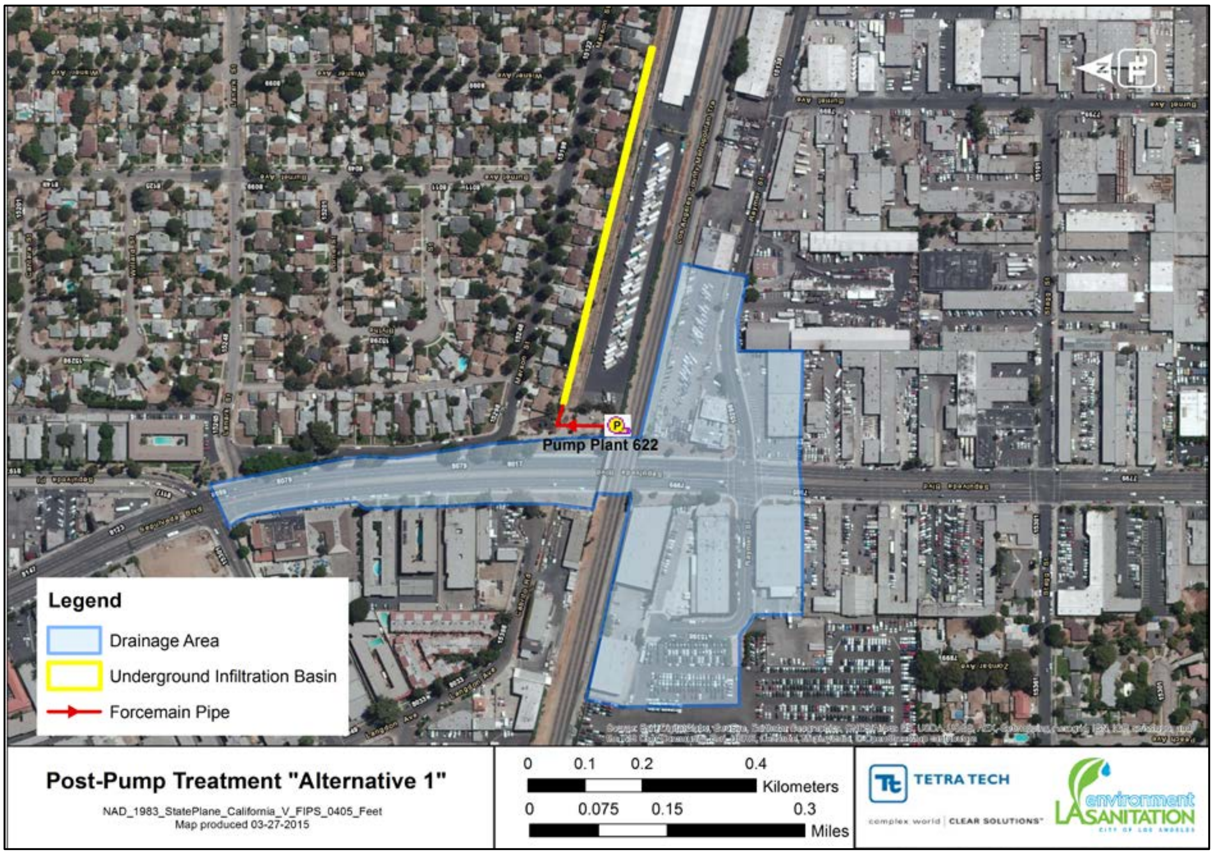

Figure 6. Alternative 1 potential BMP location.

Alternative 1-Scenario 1: Under this Scenario, it is assumed that the wet weather runoff would be pumped out at a rate of 40 cfs, once the pumps have been upgraded, from the storage room and discharge to the existing pump outfall junction structure. The existing structure would be retrofit with a gravity diversion weir capable of diverting flow at a maximum diversion rate of 20 cfs (half of the pumping rate and half of the approximate peak flow rate for 50-year storm design) from the bottom of the existing pump outfall junction structure into the proposed underground infiltration basin through the proposed 36-inch outlet pipe (Figure 7). The rest of the flows that are higher than the diversion capacity will drain to the existing 36-inch storm drain that discharges to a double box culvert resulting in approximately half of the flow reaching the pump plant being diverted into the BMP.

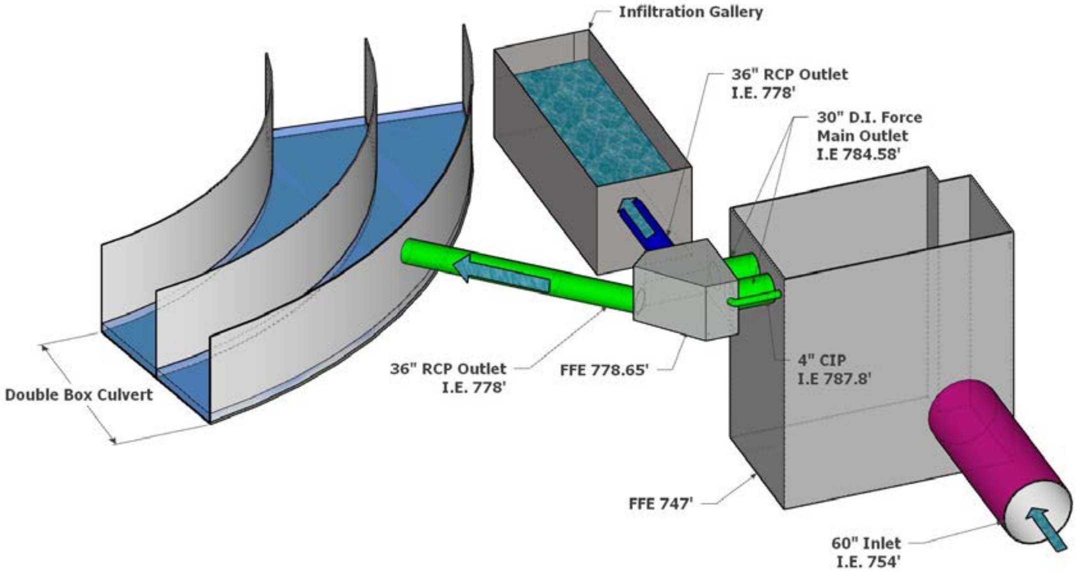

Figure 7. Weir-based Gravity Diversion System for Alternative 1-Scenario 1.

Alternative 1-Scenario 2: In this scenario, the wet weather runoff from the existing storage room would be pumped out at a constant rate of 2.5 cfs. To achieve this flow would require that the existing sump pump be upgraded to allow pumping of the peak flow rate for the 85th percentile storm design. A 4-inch outlet pipe would be connected to the existing 4 inch pipe and routed through the top of the existing pump outfall junction structure to divert the water from the sump pump to the proposed infiltration gallery Treatment of the 85th-percentile runoff volume would constitute compliance with all water quality requirements for the tributary drainage area (based on current interpretation of the MS4 Permit, as discussed in the EWMPs). This flow would be pumped into a underground infiltration basin underneath of W Cabrito Road on the east side of Sepulveda Blvd similar to the one proposed in scenario 1 (Figure 8). Utilizing the sump pump to pump runoff to the underground infiltration basin not only can significantly improve water quality but also, could greatly reduce the need for the main pumps to turn on during small storm events and decrease the operation time considerably during larger storm events.

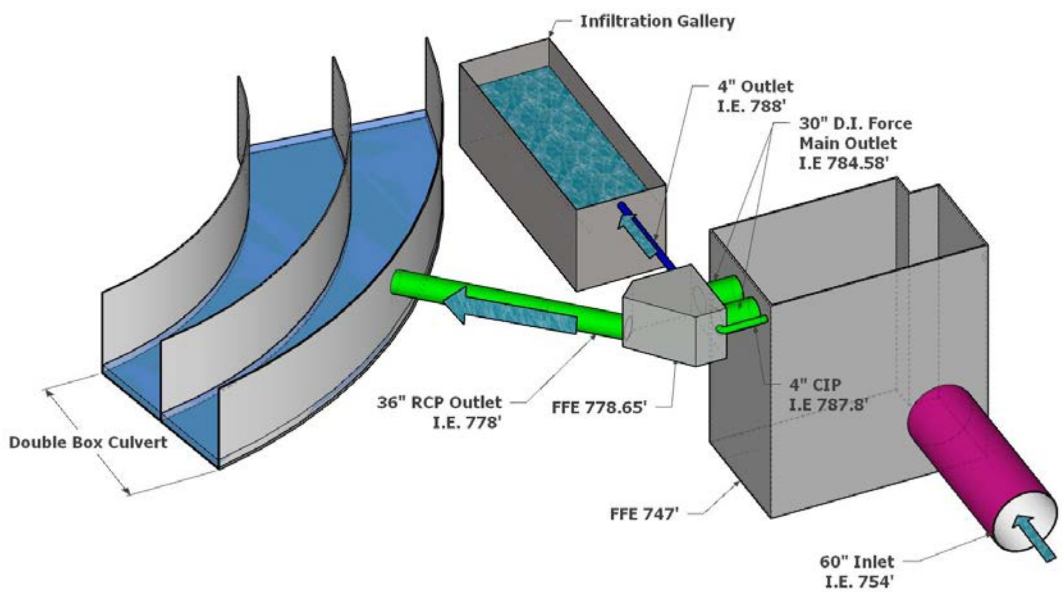

Figure 8. Direct Pumping System for Alternative 1-Scenario 2.

Alternative 2, referred to as "**Pre-Pump Treatment**", is intended to treat the wet weather runoff from a 12.7-acre drainage area through permeable pavement and bioretention areas implemented within the bicycle lane and the right-of-way of Sepulveda Boulevard (Figure 9) prior to its arrival at the pump plant. To treat this runoff, bioretention areas could be implemented along the east side of Sepulveda Blvd. and along the outside edge of a newly created bicycle lane on the west side of Sepulveda Blvd. Overflow from bioretention and additional runoff should be treated in permeable pavement implemented within the newly created bicycle lane on the West side of Sepulveda Boulevard.

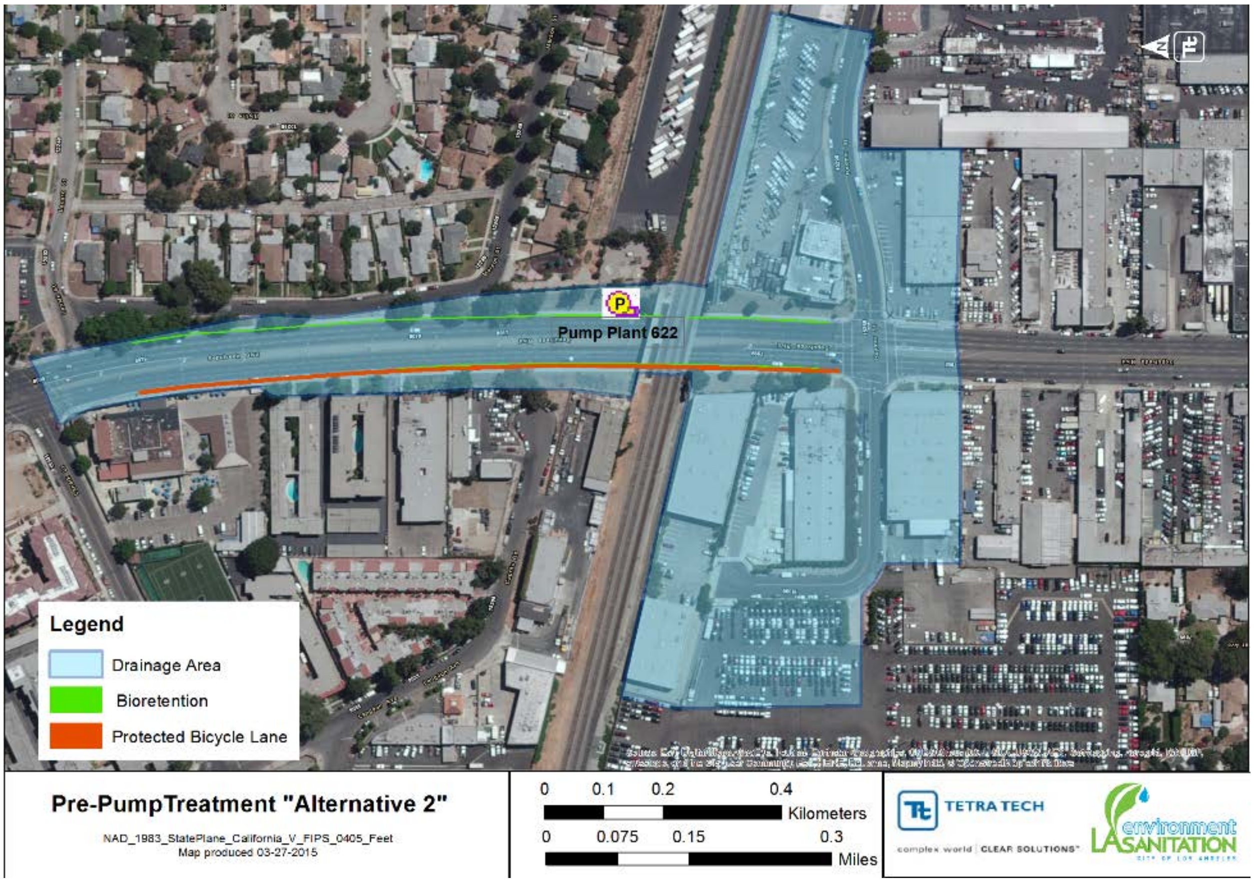

Figure 9. Alternative 2 recommended areas for BMP implementation.

Table 3 presents a comparison of the configuration of each alternative. Details for the sizing and evaluation of each alternative is presented in Section 3.5

Table 3. Comparison of Alternatives.

Alternative	Scenario	Sump Pump Flow Rate (cfs)	Diversion Rate (cfs)	BMP Area (ac)			Annual Volumetric Treatment (ft^3)
				Bioretention	Permeable Pavement	Underground Infiltration Basin	
Post-Pump Treatment	1	N/A	20	N/A	N/A	0.17	216,839
	2	2.5	N/A	N/A	N/A	0.17	302,604
Pre-Pump Treatment	N/A	N/A	N/A	0.12	0.19	N/A	310,157

4.1. BMP Sizing and Evaluation

The entire drainage area primarily encompasses industrial and secondary roadway land uses, and contains approximately 90 percent impervious surface. Table 4 and Table 5 illustrate the predominant soil texture and the land use types within SWS 685149. The details of the two proposed alternatives are outlined below.

Table 4. SWS 685149 soils summary.

Soil Series	Infiltration Rate (in/hr) (Source: USDA)	Hydrologic Soil Group (Source: USDA/ LA Soils GIS Layer)	Percentage of Watershed
Yolo loam	0.57 to 1.98	A/B	100%

Table 5. SWS 685149 distribution of land use types.

Landuse type	Acres	Percent
High Density Single Family Residential	0.03	0.2%
Multi-family Residential	0.02	0.2%
Commercial	0.15	1.2%
Institutional	0.03	0.2%
Industrial	7.31	57.6%
Secondary Roads	5.14	40.6%
Total	**12.7**	**100**%

4.1.1. Wet Weather Flow

Wet weather flow can vary significantly from storm to storm and from year to year. To analyze the proposed system and determine the potential inflow, a 10-year continuous simulation period from January 1, 2002 to December 31, 2011 was used. Hourly wet weather runoff time series for each contributing land use were obtained from the calibrated Watershed Management Modeling System (WMMS; Tetra Tech 2010a and Tetra Tech 2010b).

4.1.2. Existing Pollutant Loading Assessment

According to the ULAR EWMP, for the Sepulveda Boulevard study area, zinc is found to be the limiting pollutant among metals and bacteria, and the initial EWMP suggested that a 34% reduction of zinc throughout the Los Angeles River Reach 4 watershed would be necessary for final compliance. Therefore for this study area, zinc was used as the basis for removal comparison. The zinc load entering the storm drain varies depending on the size of the storm and the number of dry days between storms. A 10-year continuous simulation period from January 1, 2002 to December 31, 2011 was used to analyze the zinc removal and water quality improvement. The long-term time series for zinc load across the watershed was obtained from the calibrated WMMS at an hourly time step (Tetra Tech 2010a and Tetra Tech 2010b). Other pollutants including copper, lead, nitrogen, phosphorous, and pathogens, long-term time series from the calibrated WMMS were used to analyze the comprehensive water quality benefits for the recommended alternative.

4.1.3. Geotechnical Literature Review

A geotechnical literature review was performed to identify potential geologic or subsurface issues that could affect BMP implementation or configuration. According to the City of LA Bureau of Standards soil report adjacent to the pump plant 622, the first 10.5 feet of the site soils consist of brown fine to medium-grained poorly graded sand (SP) with a trace of clay fines. Below that layer, there is 2.5 feet of brown clayey sand (SC) following by 2 feet of brownish tan fine to medium-grained poorly graded sand with some clay fines (SP). No water table is detected up to the depth of 15 feet from the surface. Based on the United State Department of Agriculture (USDA) sandy soil has a moderate water storage capacity of about 8.3 inches which indicates the maximum amount of plant available water a soil can provide. This is an important factor which supports plant growth and soil biological activity. The infiltration rates of the sandy soils can vary from 0.5 inches per hour to 1 inches per hour. Soil borings from the area around the pump plant are include in Appendix F.

This review was limited to existing data and should be supplemented with a full, site-specific geotechnical and seismic investigation prior to preliminary designs. Infiltration rates and other subsurface conditions must be verified to ensure project success and public safety.

4.1.4. BMP Optimization and Performance

To optimize the size of the proposed BMPs, a range of possible BMPs sizes for both alternatives were modeled in the EPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) using the 10-year, continuous simulation data to measure the overall impact on the water quality. SUSTAIN was developed by the EPA Office of Research and Development to facilitate selection and placement of BMPs and green infrastructure techniques at strategic locations in urban watersheds. It assists to develop, evaluate, and select optimal BMP combinations at various watershed scales on the basis of cost and effectiveness. In this study, the BMP's effectiveness was measured by its ability to remove total zinc. Total zinc was determined to be the limiting pollutant, indicating that if total zinc is controlled, other pollutants would have similar or greater removal rates.

In addition, identifying appropriate numeric targets is necessary to evaluate and optimize performance of the stormwater facilities. One common hydrologic criterion for integrated water quality, flow reduction, and resources management is retention of the runoff volume generated by the 85th percentile storm event. At the study area, the 85th percentile storm event depth is 0.94 inch, according to the Los Angeles County isohyetal map. As a result, an additional analysis was performed to identify the size required to capture and treat the 85th percentile, 24-hour design storm event. The 10-year continuous time period (from 2002 to 2011) was then modeled through the identified BMP size to measure the overall, long-term expected water quality impacts. Three sets of analyses were performed for different solutions including Alternative 1"Post-Pump Treatment" (Scenario 1, and 2) and Alternative 2 "Pre-Pump Treatment".

Figure 10 shows the 85th percentile 24-hour hydrograph for the drainage area (12.7 acres), derived from the HydroCalc (Version 0.3.0 beta). The peak flow for the 85th percentile storm for the 12.7-acre study area was calculated to be 2.3 cfs, as illustrated in Figure 10.

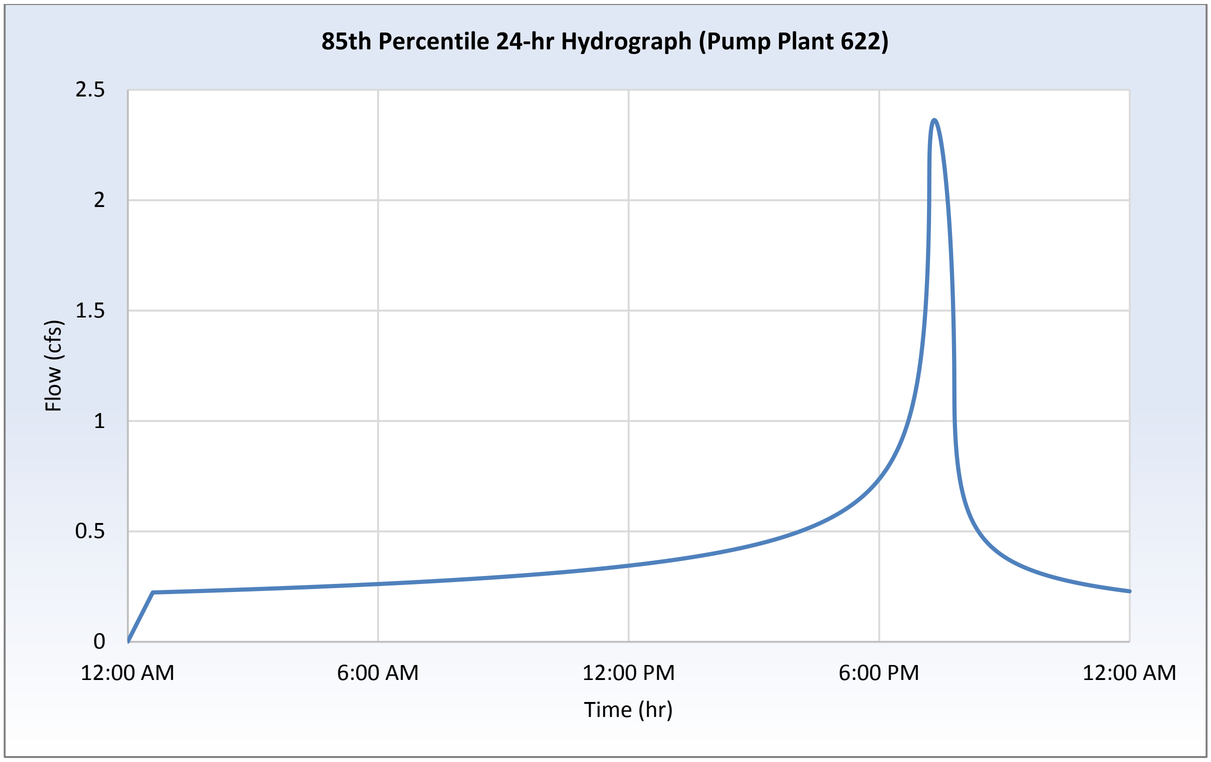

Figure 10. 85th Percentile 24-Hour Hydrograph for the 12.7- acre drainage area with 0.94 inch Rainfall Depth.

For alternative 1, scenario 1 it is assumed that the main pumps cycle on when the wet well reaches a certain level. At that point, all of the volume in the wet well is pumped out at a rate of 40 cfs. This pumping scheme results in the pump cycling on and off multiple times throughout the duration of the storm event. It may not be feasible to assume that all of the 40 cfs flow can be diverted into a BMP. For the purpose of this analysis it was assume that a portion of the flow is diverted to the BMP at a diversion rate of 20 cfs. This would result in approximately half of the volume that reaches the pumping plant being diverted into the BMP. For comparison purposes, a BMP capable of treating the volume of runoff produced by the 85th percentile storm was evaluated for both scenario 1 and scenario 2. A BMP foot print of 7,600 ft^2 with a capacity of approximately 30,400 ft^3 would provide a 37% reduction in volume (Figure 11) and a 44% reduction in zinc (Figure 12).

For alternative 1, scenario 2, the smaller sump pump would be utilized to pump all of the flow entering the pump plant at a rate of 2.5 cfs or less. This pump would operate throughout the duration of the storm providing a more consistent flow into the BMP, ultimately diverting a higher volume than in scenario 1 despite the much lower flow rate. Diverting flow into a similar sized BMP would results in a 52 percent reduction in volume (Figure 11) and a 61 percent reduction in zinc (Figure 12).

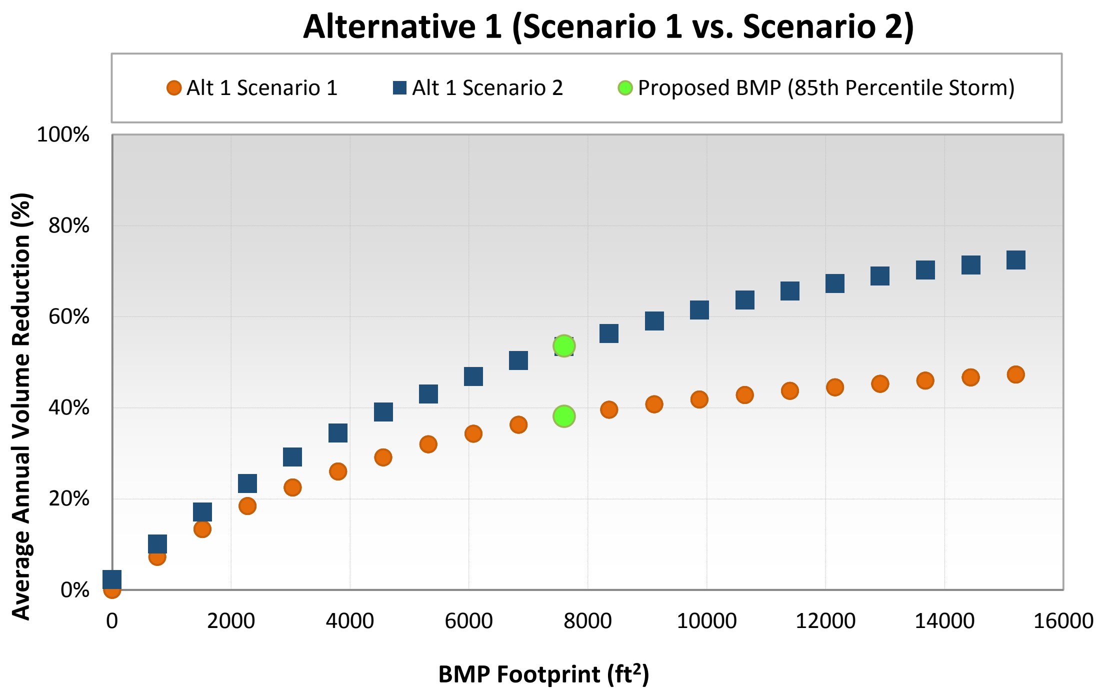

Figure 11. Comparison of 20 cfs diversion versus 2.5 cfs direct pumping for Alternative 1 (Post-Pump Treatment).

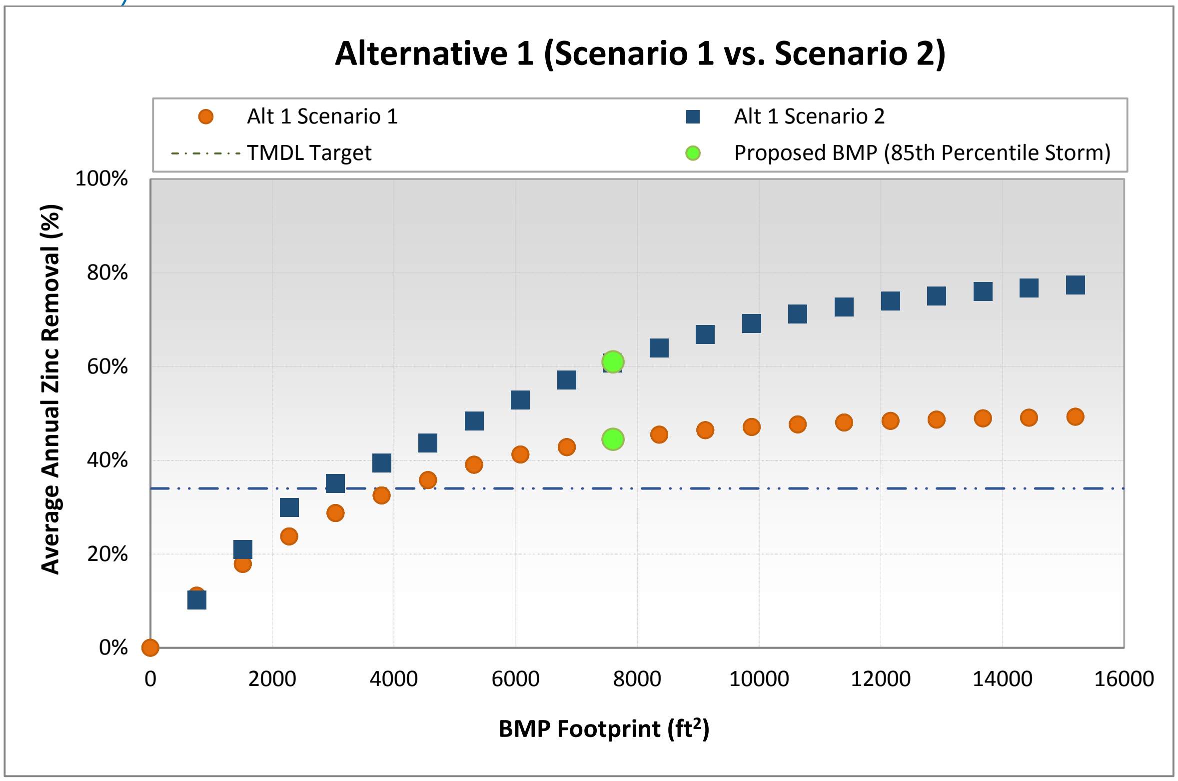

Figure 12. Comparison of water quality benefit for scenario 1 and scenario 2 (Post-Pump Treatment).

Upgrading the sump pump, while requiring some extra cost, will provide a higher level of treatment efficiency in the system (see Section 8 pump plant upgrade cost estimates).

For alternative 2 the BMPs opportunities would be implemented along Sepulveda Boulevard to treat wet weather runoff from a 12.7-acre drainage before reaching the Pumping Plant. The 10-year continuous time period (from 2002 to 2011) is modeled to generate the cost-effectiveness curve and measure the overall, long-term expected water quality impacts (Figure 13 and Figure 14). Relative cost is presented in Figure 13 and Figure 14 (instead of BMP footprints like those shown in Figure 11 and Figure 12) because a combination of multiple BMPs were modeled. The result of the analysis showed that the combination of permeable pavement and bioretention with the sizes of 8,400 and 5,000 square feet and retention volumes of 12,600 and 14,465 cubic feet respectively provide the capacity to treat the 85th percentile storm event. The respective BMPs sizes would result in 53 percent flow volume removal and 54 percent zinc.

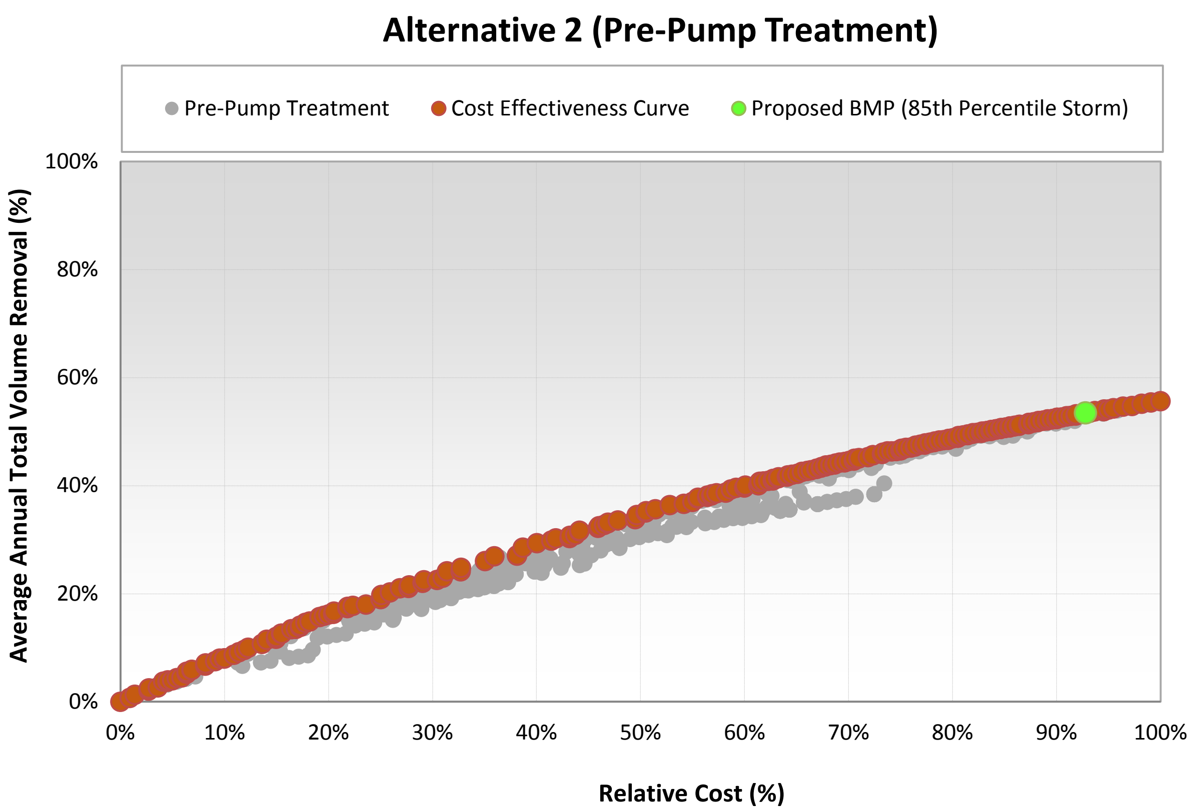

Figure 13. Relative Cost vs Average Annual Total Volume reduction.

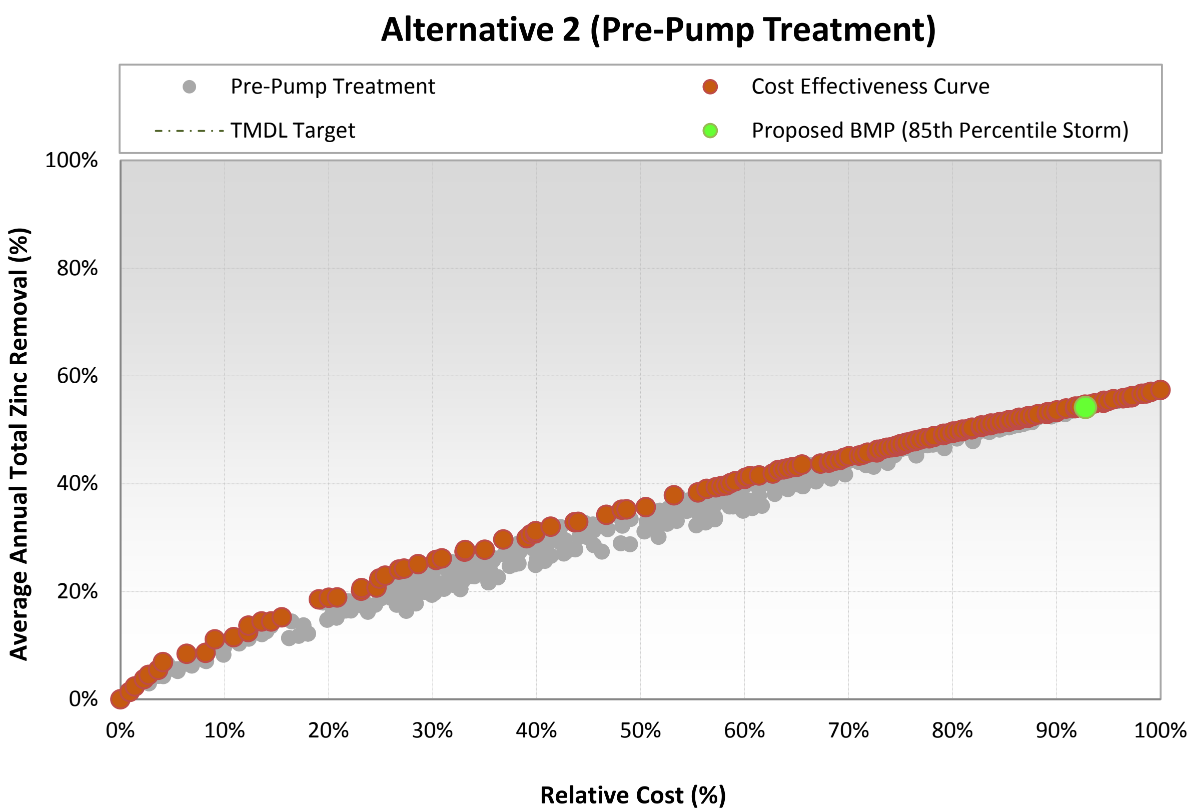

Figure 14. Relative Cost vs Average Annual Total Zinc Reduction.

4.1.5. Treatment Alternative Comparison and Conclusions

Based on the comparison of the two alternatives presented in Table 6, Alternative-1-Scenario 1 (20 cfs gravity diversion) will provide the reasonable volume and associated pollutant load reduction however, that benefit comes at a cost. The high construction cost associated with Alternative 1-Senario 1 is due to the deep excavation required for the gravity diversion of the flow to the underground infiltration basin (See Section 5).

Table 6. Average annual expected pollutant reductions and cost.

Constituent	Average annual loads	Average annual reduction					
		Post-Pump Treatment				Pre-Pump Treatment	
		Scenario 1		Scenario 2		Alternative 2	
	Pre-BMP	Reduction	Percentage	Reduction	Percentage	Reduction	Percentage
Volume, (ft^3)	579,619	216,839	37%	30,2604	52%	310,157	54%
TSS, (lbs)	2471	1090	44%	1490	60%	1316	53%
TN,(lbs)	72.4	28.3	39%	39.7	55%	39.0	54%
TP, (lbs)	42.7	16.7	39%	23.4	55%	22.9	54%
Copper, (lbs)	0.7	0.3	45%	0.4	61%	0.4	55%
Lead, (lbs)	0.6	0.3	45%	0.4	62%	0.3	57%
Zinc, (lbs)	7.6	3.4	44%	4.6	61%	4.1	54%
Fecal counts	3.8E+11	1.5E+11	40%	2.2E+11	57%	2.1E+11	54%
Cost		$1,287,340		$1,079,200		$944,940	

Implementing Alternative 1, scenario 1 will require the least impact to the existing function and performance of the pump plant but also has the lowest performance for stormwater treatment. The excavation cost of this scenario for the BMP implementation is also more costly because of the depth of excavation required to divert flows from the pump plant by gravity. Alternative 1, scenario 2 will require a small upgrade to the current pump plant configuration to provide a larger sump pump. This cost will be offset by the cost saving from excavation since the BMP can be implemented closer to the surface and flow would be pumped out. This scenario also provides some resiliency for the large and more costly main pumps. By using the sump pump to divert flows to the BMP, the main pumps will not have to operate as often. Among all solutions, Alternative 2 is recommended since it requires no alteration to the current sump pump configuration. This alternative provides maximum resiliency for the main pumps. Treating the volume produced by the 85^{th} percentile storm before entering the pump plant significantly reduces the amount of time that the main pumps have to operate, approximately 70%, reducing the strain on the pumps and the required maintenance to make sure the pumps remain operational.

5. BMP Conceptual Layout, Design, and Performance Specifications

5.1. Post Pumping Alternative 1

The recommended BMP for alternative 1 is an underground infiltration basin. An infiltration basin is typically an excavated area containing amended soils functions like a bioretention area but is implemented at a larger scale. Infiltration basins can be designed as surface or subsurface units allowing for implementation around paved streets, parking lots, and buildings to provide initial stormwater detention and treatment of runoff. Such applications offer an ideal opportunity to minimize directly connected impervious areas in highly urbanized areas. In addition to stormwater management benefits, surface infiltration galleries provide green space and improve natural aesthetics in urban environments (Figure 15).

Figure 15. Subsurface Infiltration Gallery. (Source: www.oldcastlestormwater.com)

Typically, runoff percolates through the bottom of the gallery and an approximately 1-foot amended, tilled native soil layer, which has an infiltration rate capable of draining the infiltration gallery within a specified design drawdown time (usually up to 72 hours). After the stormwater infiltrates through the amended surface, it percolates into the subsoil, if site conditions allow for adequate infiltration and slope protection. If site conditions do not allow for adequate infiltration or slope protection, filtered water is directed toward a stormwater conveyance system or other stormwater runoff BMP via underdrain pipes. Observation ports and cleanouts should be included at the inlet of the infiltration gallery and along the length of the system to allow maintenance access and observation of any potential sediment accumulation. Infiltration galleries can be designed to help meet hydromodification criteria and also for conveyance of higher flows.

There are multiple systems available designed to provide storage for underground systems. Most systems are intended to provide void space; however, some systems provide greater void space than others. One product that provides adequate voice space is the StormTrap system (Figure 16).

Source: www.stormtrap.com Source: City of Los Angeles

Figure 16. Typicall StormTrap System.

5.1.1. Scenario 1

Because of the elevation of the diversion structure, the surface of the infiltration basin will be at approximately 778 feet (approximately 12 feet below ground surface). This will required a significant amount of excavation. Figure 17 shows the relative configuration of the pump station, the diversion, and the underground infiltration basin.

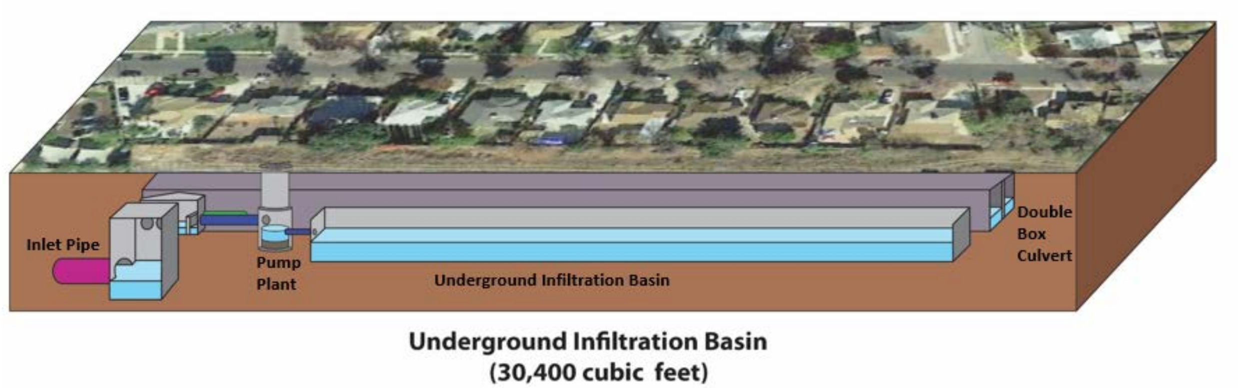

Figure 17. BMP configuration for Alternative 1, scenario 1.

5.1.2. Scenario 2

Utilizing the sump pump to divert flow into the BMP will allow some flexibility in the configuration and depth of the BMP allowing the underground infiltration basin to be close to the surface (approximately two feet below ground surface). Figure 18 shows the relative configuration of the diversion and underground infiltration basin.

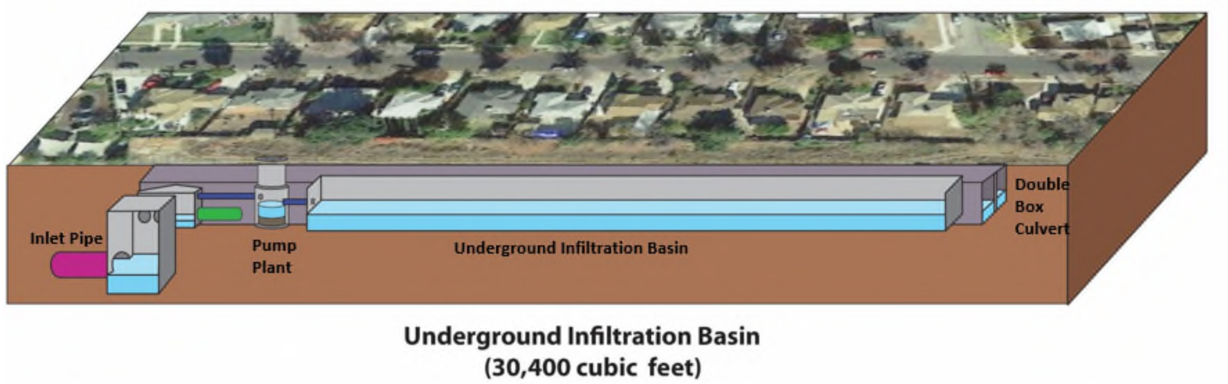

Figure 18. BMP configuration for Alternative 1, scenario 2.

For both scenarios observation ports and cleanouts are recommended for the purpose of maintenance.

5.2. Pre-Pumping Alternative 2

For alternative 2, the conceptual configuration of the BMPs providing the optimum level of treatment is intended to divert and treat water flowing from the street and surrounding parcels. Sepulveda Boulevard is designated as a Major Highway – Class II with a required right of way width of 104 feet (details of original street design in Bureau of Engineering "D" plans, D-21701, is provided in Appendix D). Bike lanes are proposed for this section in the 2010 Bicycle Plan (LDCP 2010). BMPs proposed are intended to fit within the typical widths for the designation and the proposed bike lanes and should be coordinated with proposed plans for the area. Runoff from Sepulveda Boulevard should be treated in bioretention areas in accordance with LA Standard Plan S-481 on the east side of Sepulveda Boulevard. The depth of engineered soil layer, storage layer and ponding zone of the bioretention cells should be 2', 2'-9", and 2'-6" respectively. The west side of Sepulveda Blvd. will have a newly constructed protected bicycle lane, in which bioretention will be placed along the outside edge of the lane serving as protection, and permeable pavement will be the foundation of the bicycle lane. The depth of paving surface, and storage layer of the permeable pavement should be 1", and 2'-9" respectively. Current Sepulveda Blvd. conditions are shown in Figure 19. Example BMP configurations are shown in Figure 20 and Figure 21.

Figure 19. Existing Sepulveda Boulevard conditions.

Figure 20. Conceptual rendering showing protected bike lane with permeable pavement and bioretention (Note: BMPs are not recommended in the median. Vegetation in the median is a component of the Great Streets Initiative referenced in Section 4.).

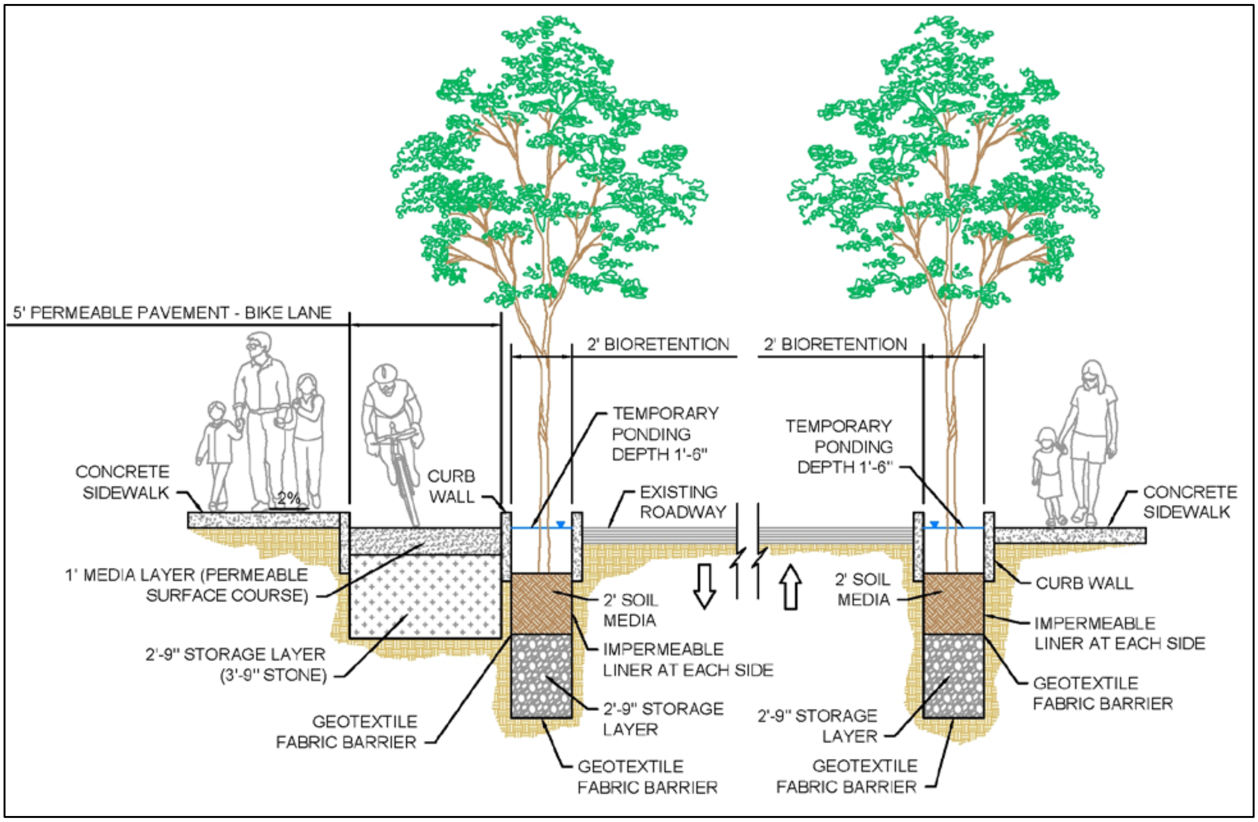

Figure 21. Expected cross section for Alternative 2.

The BMPs recommended in the Alternative 2 Pre Pumping should be designed to meet the following specifications and should comply with LA Standard Plan S-480 (Green Streets):

- Bioretention Areas
  - Ponding depth should be maintained at a minimum of 18 inches.
  - Infiltration rate in existing soils should be a minimum of 0.5 in/hr.
  - If the infiltration rate is less than 0.5 in/hr or if the site is located adjacent to a building foundation or in a liquefaction zone, underdrains and an engineered soil media should be installed. Bioretention soil media should have a minimum depth of 5 feet and should meet the following criteria:
    - Soil media consists of 85 percent washed course sand, 10 percent fines (range: 8–12 percent, and 5 percent organic matter. The expected infiltration rate should range from 0.57 to 1.98 in/hr.
    - The sand portion should consist of concrete sand (passing a one-quarter-inch sieve). Mortar sand (passing a one-eighth-inch sieve) is acceptable as long as it is thoroughly washed to remove the fines.
    - Fines should pass a # 270 (screen size) sieve.

    - Soil media must have an appropriate amount of organic material to support plant growth. Organic matter is considered an additive to help vegetation establish and contributes to sorption of pollutants but should generally be minimized (5 percent). Organic materials will oxidize over time, causing an increase in ponding that could adversely affect the performance of the bioretention area. Organic material should consist of aged bark fines, or similar organic material. Organic material should not consist of manure or animal compost. Newspaper mulch has been shown to be an acceptable additive.
    - pH should be between 6–8, cation exchange capacity (CEC) should be greater than 5 milliequivalent (meq)/100 g soil.
    - High levels of phosphorus in the media have been identified as the main cause of bioretention areas exporting nutrients. All bioretention media should be analyzed for background levels of nutrients. Total phosphorus should not exceed 15 ppm.
  - Bioretention areas should be lined on the sides with a 30 mil liner to protect the surrounding infrastructure.
  - PVC liners used for the lining of bioretention should meet the requirements of ASTM D-7176. The PVC liner should resist ultraviolet and shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45 degrees Fahrenheit without application of heat. A suitable geotextile fabric shall be placed on the top and bottom of the membrane for puncture protection.
  - A minimum 5 feet of redial clearance between the BMP and any light pole or utility must be provided
  - A minimum of 48 inches wide sidewalk access must be included at each end of the BMPs from the sidewalk to the street curb.
  - All geotextile shall comply with the following:

Property	Test Reference	Media Barrier
Grab Strength, lbs (N), Min.	ASTM D-4632	90 (400)
Elongation, Minimum (at peak load) %, Max.	ASTM D-4632	50
Puncture Strength, lbs (N), Min.	ASTM D-3787	65 (290)
Permittivity, Sec., Min.	ASTM D-4491	2.5
Burst Strength, psi (kPa), Min.	ASTM D-3786	225 (1550)
Toughness, lbs (N), Min.	% Elongation x Grab Strength	5500 (24500)
Ultraviolet Resistance % Strength Retained @ 500 Weatherometer Hours	ASTM D-D4355	70
Apparent Opening Size, US Sieve # (mm)	ASTM D-4751	70 (0.210)
Flow Rate, Gal/min/ft^2 (L/min/m^2)	ASTM D-4491	175 (7130)
Trapezoid Tear, lbs (N)	ASTM D-4533	45 (200)

- Permeable Pavement
  - Bedding material should be a 1- to 2-inch layer of washed no. 8 or 9 stone. It must be completely free of fines.
  - The structural layer below the permeable pavement must have a porosity of 40 percent and should extend to a depth of 3.75 feet below the paver surface. A washed no. 57 stone at a depth of at least 6 inches is recommended as a choker course overlaying no. 2 stone.
  - Installation must have a slope of less than 0.5 percent unless internal check dams are incorporated.

- Permeable pavement should be lined on the sides with a 30 mil liner to protect the surrounding infrastructure. If geotechnical analyses suggest that infiltration should be restricted, the entire system should be lined and an underdrain installed.
- PVC liners used for the lining of permeable pavement should meet the requirements of ASTM D-7176. The PVC liner should resist ultraviolet and shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45 degrees Fahrenheit without application of heat. A suitable geotextile fabric shall be placed on the top and bottom of the membrane for puncture protection.

5.2.1. Design Details and Drawing

A photo log, conceptual plans, and cross-sectional details are provided in Appendix A. Example product details along with a list of certified professionals qualified to install pervious concrete and concrete pavers is included in Appendix E.

6. Plant Selection

For the BMPs to function properly for stormwater treatment and blend into the landscape, vegetation selection is crucial. Appropriate vegetation will have the following characteristics:

1. Plant materials must be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 10 to 48 hours.
2. It is recommended that a minimum of three shrubs and three herbaceous groundcover species be incorporated to protect against facility failure from disease and insect infestations of a single species. To match current site landscaping, only one tree has been recommended.
3. Native plant species or hardy cultivars that are not invasive and do not require chemical inputs are recommended to be used to the maximum extent practicable.

A selection of recommended plant species, along with additional details including the recommended landscape position, size at maturity and light requirements, is provided in Table 7 based on the City of Los Angeles' Urban Forestry Division Street Tree Selection Guide (City of Los Angeles Urban Forestry Division 2011) and landscape architect recommendations. Existing trees at the site include Metrosideros tomentosa, Pinus canariensis, and Fraxinus uhdei.

Table 7. Recommended plant list

Trees		Los Angeles native - LA California native - CA Nonnative– X	Landscape position: 1 - Low[a], 2 - Mid[b], 3 - High[c]	Mature size (height x width)	Irrigation demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light requirements Sun - SU ▪ Shade - SH Part Shade - PS Sun or Shade - SS	Season Evergreen - E, Deciduous - D Semi-Evergreen – SE
***Cercisoccidentalis*[d]**	**Western redbud**	**LA**	**1**	**10-18' x 10-18'**	**M**	**SU, PS**	**D**
***Chilopsislinearis*[d]**	**Desert willow**	**LA**	**1**	**15-30' x 10-20'**	**L-M**	**SU**	**D**
Umbellulariacalifornica	California bay	LA	1	20-25' x 20-25'	L-H	SU, PS, SH	E
Shrubs							
Baccharispilularis 'Pigeon Point'	Dwarf coyote bush	LA	3	1-2' x 6'	L-M	SU	E
Rhamnuscalifornica 'Little Sur'	Dwarf California coffeeberry	LA	2	3-4' x 3'	N-M	SU, PS	E
Heteromelesarbutifolia	Toyon	LA	3	6-10' x 6-10'	M	SU, PS	E
***Baccharissalicifolia*[d]**	**Mulefat**	**LA**	**1**	**4-10'x8'**	**M-H**	**SU, PS, SH**	**SE**
***Rosa californica*[d]**	**California rose**	**LA**	**1**	**3-6' x 6'**	**M-H**	**SU, PS, SH**	**SE**
Grasses and grass-like plants							
***Elymusglaucus*[d]**	**Blue wild rye**	**LA**	**1**	**2-4' x 5'**	**L-M**	**SU, PS**	**SE**
***Muhlenbergiarigens*[d]**	**Deer grass**	**LA**	**1**	**2-4' x 3-4'**	**L**	**SU**	**E**
***Juncuspatens*[d]**	**California gray rush**	**CA**	**1**	**2' x 2'**	**L-H**	**SU, PS**	**E**

Notes

The Landscape position is the lowest area recommended for each species. Plants in areas 1 and 2 might also be appropriate for higher locations. When specifying plants, availability should be confirmed by local nurseries. Some species might need to be contract-grown, and it might be necessary for the contractor to contact the nursery well before planting because some species might not be available on short notice.

[a]Landscape Position 1 (Low): These areas experience seasonal flooding. Seasonal flooding for bioretention areas is typically 9 inches deep, for up to 72 hours (the design infiltration period for a bioretention area). If parts of the bioretention area are to be inundated for longer durations or greater depth, the designer should develop a plant palette with longer term flooding in mind. Several of the species listed as tolerant of seasonal flooding might be appropriate, but the acceptability of each species considered should be researched and evaluated case by case.

[b]Landscape Position 2 (Mid): These areas are low but are not expected to flood. However, they are likely to have saturated soils for extended periods.

[c]Landscape Position 3 (High): These areas are generally on well-drained slopes adjacent to stormwater BMPs. Soils typically dry out between storm events.

[d]**Bolded species** have been observed in the city and are known to be suitable for the recommended landscape position.

7. Green Infrastructure Operations and Maintenance

Maintenance of stormwater BMPs should be incorporated into existing routine maintenance activities. Permeable pavement should be swept during the existing monthly street sweeping schedule and City of LA Bureau of Street Services maintenance personnel should be trained to maintain stormwater BMPs located in the public right-of-way. Maintenance activities for the BMPs should be focused on the major system components, especially landscaped areas. Landscaped components should blend over time through plant and root growth, organic decomposition, and they should develop a natural soil horizon. The biological and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Irrigation might be needed, especially during plant establishment or in periods of extended drought. Irrigation frequency will depend on the season and type of vegetation. Drought tolerant plants require less irrigation than other plants.

Table 8, Table 9, and Table 10 outline the required maintenance tasks, their associated frequency, and notes to expand on the requirements of each task based on recommendations from researchers in the green infrastructure field.

Table 8. Inspection and maintenance tasks for underground infiltration basins.

Task	Frequency	Maintenance Notes
Dry season inspection	One time per year	Inspect once during the dry season to ensure volume capacity. Clean if required.
Wet season inspection	Monthly during wet season	Monthly during the wet season to ensure volume capacity. Inspect and confirm level of silt and sediment.
Vault cleaning	Dry season – 1 time Wet season – 1 times	Dry season cleaning to happen just before the start of the wet season.
Valve maintenance	As needed	

Table 9. Bioretention operations and maintenance considerations.

Task	Frequency	Maintenance notes
Monitor infiltration and drainage	1 time/year	Inspect drainage time (12–24 hours). Might have to determine the infiltration rate (every 2–3 years). Turning over or replacing the media (top 2–3 inches) might be necessary to improve infiltration (at least 0.5 in/hr).
Pruning	1 time/year	Nutrients in runoff often cause bioretention vegetation to flourish.
Mulching	1 time/year	Recommend maintaining 1-inch to 3-inch uniform mulch layer.
Mulch removal	1 time/3–4 years	Biodegraded mulch accumulation reduces available water storage volume. Removal of mulch also increases surface infiltration rate of fill soil.
Watering	1 time/2–3 days for first 1–2 months; sporadically after establishment	If drought conditions exist, watering after the initial year might be required.
Soil amendments	1 time initially	One-time spot soil amendments for first year vegetation.
Remove and replace dead plants	1 time/year	It is common for 10% of plants to die during first year. Survival rates tend to increase with time.
Inlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow into the retention area is as designed. Remove any accumulated sediment.
Outlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for erosion at the outlet and remove any accumulated mulch or sediment.
Miscellaneous upkeep	2 times/year	Tasks include trash collection, plant health, spot weeding, and removing mulch from the overflow device.

Table 10. Permeable pavement operations and maintenance considerations.

Task	Frequency	Maintenance notes
Impervious to pervious interface	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow onto the permeable pavement is not restricted. Remove any accumulated sediment. Stabilize any exposed soil.
Street sweeping	Weekly during routine mechanical sweeping and twice a year with vacuum sweeper (or as needed)	Portions of pavement should be swept with a vacuum street sweeper at least twice per year or as needed to maintain infiltration rates.
Replace void fill materials (applies to pervious pavers only)	1-2 times per year (and after any vacuum truck sweeping)	Fill materials will need to be replaced after each sweeping and as needed to keep interstitial bedding material even with the paver surface.
Miscellaneous upkeep	4 times per year or as needed for aesthetics	Tasks include trash collection, sweeping, and spot weeding. Ensure landscaping materials (soil, mulch, grass clippings, etc.) are not stockpiled on permeable pavement surfaces.

8.Cost Estimate

The estimated cost of the pump station upgrades are included in Table 11 and the costs of implementing each of the alternative described above are included in Table 12, Table 13, and Table 14. This cost estimate is a guide only and should be updated at the time of preliminary design to account for fluctuation in cost of material, labor, or components, or unforeseen contingencies.

Table 11. Pump plant upgrade costs.

Item No.	Description	Estimated Qty	Unit	Unit Cost	Total
1	Mobilization and Demobilization	1	LS	$145,000	$145,000
2	Demolition/Removal of Existing Pumps and Discharge Piping	1	LS	$30,000.00	$30,000
3	Furnish and Install 1,200 GPM Submersible Pump	1	EA	$60,000.00	$60,000
4	Furnish and Install 17,900 GPM Vertical Turbine Solids Handling Pump	2	EA	$300,000.00	$600,000
5	Furnish and Install 4-inch Outlet Piping	1	LS	$7,500.00	$7,500
6	Furnish and Install 30-inch Outlet Piping	1	LS	$15,000.00	$15,000
7	Replace Chain-Link Fencing Around Site	350	LF	$20.00	$7,000
8	Replace Damaged Bar Screens	1	LS	$10,000.00	$10,000
9	Upgrade Railing and Ladders	1	LS	$10,000.00	$10,000
10	Replace Damaged Louver in Motor Room	1	LS	$1,000.00	$1,000
11	Sand Blast and Paint the Interior and Exterior of the Building	1	LS	$30,000.00	$30,000
12	Replace the Ventilation System	1	LS	$30,000.00	$30,000
13	Upgrade the Interior and Exterior Lighting	1	LS	$10,000.00	$10,000
14	Furnish and Install 250 KW Natural Gas Generator, Tier 4F	1	LS	$400,000.00	$400,000
15	Furnish and Install MCC	1	LS	$175,000.00	$175,000
16	Furnish and Install SCADA/I&C	1	LS	$60,000.00	$60,000
Subtotal Cost					**$1,590,500**
17	Construction contingency (25% of subtotal)				$400,000
Total Cost					**$1,990,500**

Table 12. Alternative 1 scenario 1: Post-Pump Treatment 20 cfs Gravity Diversion cost estimate.

Item No	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Temporary Construction Fence	1,916	LF	$2.50	$4,790
2	Silt Fence	1,916	LF	$3.00	$5,748
	Site Preparation				
3	Excavation and Removal	3,941	CY	$45.00	$177,332
	Structures				
4	Structural Layer (washed no 57 or no 2 stone)	281	CY	$50.00	$14,050
5	Utility Conflicts	1	LS	$10,000.00	$10,000
6	Connection to Infiltration Gallery	1	LS	$350.00	$350
7	Diversion Structure	1	EA	$8,000.00	$8,000
8	Force Main 30" DI	80	LF	$60.00	$4,800
	Underground Storage				
9	Fine Grading	7,600	SF	$0.72	$5,472
10	Underground Infiltration Basin	1,126	CY	$378.00	$425,590
11	Maintenance/Observation Access to the Underground Infiltration Basin	5		$5,000.00	$25,000
Construction Subtotal					**$681,130**
12	Bond (5% of subtotal)				$34,060
13	Mobilization (10% of subtotal)				$68,110
14	Construction contingency (20% of subtotal)				$136,230
Construction Total					**$919,530**
15	Design (40% of Construction Total)				$367,810
Total Cost					**$1,287,340**

Table 13. Alternative 1 scenario 2: Post-Pump Treatment 2.5 cfs Direct Pumping cost estimate.

Item No	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Temporary Construction Fence	1,916	LF	$2.50	$4,790
2	Silt Fence	1,916	LF	$3.00	$5,748
	Site Preparation				
3	Excavation and Removal	1,689	CY	$45.00	$76,005
	Structures				
4	Structural Layer (washed no 57 or no 2 stone)	281	CY	$50.00	$14,050
5	Utility Conflicts	1	LS	$10,000.00	$10,000
6	Connection to Existing Wet-Well	1	LS	$350.00	$350
7	Force Main 4" DI	80	LF	$50.00	$4,000
	Underground Storage				
8	Fine Grading	7,600	SF	$0.72	$5,472
9	Underground Infiltration Basin	1,126	CY	$378.00	$425,590
10	Maintenance/Observation Access to the Underground Infiltration Basin	5		$5,000.00	$25,000
Construction Subtotal					**$571,010**
11	Bond (5% of subtotal)				$28,550
12	Mobilization (10% of subtotal)				$57,100
13	Construction contingency (20% of subtotal)				$114,200
Construction Total					**$770,860**
14	Design (40% of Construction Total)				$308,340
Total Cost					**$1,079,200**

Table 14. Alternative 2: Pre-Pump Green Infrastructure Treatment cost estimate.

Item No	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Traffic Control	40	Day	$1,000.00	$40,000
2	Temporary Construction Fence	4,824	LF	$2.50	$12,060
3	Silt Fence	4,824	LF	$3.00	$14,472
	Site Preparation				
4	Curb and Gutter Removal	2,400	LF	$3.30	$7,920
5	Saw Cut Existing Asphalt	1,200	LF	$5.12	$6,144
6	Asphalt Removal	8,400	SF	$3.36	$28,224
7	Sidewalk Removal	2,400	SF	$2.01	$4,824
8	Excavation and Removal	2,182	CY	$45.00	$98,190
	Structures				
9	Curb and Gutter	2,400	LF	$22.00	$52,800
10	Permeable Pavement	8,400	SF	$12.00	$100,800
11	Structural Layer (washed no 57 or no 2 stone)	907	CY	$50.00	$45,370
12	Concrete Transition Strip	1,200	LF	$4.00	$4,800
13	Utility Conflicts	1	LS	$10,000.00	$10,000
	Bioretention				
14	Fine Grading	5,000	SF	$0.72	$3,600
15	Drainage Stone (washed no 57 stone)	367	CY	$50.00	$18,334
16	Hydraulic Restriction Layer (30 mil liner)	6,216	LF	$0.60	$3,730
17	Soil Media Barrier (washed sand)	30.86	CY	$40.00	$1,234
18	Soil Media Barrier (choking stone, washed no 8)	30.86	CY	$45.00	$1,389
19	Mortared Cobble Energy Dissipater	95	SF	$2.25	$214
20	Curb Opening with Grate	19	LS	$350.00	$6,650
	Landscaping				
21	Soil Media	370	CY	$45.00	$16,667
22	Vegetation	5,000	SF	$4.00	$20,000
23	Mulch	46	CY	$55.00	$2,546
Construction Subtotal					**$499,970**
24	Bond (5% of subtotal)				$25,000
25	Mobilization (10% of subtotal)				$50,000
26	Construction contingency (20% of subtotal)				$99,990
Construction Total					**$674,960**
27	Design (40% of Construction Total)				$269,980
Total Cost					**$944,940**

9. Additional Considerations

9.1. Monitoring Plan

Performance monitoring of stormwater BMPs is an important component of a BMP implementation program. Monitoring provides the BMP's designer a mechanism to validate certain design assumptions and to quantify compliance with pollutant-removal performance objectives. Specific monitoring objectives should be considered early in the design process to ensure that BMPs are adequately configured for monitoring. Detailed monitoring guidance is provided by the EPA (USEPA 2012). The instrumentation and monitoring configuration will vary from site to site, but a monitoring approach using an inlet/outlet sample location setup is recommended for this site.

9.1.1. Monitoring Hydrology

An inlet/outlet sampling setup is suggested as the most effective monitoring approach to quantify flow and volume in stormwater BMPs. The runoff source and type of BMP will dictate the configuration of inflow monitoring. A weir or flume (Figure 22) is typically installed at the inlet of a BMP. Outflow can be monitored using similar techniques as inflow by installing a weir or ADV at the point of overflow/outfall (Figure 23). Outlet samples can also be collected from systems configured with underdrains utilizing specially designed v-notch weirs such as the one shown in Figure 24. Figure 25 shows an example of potential monitoring points.

Figure 22. Inlet curb cut with an H-flume.

Figure 23. Outlet of a roadside bioretention equipped with a V-notch weir for flow monitoring.

Figure 24. Typical weir for monitoring flow in an underdrain.

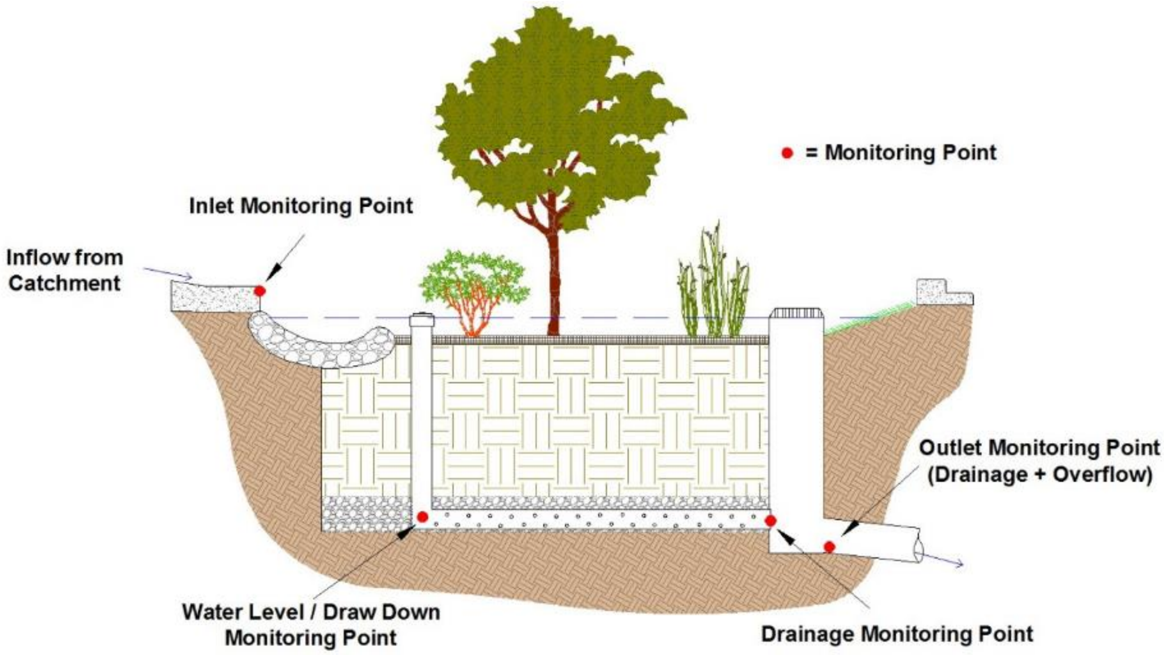

Figure 25. Typical monitoring points.

In addition to monitoring inflow and outflow, rainfall should be recorded on-site. Rainfall data can also be used to estimate inflow to BMPs that receive runoff only by sheet flow or direct rainfall (e.g., permeable pavement or green roofs). The type of rain gauge depends on monitoring goals and frequency of site visits. An automatic recording rain gauge (e.g., tipping bucket rain gauge), used to measure rainfall intensity and depth, is often paired with a manual rain gauge for data validation (Figure 26). For more advanced monitoring, weather stations can be installed to simultaneously monitor relative humidity, air temperature, solar radiation, and wind speed; these parameters can be used to estimate evapotranspiration.

Figure 26. Example of manual (left) and tipping bucket (right) rain gauges.

Water level (and drawdown rate) is another useful hydrologic parameter. Depending on project goals, perforated wells or piezometers can be installed to measure infiltration rate and drainage. Care should be taken when installing wells to ensure that runoff cannot enter the well at the surface and *short circuit* directly to subsurface layers; short circuiting can result in the discharge of untreated runoff that has bypassed the intended treatment mechanisms. It might be useful to pair soil moisture sensors with water level loggers in instances where highly detailed monitoring performance data are required (such as for calibration and validation of models).

9.1.2. Monitoring Water Quality

Although hydrologic monitoring can occur as a standalone practice, water quality data must be paired with flow data to calculate meaningful results. Flow-weighted automatic sampling is the recommended method for collecting samples that are representative of the runoff event and can be used to calculate pollutant loads (total mass of pollutants entering and leaving the system). Simply measuring the reduction in pollutant concentrations (mass per unit volume of water) from inlet to outlet can provide misleading results because it does not account for load reductions associated with infiltration, evapotranspiration, and storage.

Influent water quality samples are typically collected just upstream of the inlet monitoring device (e.g., weir box, flume) just before the runoff enters the BMP. The downstream sampler should be at the outlet control device just before the overflow enters the existing storm drain infrastructure. A strainer is usually installed at collecting end of the sampler tubing to prevent large debris and solids from entering and clogging the sampler. Automatic samplers should be programmed to collect single-event, composite samples according to the expected range of storm flows. Depending on the power requirements, a solar panel or backup power supply might be needed.

In addition to collecting composite samples, some water quality constituents can be monitored in real-time. Some examples include dissolved oxygen, turbidity, conductivity, and temperature.

9.1.3. Sample Collection and Handling

Quality assurance and quality control protocols for sample collection are necessary to ensure that samples are representative and reliable. The entire sample collection and delivery procedure should be well documented, including chain of custody (list of personnel handling water quality samples) and notes regarding site condition, time of sampling, and rainfall depth in the manual rain gauge. Holding times for water quality samples vary by constituent, but all samples should be collected, placed on ice, and delivered to the laboratory as soon as possible (typically 6 to 24 hours) after a rainfall event. Some water quality constituents require special treatment upon

collection, such as acidification, to preserve the sample for delivery. Appropriate health and safety protocols should always be followed when on-site, including using personal protective equipment such as safety vests, nitrile gloves, and goggles.

9.2. Public Education and Outreach

The green infrastructure BMPs will provide learning opportunities for community residents who frequent the area. A demonstration project will provide an example of how BMPs can be implemented in existing infrastructure and will serve as a consistent reminder of their impact on stormwater quality. When the project is completed, educational signage describing the BMPs and indicating the BMPs role in maintaining healthy water quality should remain on-site.

9.3. Future Retrofit Opportunities

The 12.7 acre drainage area of SWS 685149 was the focus of these wet weather treatment conceptual designs because of the required upgrade of Pump Plant 622. If more extensive, watershed-wide retrofits will be planned for future implementation, optimization analysis should consider the entire 505-acre drainage area in order to generate a cost effective solution for controlling the quality of runoff draining to the R4-LAR-Sepulveda storm drain system. During EWMP formulation, BMP opportunities throughout the entire R4-LAR-Sepulveda subwatershed drainage area were identified. These results can be used to guide future stormwater retrofit projects in the area.

10. References

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Appendix A - Fact Sheets

Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–EXHIBIT A.1
SITE: Pumping Plant No. 622

Site Location			
Landowner	City of Los Angeles	Latitude	34°12'54.60"N
Date of Field Visit	05/02/2015	Longitude	118°27'57.85"W
Field Visit Personnel	SD, LT, JW	Street Address	15266 Cabrito Rd Van Nuys, CA 91406
Major Watershed	LAR Sepulveda		

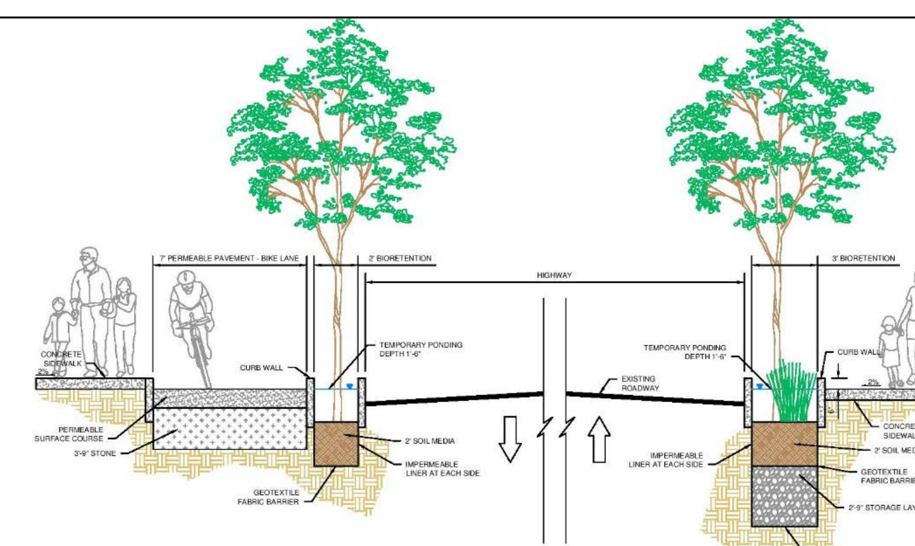
Existing Site Description: The conceptual design centers around the existing Pump Plant 622 near the intersection of Sepulveda Boulevard and Cabrito Road. The pump plant is intended to provide flood protection to an area roughly bounded by the 405 freeway to the west, Pacoima Wash to the east, Rayen Street to the north, and the Van Nuys Metrolink is immediately south of the pump station. Storm water flows from underground storm drain pipes in Sepulveda Blvd. are pumped up to a box culvert storm drain that flows to the southeast.

Watershed Characteristics		Retrofit Characteristics		
Drainage Area, acres	29.6	Proposed Retrofit	Green Street	
Hydrologic Soil Group	A/B	BMP footprint, ft²	Biretention Permeable Pavement	5000 8400
Total Impervious, %	90	Ponding Depth, ft	Biretention Permeable Pavement	1.5 0.01
Design Storm Event, in	85TH	Media Depth, ft	Biretention Permeable Pavement	2 1

Proposed Retrofit Description: The proposed retrofit would involve installation of curb cuts to convey runoff to bioretention areas in the right-of-way along Sepulveda Blvd. to provide stormwater treatment and traffic calming benefits. A protected bike lane will increase safety for bicyclists and pedestrians while protecting permeable pavement in the bike lane from vehicular traffic. Treating the 85th percentile storm will reduce the amount of time that the main pumps have to operate by approximately 70%.


Current Street View (Photo 1a)

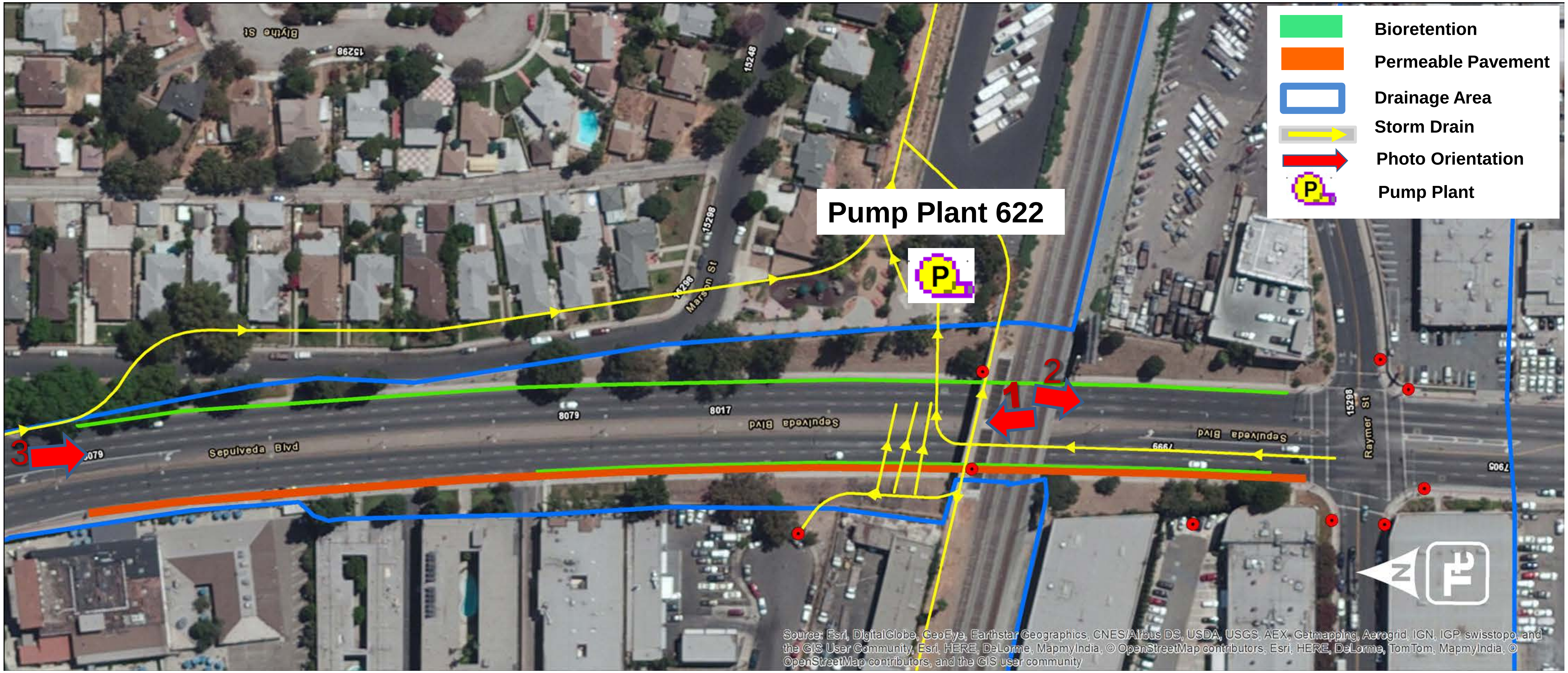

Rendered Street Improvements (Photo 1b)


Example Cross Section

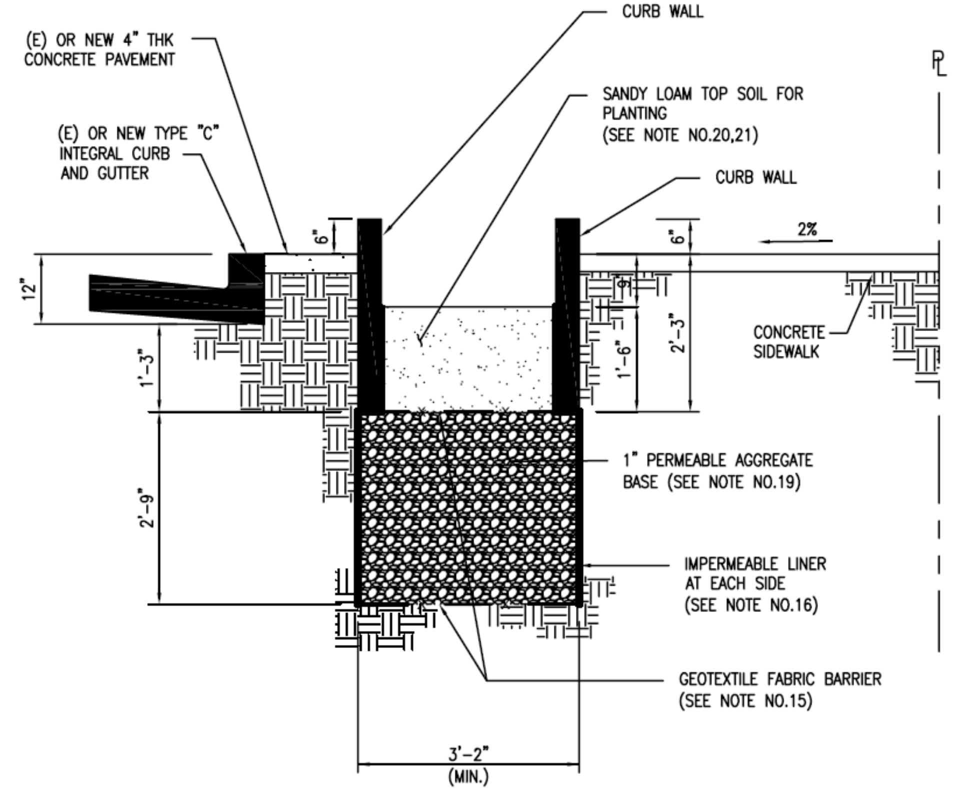
Best Management Practice Conceptual Designs for Upper Los Angeles River

CONCEPTUAL PLAN–EXHIBIT A.2

SITE: Pumping Plant No. 622



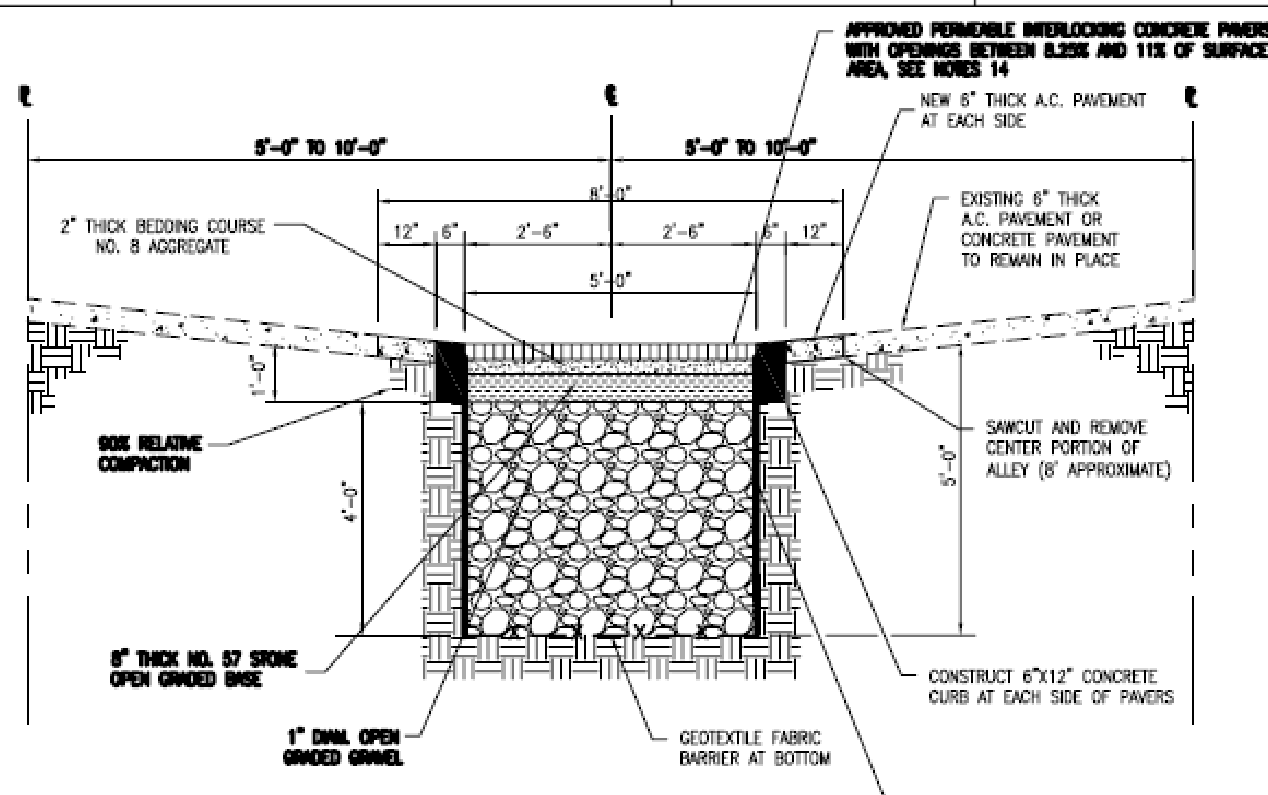
Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–EXHIBIT A.3
SITE: Pumping Plant No. 622



SECTION B–B

TYPICAL SWALE SECTION

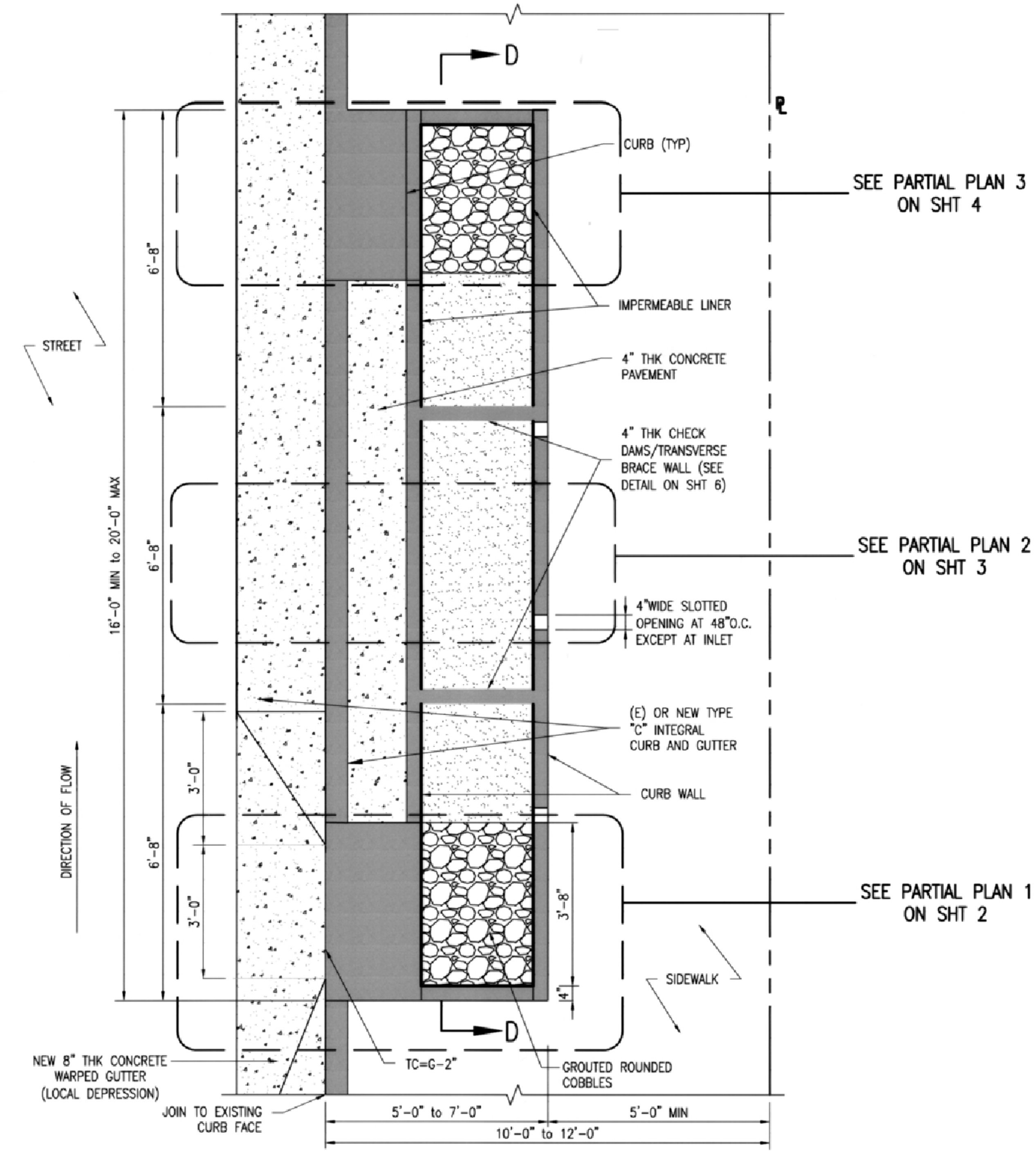
STANDARD PLAN NO. S–481–0 | SHEET 3 OF 8 SHEETS



SECTION A–A

EXISTING ALLEY

STANDARD PLAN NO. S–485–0 | SHEET 2 OF 3 SHEETS



PLAN

BUREAU OF ENGINEERING	DEPARTMENT OF PUBLIC WORKS	CITY OF LOS ANGELES
PARKWAY SWALE IN MAJOR/SECONDARY HIGHWAYS		STANDARD PLAN S–481–0

PREPARED	SUBMITTED	APPROVED	SUPERSEDES	REFERENCES
ALICE GONG, CE49107 BUREAU OF SANITATION ENRIQUE C. ZALDIVAR, P.E., DIRECTOR	6/29/10 JEONG PARK, S.E. ENGINEER OF DESIGN BUREAU OF ENGINEERING	GARY LEE MOORE, P.E. CITY ENGINEER 6-29-10		S–410 S–480 S–484
CHECKED PATRICK LEE, CE42448 BUREAU OF ENGINEERING	6/29/10 KEN REDD, P.E. ACTING DEPUTY CITY ENGINEER	REGISTERED PROFESSIONAL ENGINEER GARY LEE MOORE No. C-49446 Exp. 9/30/10 CIVIL STATE OF CALIFORNIA	VAULT INDEX NUMBER:	
			SHEET 1 OF 8 SHEETS	

CITY OF LOS ANGELES

SANITATION

DEPARTMENT OF PUBLIC WORKS

Appendix B - Hydrocalcs

Peak Flow Hydrologic Analysis

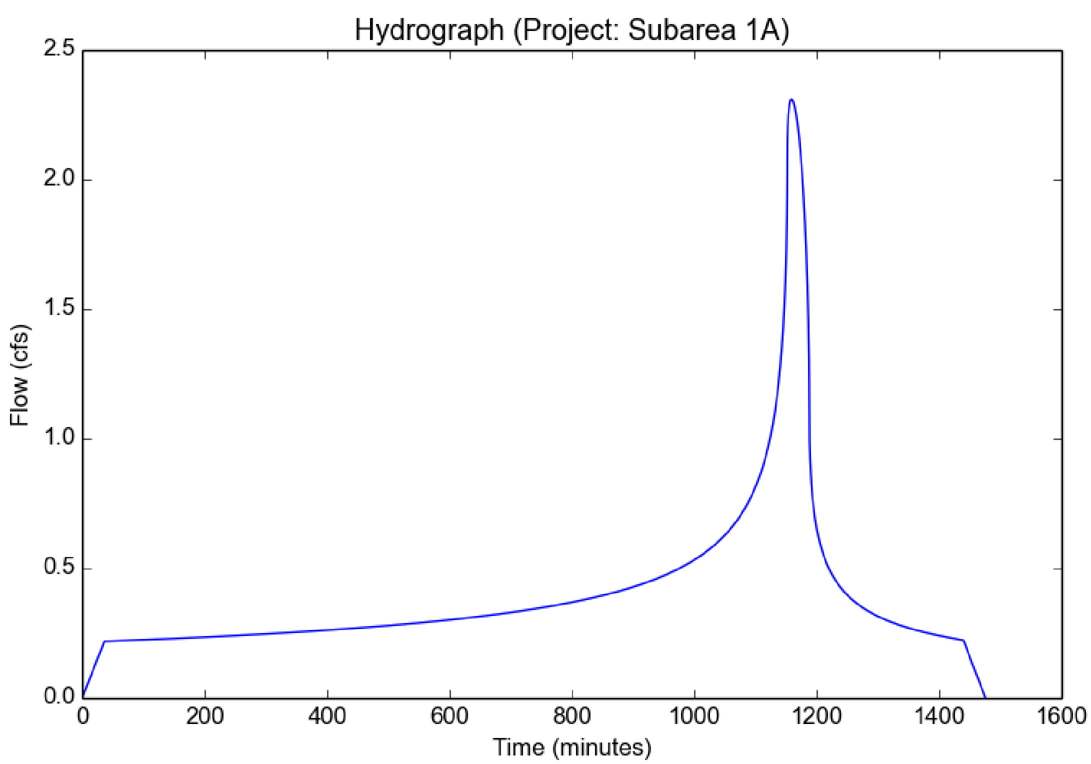
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump_622_85th.pdf
Version: HydroCalc 0.3.0-beta

Input Parameters

Project Name	Project
Subarea ID	Subarea 1A
Area (ac)	12.7
Flow Path Length (ft)	1000.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	0.94
Percent Impervious	0.9
Soil Type	16
Design Storm Frequency	85th percentile storm
Fire Factor	0.71
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.94
Peak Intensity (in/hr)	0.2218
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.82
Time of Concentration (min)	36.0
Clear Peak Flow Rate (cfs)	2.3094
Burned Peak Flow Rate (cfs)	2.3852
24-Hr Clear Runoff Volume (ac-ft)	0.809
24-Hr Clear Runoff Volume (cu-ft)	35241.5609



Peak Flow Hydrologic Analysis

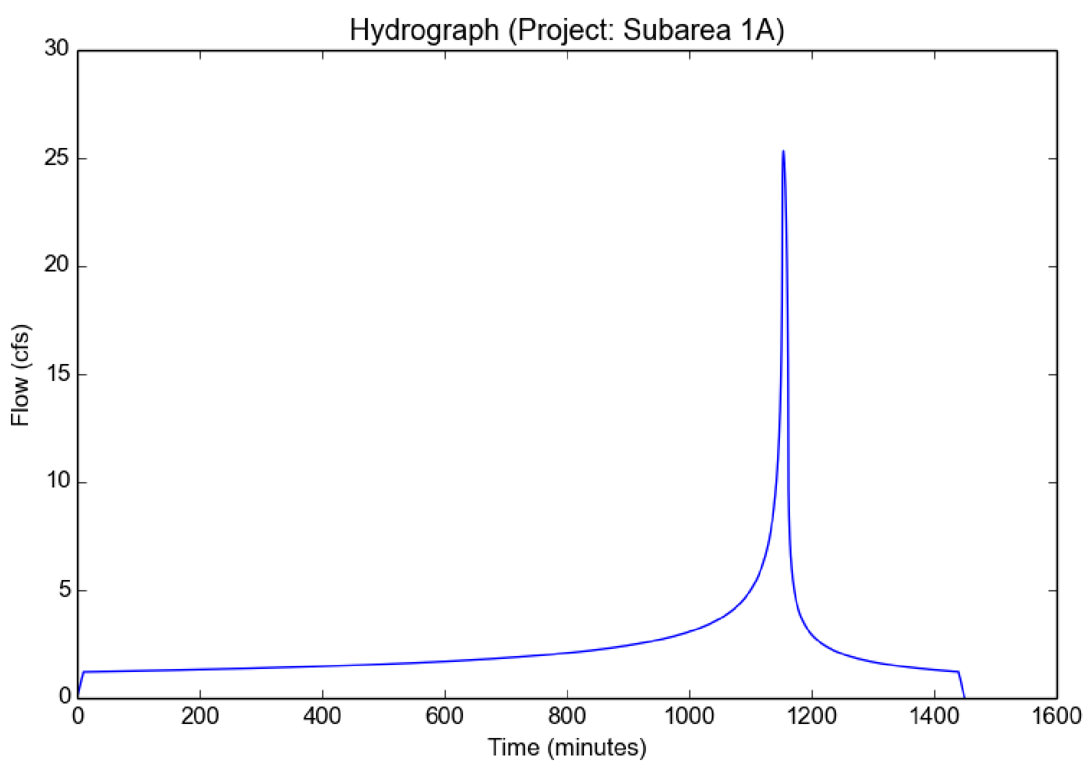
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump_622_10Yr.pdf
Version: HydroCalc 0.3.0-beta

Input Parameters

Project Name	Project
Subarea ID	Subarea 1A
Area (ac)	12.7
Flow Path Length (ft)	1000.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.3
Percent Impervious	0.9
Soil Type	16
Design Storm Frequency	10-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	5.2122
Peak Intensity (in/hr)	2.2451
Undeveloped Runoff Coefficient (Cu)	0.7835
Developed Runoff Coefficient (Cd)	0.8884
Time of Concentration (min)	10.0
Clear Peak Flow Rate (cfs)	25.3296
Burned Peak Flow Rate (cfs)	26.1809
24-Hr Clear Runoff Volume (ac-ft)	4.5316
24-Hr Clear Runoff Volume (cu-ft)	197396.8282



Peak Flow Hydrologic Analysis

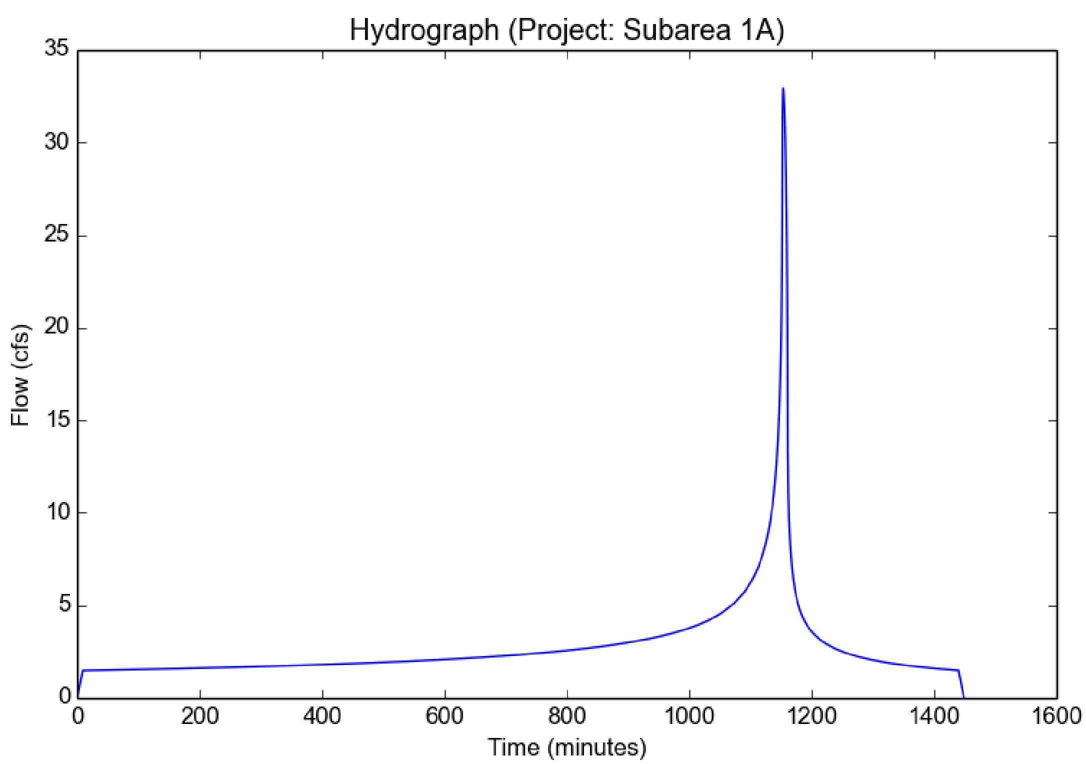
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump_622_25Yr.pdf
Version: HydroCalc 0.3.0-beta

Input Parameters

Project Name	Project
Subarea ID	Subarea 1A
Area (ac)	12.7
Flow Path Length (ft)	1000.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.3
Percent Impervious	0.9
Soil Type	16
Design Storm Frequency	25-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	6.4094
Peak Intensity (in/hr)	2.901
Undeveloped Runoff Coefficient (Cu)	0.8417
Developed Runoff Coefficient (Cd)	0.8942
Time of Concentration (min)	9.0
Clear Peak Flow Rate (cfs)	32.9434
Burned Peak Flow Rate (cfs)	34.0304
24-Hr Clear Runoff Volume (ac-ft)	5.5879
24-Hr Clear Runoff Volume (cu-ft)	243408.3593



Peak Flow Hydrologic Analysis

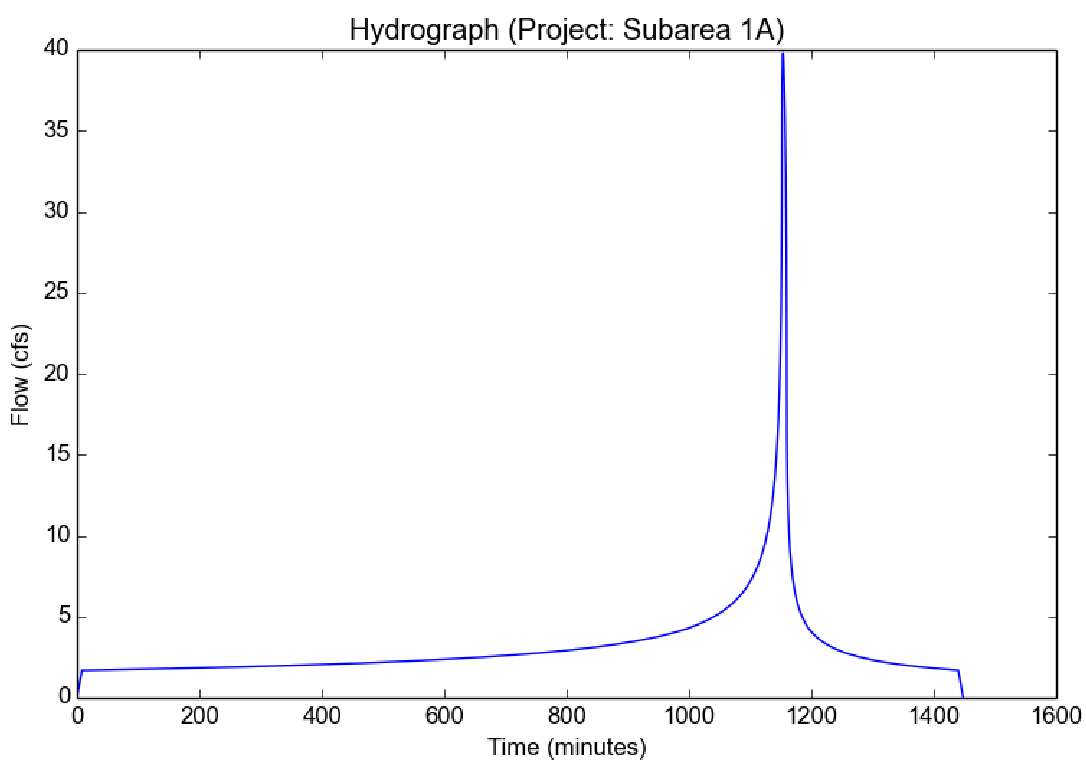
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump_622_50Yr.pdf
Version: HydroCalc 0.3.0-beta

Input Parameters

Project Name	Project
Subarea ID	Subarea 1A
Area (ac)	12.7
Flow Path Length (ft)	1000.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.3
Percent Impervious	0.9
Soil Type	16
Design Storm Frequency	50-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	7.3
Peak Intensity (in/hr)	3.4921
Undeveloped Runoff Coefficient (Cu)	0.8746
Developed Runoff Coefficient (Cd)	0.8975
Time of Concentration (min)	8.0
Clear Peak Flow Rate (cfs)	39.8024
Burned Peak Flow Rate (cfs)	41.1071
24-Hr Clear Runoff Volume (ac-ft)	6.3775
24-Hr Clear Runoff Volume (cu-ft)	277805.1634



Appendix C – Pump Calculations

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #622 (Sepulveda) Storm Water PS

Givens:
1. The original pump design point is 15,550 gpm @ 32 TDH
2. Minor losses at the pump station are based on the As-Built plans.
3. The required design flow is 17,900 gpm @ 36 TDH

Assumptions:
1. The Hazen-Williams C-factors are assumed to be as follows:
   Aged Ductile Iron Pipe = 100
2. Minor losses are neglected within the pipeline except at the pump station.
3. The minor losses are taken from "Pumping Station Design" pgs. 898-900
4. The pump suction grade line is based on the water levels in the Plant #622 wet well
   LWL = 750 HWL = 760.25
5. The pump discharge is pumping to the summit manhole.
   Elev = 785.83

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: h_L=10.44*L(ft)*$Q^{1.85}$(gpm)/$C^{1.85}$*$D^{4.87}$(inches)

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
30	17	DIP	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
30	Ent. Loss	0.05	1	0.05
Total K Value for 16-inch Pipe				**0.05**

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Step 2 ***Minor Losses (Continued)***

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
30	45-Bend	0.2	2	0.4
30	Exit	1	1	1
Total K Value for 12-inch Pipe				**1.4**

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift	
Summit MH	785.83
Low Water Level	750
$H_{(static-max)}$=	35.83

Minimum Static Lift	
Summit MH	785.83
High Water Level	760.25
$H_{(static-min)}$=	25.58

System Curve Calculations

Step 4 ***Determine System Curve***

Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	35.8	25.6	30.7	0.00
800	0.0	0.0	35.8	25.6	30.7	0.36
1600	0.0	0.0	35.8	25.6	30.7	0.73
2400	0.0	0.0	35.9	25.6	30.7	1.09
3200	0.0	0.0	35.9	25.6	30.8	1.45
4000	0.0	0.1	35.9	25.7	30.8	1.82
4800	0.0	0.1	36.0	25.7	30.8	2.18
5600	0.0	0.1	36.0	25.7	30.9	2.54
6400	0.0	0.2	36.0	25.8	30.9	2.91
7200	0.0	0.2	36.1	25.9	31.0	3.27
8000	0.0	0.3	36.2	25.9	31.0	3.63
8800	0.0	0.4	36.2	26.0	31.1	4.00
9600	0.1	0.4	36.3	26.1	31.2	4.36
10400	0.1	0.5	36.4	26.1	31.3	4.72
11200	0.1	0.6	36.5	26.2	31.4	5.09
12000	0.1	0.7	36.6	26.3	31.5	5.45
12800	0.1	0.8	36.7	26.4	31.6	5.81
13600	0.1	0.9	36.8	26.5	31.7	6.18
14400	0.1	1.0	36.9	26.7	31.8	6.54
15200	0.1	1.1	37.0	26.8	31.9	6.90
16000	0.1	1.2	37.2	26.9	32.0	7.27
16800	0.1	1.3	37.3	27.0	32.2	7.63
17600	0.2	1.4	37.4	27.2	32.3	7.99
18400	0.2	1.6	37.6	27.3	32.5	8.36
19200	0.2	1.7	37.7	27.5	32.6	8.72
20000	0.2	1.9	37.9	27.6	32.8	9.08
20800	0.2	2.0	38.1	27.8	32.9	9.45
21600	0.2	2.2	38.2	28.0	33.1	9.81
22400	0.3	2.3	38.4	28.2	33.3	10.17
23200	0.3	2.5	38.6	28.3	33.5	10.54
24000	0.3	2.7	38.8	28.5	33.7	10.90
24800	0.3	2.9	39.0	28.7	33.9	11.26
25600	0.3	3.0	39.2	28.9	34.1	11.63
26400	0.3	3.2	39.4	29.2	34.3	11.99
27200	0.4	3.4	39.6	29.4	34.5	12.35
28000	0.4	3.6	39.9	29.6	34.7	12.72
28800	0.4	3.9	40.1	29.8	35.0	13.08

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

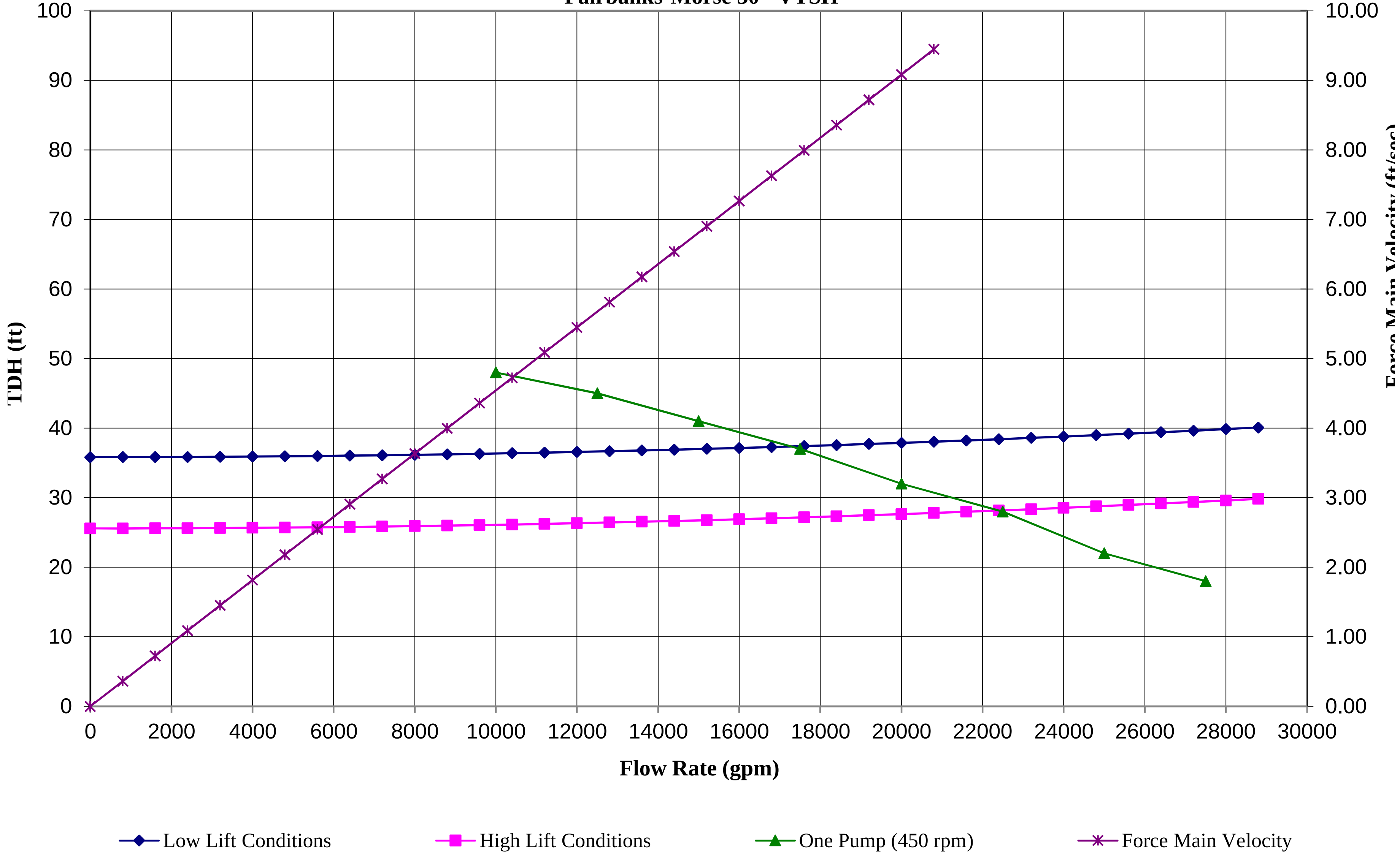
Step 5 ***New Pump Curve***

Fairbanks-Morse
Vertical Turbine Solids Handling

450 RPM - 200 HP - 29.75 in Impeller

Q (gpm)	TDH (ft)
10000	48
12500	45
15000	41
17500	37
20000	32
22500	28
25000	22
27500	18

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS
System Curve
Fairbanks-Morse 30" VTSH



CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #622 (Sepulveda) maintenance pump

Givens:
1. The original pump design point is 500 gpm @ 43 TDH
2. Minor losses at the pump station are based on the As-Built plans.
3. The maintenance pump will be used to drain the last 4' of water in the wet well.
4. The new design point shall match the existing.

Assumptions:
1. The Hazen-Williams C-factors are assumed to be as follows:
   Aged Ductile Iron Pipe = 100
2. Minor losses are neglected within the pipeline except at the pump station.
3. The minor losses are taken from "Pumping Station Design" pgs. 898-900
4. The pump suction grade line is based on the water levels in the Plant #622 wet well
   LWL = 744 HWL = 750.5
5. The pump discharge is pumping to the summit manhole.
   Elev = 787.2

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: h_L=10.44*L(ft)*$Q^{1.85}$(gpm)/$C^{1.85}$*$D^{4.87}$(inches)

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
4	55	DIP	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
4	Ent. Loss	0.05	1	0.05
Total K Value for 4-inch pipe				**0.05**

System Curve Calculations

Step 2 ***Minor Losses (Continued)***

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
4	Exit Loss	1	1	1
4	45-bend	0.2	1	0.2
4	90-bend	0.8	1	0.8
Total K Value for 4-inch Pipe				**2**

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift	
Summit MH	787.2
Low Water Level	744
$H_{(static\text{-}max)}$=	43.2

Minimum Static Lift	
Summit MH	787.2
High Water Level	750.5
$H_{(static\text{-}min)}$=	36.7

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Step 4 ***Determine System Curve***

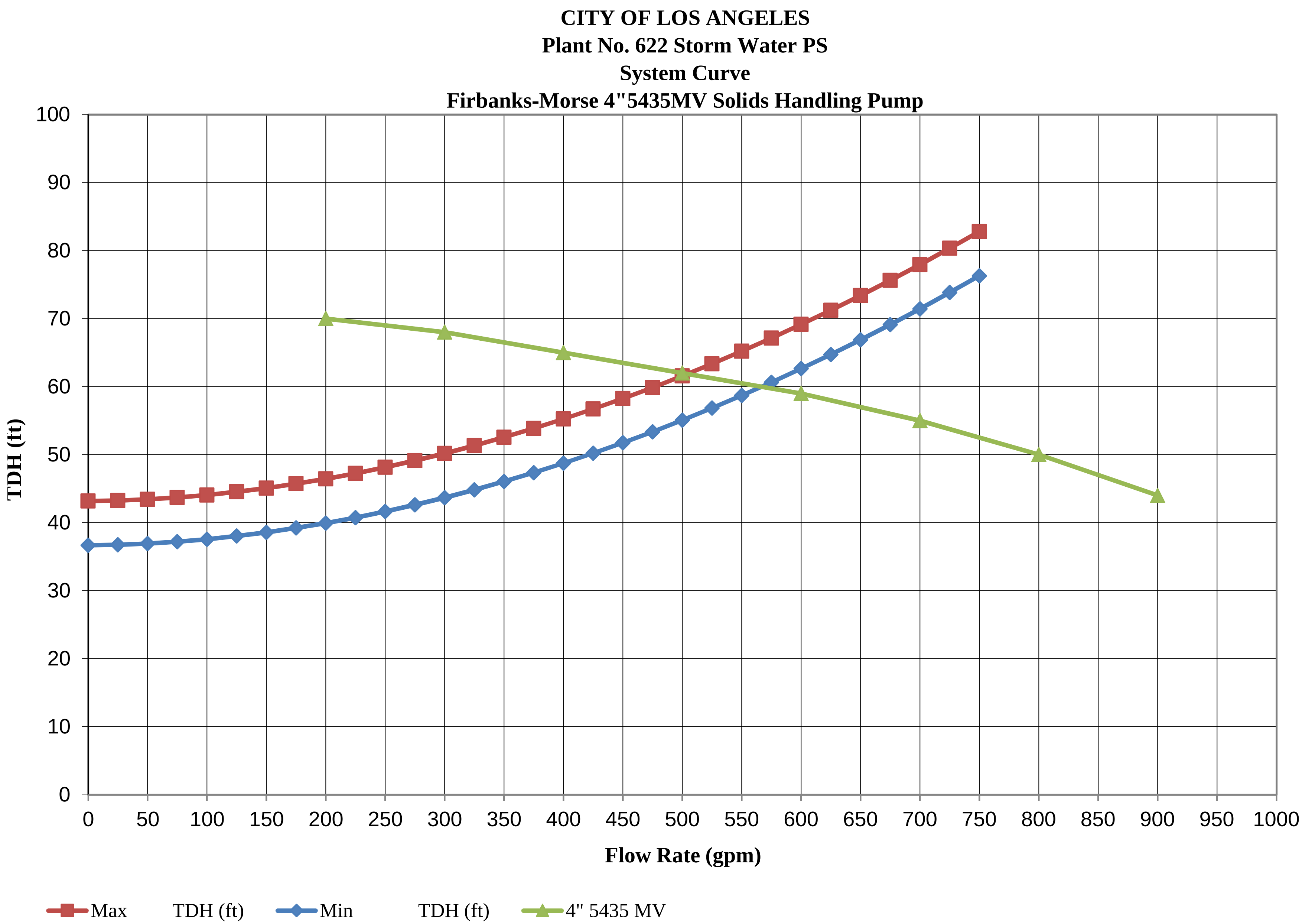
Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	43.2	36.7	40.0	0.00
25	0.1	0.0	43.3	36.8	40.0	0.64
50	0.2	0.1	43.4	36.9	40.2	1.28
75	0.4	0.1	43.7	37.2	40.5	1.92
100	0.7	0.2	44.1	37.6	40.8	2.55
125	1.0	0.3	44.5	38.0	41.3	3.19
150	1.4	0.5	45.1	38.6	41.8	3.83
175	1.9	0.6	45.7	39.2	42.5	4.47
200	2.4	0.8	46.5	40.0	43.2	5.11
225	3.0	1.1	47.3	40.8	44.0	5.75
250	3.7	1.3	48.2	41.7	44.9	6.39
275	4.4	1.6	49.1	42.6	45.9	7.03
300	5.1	1.9	50.2	43.7	46.9	7.66
325	5.9	2.2	51.3	44.8	48.1	8.30
350	6.8	2.5	52.6	46.1	49.3	8.94
375	7.7	2.9	53.9	47.4	50.6	9.58
400	8.7	3.3	55.3	48.8	52.0	10.22
425	9.8	3.8	56.7	50.2	53.5	10.86
450	10.9	4.2	58.3	51.8	55.0	11.50
475	12.0	4.7	59.9	53.4	56.6	12.13
500	13.2	5.2	61.6	55.1	58.3	12.77
525	14.4	5.7	63.4	56.9	60.1	13.41
550	15.7	6.3	65.2	58.7	62.0	14.05
575	17.1	6.9	67.1	60.6	63.9	14.69
600	18.5	7.5	69.2	62.7	65.9	15.33
625	19.9	8.1	71.2	64.7	68.0	15.97
650	21.4	8.8	73.4	66.9	70.2	16.60
675	23.0	9.5	75.6	69.1	72.4	17.24
700	24.6	10.2	78.0	71.5	74.7	17.88
725	26.2	10.9	80.3	73.8	77.1	18.52
750	27.9	11.7	82.8	76.3	79.6	19.16

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Step 5 ***New Pump Curve***

Fairbanks 4" 5435 MV 10hp - 115 rpm		
Q (gpm)	**TDH (ft)**	**Q (gpm)**
200	70	
300	68	
400	65	
500	62	
600	59	
700	55	
800	50	
900	44	


CITY OF LOS ANGELES
Plant No. 622 Storm Water PS
System Curve
Firbanks-Morse 4"5435MV Solids Handling Pump
TDH (ft)
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
Flow Rate (gpm)
Max TDH (ft)
Min TDH (ft)
4" 5435 MV

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #622 (Sepulveda) maintenance pump

Givens:
1. The original pump design point is 500 gpm @ 43 Static Head
2. Minor losses at the pump station are based on the As-Built plans.
3. The maintenance pump will be used to drain the last 4' of water in the wet well.
4. The new design point be 1200 gpm (2.5 cfs) @ 59 TDH

Assumptions:
1. The Hazen-Williams C-factors are assumed to be as follows:
   Aged Ductile Iron Pipe = 100
2. Minor losses are neglected within the pipeline except at the pump station.
3. The minor losses are taken from "Pumping Station Design" pgs. 898-900
4. The pump suction grade line is based on the water levels in the Plant #622 wet well
   LWL = 744 HWL = 750.5
5. The pump discharge is pumping to the summit manhole.
   Elev = 787.2

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: $h_L=10.44*L(ft)*Q^{1.85}(gpm)/C^{1.85}*D^{4.87}(inches)$

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
6	55	DIP	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
6	Ent. Loss	0.05	1	0.05
Total K Value for 4-inch pipe				**0.05**

System Curve Calculations

Step 2 ***Minor Losses (Continued)***

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
6	Exit Loss	1	1	1
6	45-bend	0.2	1	0.2
6	90-bend	0.8	1	0.8
Total K Value for 4-inch Pipe				**2**

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift	
Summit MH	787.2
Low Water Level	744
$H_{(static-max)}$=	43.2

Minimum Static Lift	
Summit MH	787.2
High Water Level	750.5
$H_{(static-min)}$=	36.7

CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Step 4 ***Determine System Curve***

Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	43.2	36.7	40.0	0.00
50	0.0	0.0	43.2	36.7	40.0	0.57
100	0.1	0.0	43.3	36.8	40.1	1.14
150	0.2	0.1	43.5	37.0	40.2	1.70
200	0.3	0.2	43.7	37.2	40.5	2.27
250	0.5	0.3	44.0	37.5	40.7	2.84
300	0.7	0.4	44.3	37.8	41.0	3.41
350	0.9	0.5	44.6	38.1	41.4	3.97
400	1.2	0.7	45.1	38.6	41.8	4.54
450	1.5	0.8	45.5	39.0	42.3	5.11
500	1.8	1.0	46.1	39.6	42.8	5.68
550	2.2	1.2	46.6	40.1	43.4	6.24
600	2.6	1.5	47.2	40.7	44.0	6.81
650	3.0	1.7	47.9	41.4	44.7	7.38
700	3.4	2.0	48.6	42.1	45.4	7.95
750	3.9	2.3	49.4	42.9	46.1	8.52
800	4.4	2.6	50.2	43.7	46.9	9.08
850	4.9	3.0	51.1	44.6	47.8	9.65
900	5.4	3.3	52.0	45.5	48.7	10.22
950	6.0	3.7	52.9	46.4	49.7	10.79
1000	6.6	4.1	53.9	47.4	50.7	11.35
1050	7.2	4.5	54.9	48.4	51.7	11.92
1100	7.9	5.0	56.0	49.5	52.8	12.49
1150	8.5	5.4	57.2	50.7	53.9	13.06
1200	9.2	5.9	58.4	51.9	55.1	13.62
1250	10.0	6.4	59.6	53.1	56.3	14.19
1300	10.7	6.9	60.9	54.4	57.6	14.76
1350	11.5	7.5	62.2	55.7	58.9	15.33
1400	12.3	8.0	63.5	57.0	60.3	15.90
1450	13.1	8.6	64.9	58.4	61.7	16.46
1500	14.0	9.2	66.4	59.9	63.2	17.03

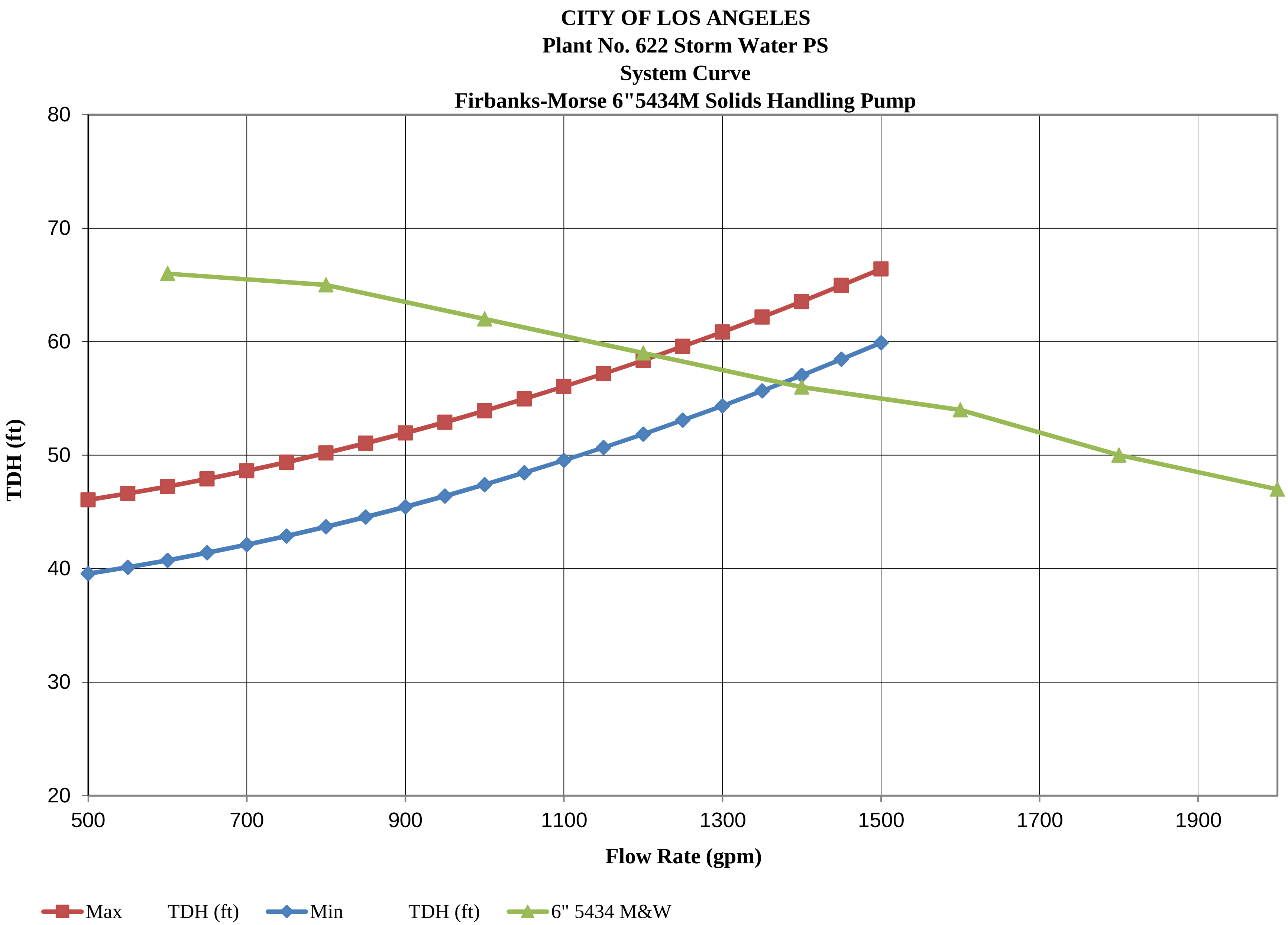
CITY OF LOS ANGELES
Plant No. 622 Storm Water PS

System Curve Calculations

Step 5 ***New Pump Curve***

Fairbanks
6" 5434 M&W
25hp - 115 rpm

Q (gpm)	TDH (ft)	Q (gpm)
600	66	
800	65	
1000	62	
1200	59	
1400	56	
1600	54	
1800	50	
2000	47	



CITY OF LOS ANGELES
Plant No. 622 Storm Water PS
System Curve
Firbanks-Morse 6"5434M Solids Handling Pump
TDH (ft)
80
70
60
50
40
30
20
500
700
900
1100
1300
1500
1700
1900
Flow Rate (gpm)
Max TDH (ft)
Min TDH (ft)
6" 5434 M&W

Pump Data Sheet - Fairbanks Morse Pump, 60 Hz

PENTAIR

FAIRBANKS NIJHUIS™

Company:
Name:
Date: 4/1/2015

Pump:

Size: 6"5434M&W (BH)

Type: 5430-SOLIDS HANDLING
Synch speed: 900 rpm
Speed: 880 rpm
Dia: 15.9375 in

Curve: 340608BH
Impeller: TAJC5BH

Specific Speeds:
Ns: 1918
Nss: 7044

Dimensions:
Suction: 6 in
Discharge: 6 in

Search Criteria:

Flow: 1200 US gpm
Head: 59 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: ---
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Consult Fairbanks Morse Pump, 60 Hz to select a motor for this pump.

Pump Limits:

Temperature: 104 °F
Pressure: 75 psi g
Sphere size: 3 in
Power: ---
Eye area: ---

---- Data Point ----

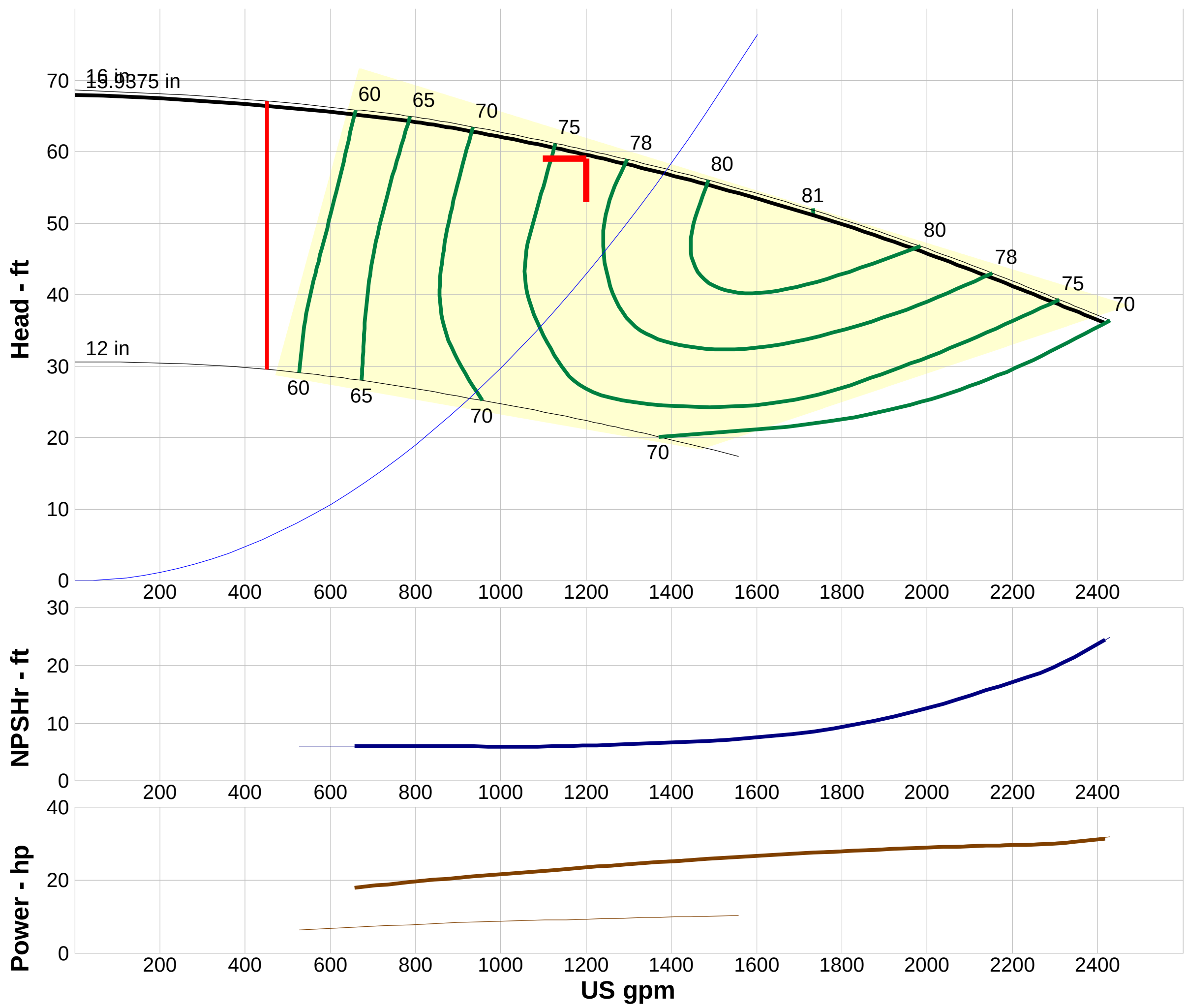
Flow: 1200 US gpm
Head: 59.6 ft
Eff: 76%
Power: 23.6 hp
NPSHr: 6.18 ft

---- Design Curve ----

Shutoff head: 68 ft
Shutoff dP: 29.4 psi
Min flow: 450 US gpm
BEP: 81% @ 1733 US gpm
NOL power:
31.4 hp @ 2415 US gpm

-- Max Curve --

Max power:
31.9 hp @ 2428 US gpm



Curve efficiencies are typical. For guaranteed values, contact Fairbanks Morse or your local distributor. Las eficiencias en curvas son típicas. Para valores garantizados contacte a Fairbanks Morse o a su distribuidor local.

Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
1440	880	56.1	80	25.6	6.82
1200	880	59.6	76	23.6	6.18
960	880	62.5	71	21.4	6
720	880	64.8	63	18.8	6
480	880	66	53	15.8	6

Appendix D – BOE "D" Plans

INDEX TO PLANS

PLAN NO.	SHEET NO.	
D-21700		**RAILROAD AND STORM DRAIN BRIDGE**
	1	INDEX TO PLANS
	2	KEY MAP
	3	GENERAL PLAN, DESIGN DATA, GENERAL NOTES
	4	FOUNDATION PLAN
	5	PIER PLAN
	6	WEST ABUTMENT
	7	EAST ABUTMENT
	8	BEARING PAD AND SHEAR KEY DETAILS
	9	SOUTH WINGWALL
	10	NORTH WINGWALL
	11	DECK PLAN
	12	DECK DETAILS
	13	MISCELLANEOUS DETAILS
	14	MISCELLANEOUS DETAILS
	15	RAILING DETAILS
	16 - 17	PLAN OF EXISTING UTILITIES AND SUBSTRUCTURES
	18 - 20	PLAN OF RELOCATED UTILITIES AND SUBSTRUCTURES
	21	LOG OF TEST BORINGS
	22 - 23	SHOOFLY AND TEAM TRACKS
	24	MAINLINE AND TEAM TRACKS
	25	TRACK SUBGRADE CROSS-SECTIONS
D-21689		**PUMP PLANT - STRUCTURAL, CIVIL, MECHANICAL AND ELECTRICAL**
	1	INDEX TO PLANS
	2	GENERAL PLAN
	3	ROOF PLAN AND BEAM DETAILS
	4	MOTOR ROOM PLAN AND BEAM DETAILS
	5	BAR SCREEN ROOM AND BEAM DETAILS
	6	STORAGE ROOM PLAN AND SECTIONS
	7	SECTIONS AND WALL BEAM AND STRUT DETAILS
	8	STAIRWELL DETAILS AND SECTIONS
	9	SECTIONS
	10	MISCELLANEOUS DETAILS
	11	ARCHITECTURAL DETAILS
	12	JUNCTION STRUCTURE
	13	PLAN VIEWS
	14 - 15	ELEVATION VIEWS
	16	VENTILATION SYSTEM
	17	HATCH COVER DETAILS
	18	PIPE SUPPORTS AND MISCELLANEOUS DETAILS
	19	SILENCER AND MISCELLANEOUS DETAILS
	20	BAR SCREEN AND ELECTRODE WELL DETAILS
	21	MISCELLANEOUS DETAILS
	22	PLANS AND PROFILES OF FORCE MAIN AND DISCHARGE PIPE
	23	ELECTRICAL PLANS
	24	ELECTRICAL DETAILS
D-21688		**SEWERS**
	1	INDEX TO PLANS
	2	GENERAL PLAN
	3-4	PLAN AND PROFILE OF SEWERS IN SEPULVEDA BLVD.
	5	PLAN AND PROFILE OF SEWERS IN LANGDON AVE.; NOBLE AVE. AND BURNET AVE.

PLAN NO.	SHEET NO.	
D-21701		**STORM DRAINS**
	1	INDEX TO PLANS
	2	TITLE SHEET, INDEX OF STANDARD PLANS
	3	KEY MAP AND GENERAL NOTES
	4	RESURFACING PLAN AND TYPICAL DETAILS
	5 - 21	STORM DRAIN PLAN AND PROFILE
	22	CROSS SECTIONS OF GRADED CHANNEL
	23	SUB-DRAINS
	24	CROSS SECTIONS OF GRADED DITCH OVER STORM DRAIN
	25	LOG OF SOIL BORINGS
	26	LOG OF SOIL BORINGS
	27-30	STRUCTURAL DETAILS
P-25813		**STREET PLANS**
	1	INDEX TO PLANS
	2	TYPICAL SECTIONS AND STREET INDEX
	3	KEY MAP AND NOTICE TO CONTRACTORS
	4 - 5	PROFILE: SEPULVEDA BLVD. FROM LANARK ST. TO STAGG ST.
	6	PLAN: SEPULVEDA BLVD. AND ROSCOE BLVD. INTERSECTION
	7 - 12	PLAN: SEPULVEDA BLVD., 169 FT S/O ROSCOE BLVD. TO STAGG ST.
	13 - 14	PLAN AND PROFILE: SEPULVEDA BLVD. (FRONTAGE ROAD) AND CABRITO RD.
	15 - 16	PLAN AND PROFILE: LANARK ST.
	17	PLAN AND PROFILE: LANGDON AVE. AND PLAN: OLD RAYMER ST.
	18 - 19	PLAN AND PROFILE: RAYMER ST.
P-25814		**STREET PLANS**
	1	INDEX TO PLANS
	2	STREET INDEX AND GRADING PLAN
	3	DETOUR SIGNING PLAN
	4 - 8	DETOUR ROAD
	9	PLANS: ROSCOE BLVD. INTERSECTION WITH BURNET AVE. AND NOBLE AVE.
	10	PLANS: MARSON AVE. INTERSECTION WITH BURNET AVE. AND NOBLE AVE.
	11	PLANS: ROSCOE BLVD. INTERSECTION WITH LANGDON AVE., COLUMBUS AVE. AND ORION AVE.
	12	STAIRWAY DETAILS
	13 - 15	DEMOLITION AND REMOVAL PLAN
	16 - 17	SEPULVEDA BLVD. CROSS-SECTIONS
	18	SEPULVEDA BLVD. AND RAYMER ST. CROSS-SECTIONS
	19	PLAN AND PROFILE: ROSCOE BLVD. W/O ORION AVE.
D-21703		**STREET LIGHTING AND TRAFFIC**
	1	INDEX TO PLANS
	2	NOTICE TO CONTRACTORS AND DETOUR LIGHTING
	3 - 5	FINAL STREET LIGHTING
	6	RAYMER ST. AND SEPULVEDA BLVD. TRAFFIC SIGNAL
	7	LANARK ST., SEPULVEDA BLVD. & SEPULVEDA PL. TRAFFIC SIGNAL
	8	RAYMER ST. & SEPULVEDA BLVD. DETOUR RD.
	9	NOBLE AVE. & ROSCOE BLVD.
	10	ROSCOE BLVD. & SEPULVEDA BLVD.

PLAN NO.	SHEET NO.	
D-21702		**EROSION CONTROL**
	1	INDEX TO PLANS
	2 - 3	IRRIGATION PLANS
	4	EROSION CONTROL DETAILS

SEPULVEDA BOULEVARD GRADE SEPARATION AT RAYMER STREET AND THE SOUTHERN PACIFIC COMPANY'S COAST LINE TRACKS

CITY OF LOS ANGELES
LYALL A. PARDEE CITY ENGINEER

DATUM NOTE

U. S. G. S. DATUM EFFECTIVE JULY 1, 1925 ORDINANCE NO. 52222 DEDUCT 5.775 FEET TO ADJUST TO DATUM PLANE IN USE PRIOR TO SAID DATE

REFERENCES

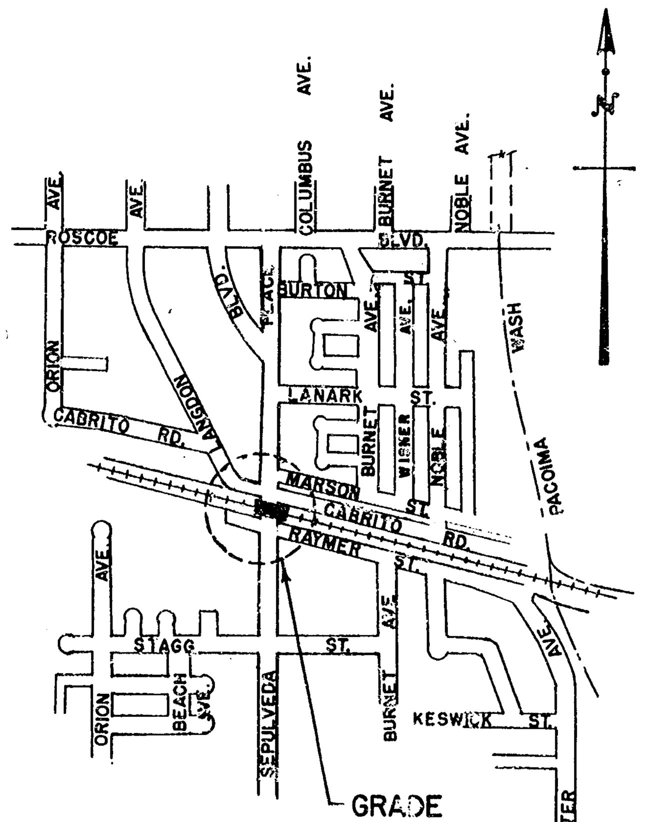
FIELD BOOK NO. 40053, 25716, 26066, 22407, 40042
DATE OF SURVEY April-67, Nov-64, April-62, July-67, May-67
DISTRICT MAP NO. 7497, 7498, 7519, 7520, 7581, 7582
ASSESSMENT MAP NO. ____ DIV. 597, 598, 749, 750, 791, 792, 793
DRAINAGE MAP NO. 398
SUPERSEDES PROFILE NO. ____

NOTICE TO CONTRACTORS

THIS IMPROVEMENT ALSO INCLUDES WORK CALLED FOR ON THE FOLLOWING SPECIAL PLANS AND PROFILES

STREET IMP. PROFILES P-25813 P-25814
SEWER PLANS D-21688
STORM DRAIN PLANS ____
STRUCTURAL PLANS D-21689 D-21700
ORNAMENTAL LIGHTING PLANS D-21703
EXISTING MANHOLES (TOTALS): STORM DRAIN 0 SEWER ____

SPECIFICATIONS: ALL WORK DETAILED ON THESE PLANS TO BE PERFORMED UNDER CONTRACT SHALL, EXCEPT AS OTHERWISE STATED OR PROVIDED FOR HEREON, BE CONSTRUCTED IN ACCORDANCE WITH "STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, 1967 EDITION" AND THE SPECIAL SPECIFICATIONS.



VICINITY MAP
Not to Scale

BENCH MARKS			
F.B.	Pg.	Elev.	Description
25716	59	786.775	Standard Survey Mon. ℄ Int. Sepulveda Blvd. & Cabrito Rd. (W) 1960 adj.
25716	41	800.175	Standard Trav. Mon. 8-J-21 on ℄ Int. Sepulveda Blvd. & Roscoe Blvd. 1960 adj.
24701	28	781.085	Spk. ℄ Sepulveda Blvd. in ret. to curb of center island 30' S/O ℄ Stagg St. 1960 adj.
27831	42	781.730	Spk. West Curb Kester Ave. 3' S/O B.C.R. S.W. Corner Raymer St. 1960 adj.
27831	42	788.695	U.S.C. & G.S.-B.M. Disk "K-1135" on top of S. Diversion Gate Wall - 200'± N/O ℄ Raymer St. 1960 adj.
25716	41	792.375	Spk. N. Curb Lanark St. 5' E/O B.C.R. to Sepulveda Place 1960 adj.

SEPULVEDA BOULEVARD GRADE SEPARATION AT RAYMER STREET AND THE SOUTHERN PACIFIC COMPANY'S COAST LINE TRACKS BETWEEN ROSCOE BOULEVARD AND STAGG STREET AND BETWEEN ORION AVENUE AND KESTER AVENUE - W.O. 71257

1958 STORM DRAIN BOND ISSUE
LOS ANGELES COUNTY FLOOD CONTROL DISTRICT
LOS ANGELES
PROJECT NO. 651
LINES A, B, C, & D

RECOMMENDED BY C. F. Cahill, DIVISION ENGINEER (DESIGN)
APPROVAL RECOMMENDED BY ____ CHIEF DEPUTY ENGINEER 7-5-68
APPROVED BY Walter J. Wood, CHIEF ENGINEER

REVISIONS			APPROVALS		
DATE	DESCRIPTION	BY	DIVISION ENGINEER	CITY ENGINEER	DATE
7/68	Rev. Sh. Nos. 6, 27, & 28.				

APPROVALS		
DIVISION OR DEPT.	ENGINEER	DATE
STREET OPENING		
STREET AND FREEWAY		
SANITARY SEWERS	Mark F. Riffin	2/14/68
STORM DRAIN		3/15/68
BRIDGE DESIGN		3/6/68
STREET LIGHTS	JK	2/9/68
WATER DEPARTMENT		
TRAFFIC DEPT.		

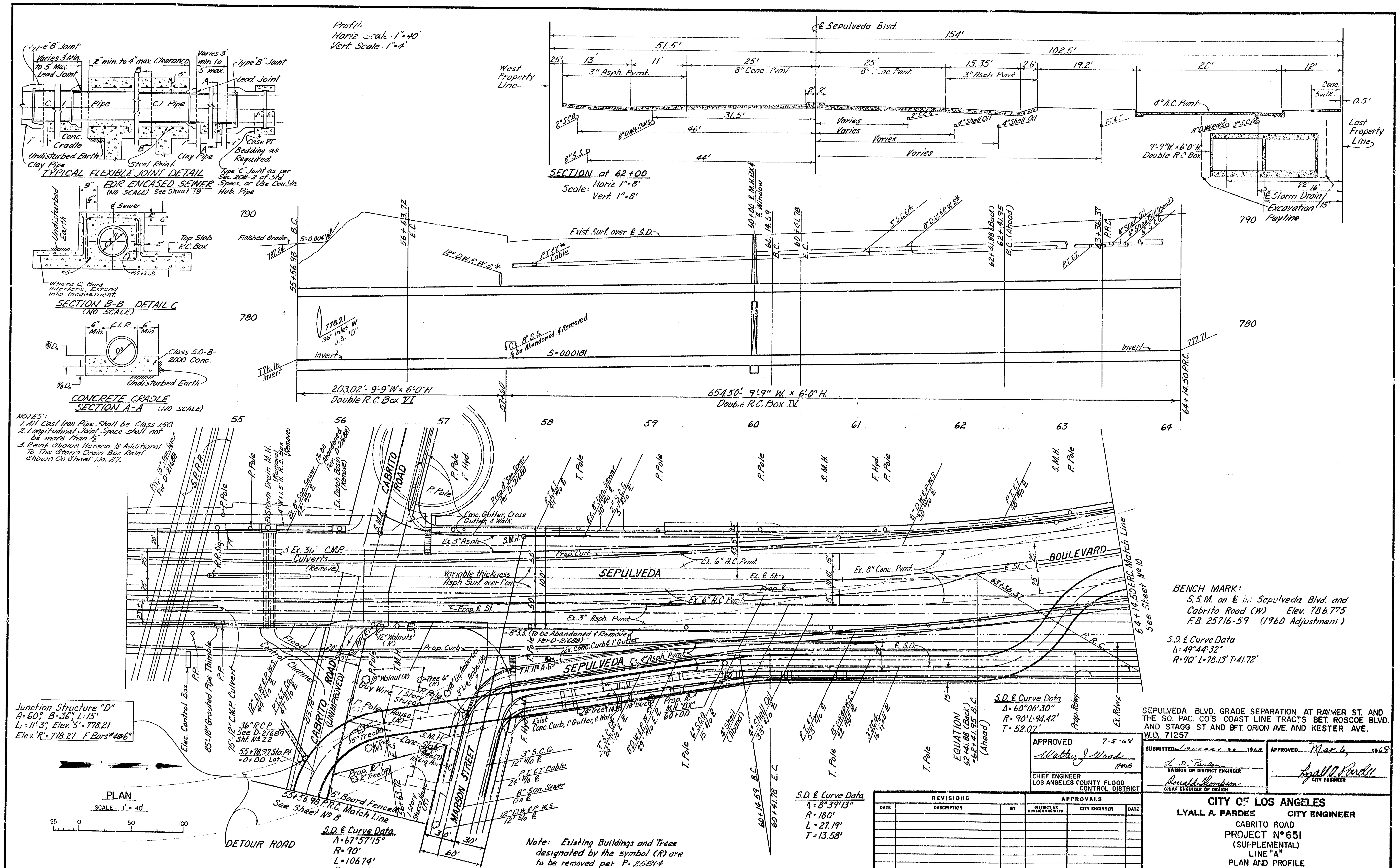
SUBMITTED January 30 1968
BY L. D. Pardee DIVISION OR DISTRICT ENGINEER
Donald Thompson CHIEF DEPUTY ENGINEER (DESIGN)
APPROVED Mar. 6, 1968
Lyall A. Pardee CITY ENGINEER

SHEET NO. 1 OF 30 SHEETS

D-21701

DATE - JULY '68 L.A.C.F.C.D DWG. NO. 275-651-D3.1

D-21701



NOTES:
1. All Cast Iron Pipe Shall be Class 150.
2. Longitudinal Joint Space Shall not be more than ½".
3. Reinf. Shown Hereon Is Additional To The Storm Drain Box Reinf. Shown On Sheet No. 27.

SEPULVEDA BLVD. GRADE SEPARATION AT RAYMER ST. AND THE SO. PAC. CO'S COAST LINE TRACTS BET. ROSCOE BLVD. AND STAGG ST. AND BET. ORION AVE. AND KESTER AVE.
W.O. 71257

APPROVED 7-5-68
Walter J. Wood
CHIEF ENGINEER
LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

SUBMITTED January 30 1968
L. D. Paulson — DIVISION OR DISTRICT ENGINEER
Donald Thompson — CHIEF ENGINEER OF DESIGN

APPROVED Mar. 4, 1968
Lyall A. Pardee — CITY ENGINEER

REVISIONS			APPROVALS		
DATE	DESCRIPTION	BY	DISTRICT OR DIVISION ENGINEER	CITY ENGINEER	DATE

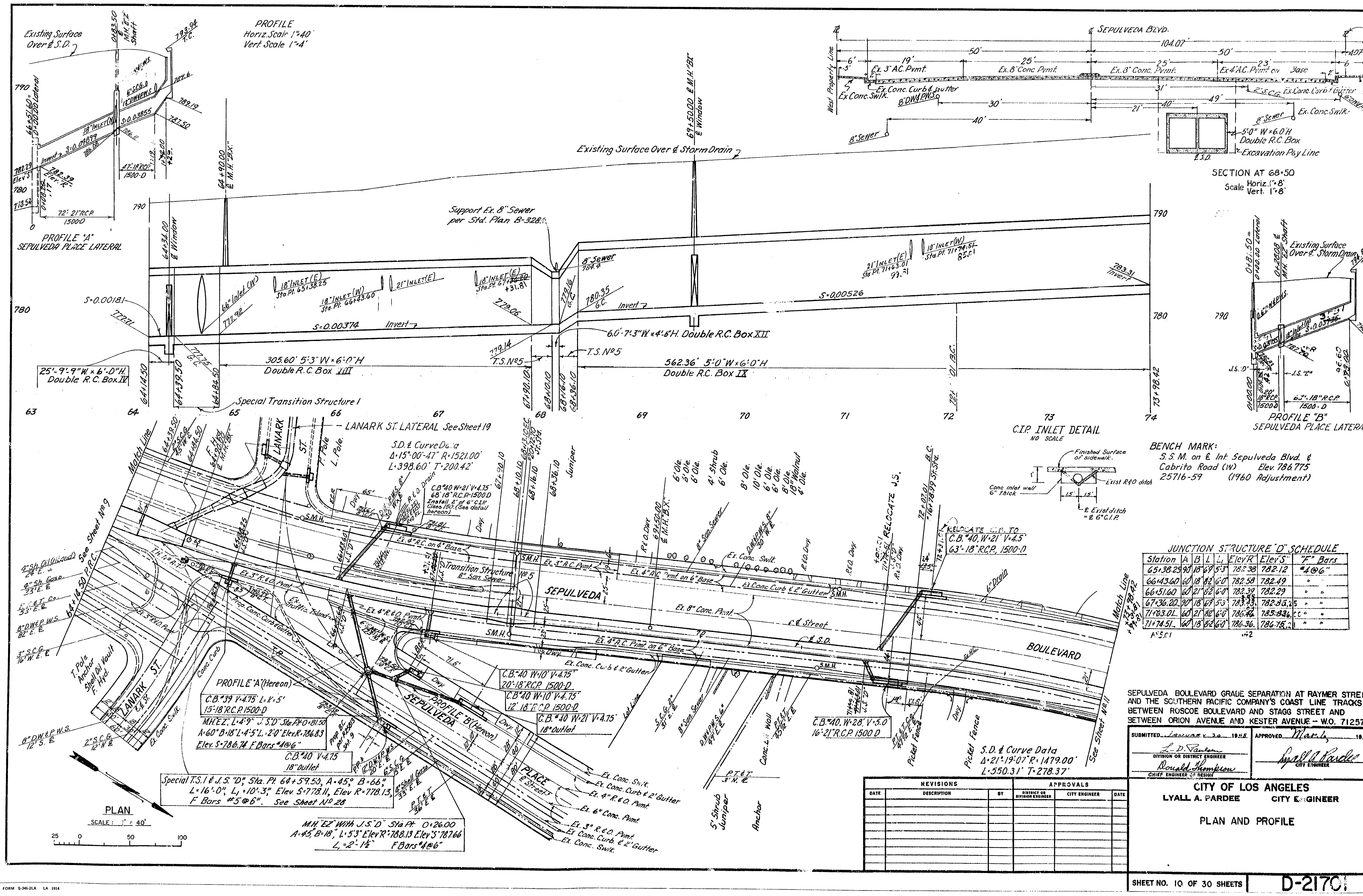
CITY OF LOS ANGELES
LYALL A. PARDEE CITY ENGINEER
CABRITO ROAD
PROJECT Nº 651
(SUPPLEMENTAL)
LINE "A"
PLAN AND PROFILE
DOUBLE R.C. BOX
STATION 55+56.98 TO STATION 64+14.50

SHEET NO. 9 OF 30 SHEETS — D-21701

DATE-JULY'68 L.A.C.F.C.D. DWG. NO. 275-651-03.9

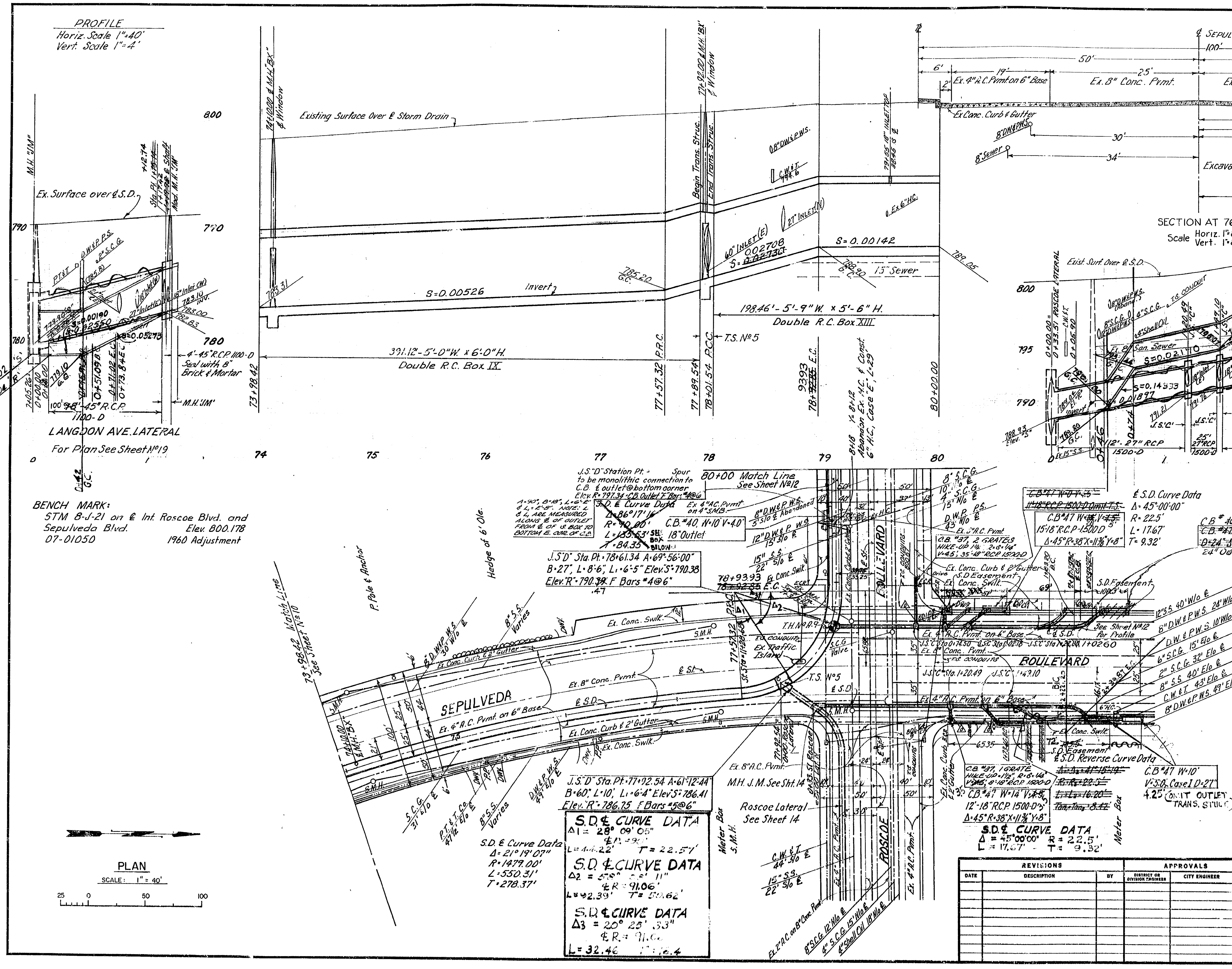
D-21701

CERTIFICATE
I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles, and Section 34090.5 of the Government Code.
Date 8-13- REX E. LAYTON, City Clerk
By



D-21701

CERTIFICATE
I hereby certify that this is a true and accurate copy of the official record described there, made in accordance with Section of the Charter of the City of Los Angeles, and Section .5 of the Government Code
Date 13 LAYTON, City Clerk



JUNCTION STRUCTURE "C" SCHEDULE

Station Pt.	A	B	C	D_1	D_2	E	L	Elev "R"	Elev. "S"	Steel Bars
East Lateral				27"					4.83	
1+20.49	90°	18"	3'-0"	24"	27"	2'-6"	5'-0"	796.00	791.63	A&B-#3@6", C&F #4@6"
1+49.10	45°	18"	7'-0"	24"	24"	4'-0"	5'-0"	798.00	792.17	A&B-#3@6", C&F #4@6"
West Lateral				27"				5.29	5.50 5.17	
0+74.50	90°	18"	2'-6"	27"	27"	2'-6"	5'-0"	793.87	793.24	A&B #3@6", C&F #4@6"
1+02.18	90°	18"	2'-6"	24"	27"	2'-6"	5'-0"	794.88	794.30	A&B #3@6", C&F #4@6"
1+22.00	45°	18"	4'-3"	24"	24"	4'-0"	5'-0"	795.73	795.07	A&B #3@6", C&F #4@6"
1+0260				27"				796.31	796.07	

SEPULVEDA BOULEVARD GRADE SEPARATION AT RAYMER STREET AND THE SOUTHERN PACIFIC COMPANY'S COAST LINE TRACKS BETWEEN ROSCOE BOULEVARD AND STAGG STREET AND BETWEEN ORION AVENUE AND KESTER AVENUE - W.O. 71257

SUBMITTED January 23 1968 — DIVISION OR DISTRICT ENGINEER
Donald Simpson — CHIEF ENGINEER OF DESIGN
APPROVED Mar. 6 1968 — Lyall A. Pardee, CITY ENGINEER

REVISIONS			APPROVALS		
DATE	DESCRIPTION	BY	DISTRICT OR DIVISION ENGINEER	CITY ENGINEER	DATE

CITY OF LOS ANGELES
LYALL A. PARDEE CITY ENGINEER

PLAN AND PROFILE

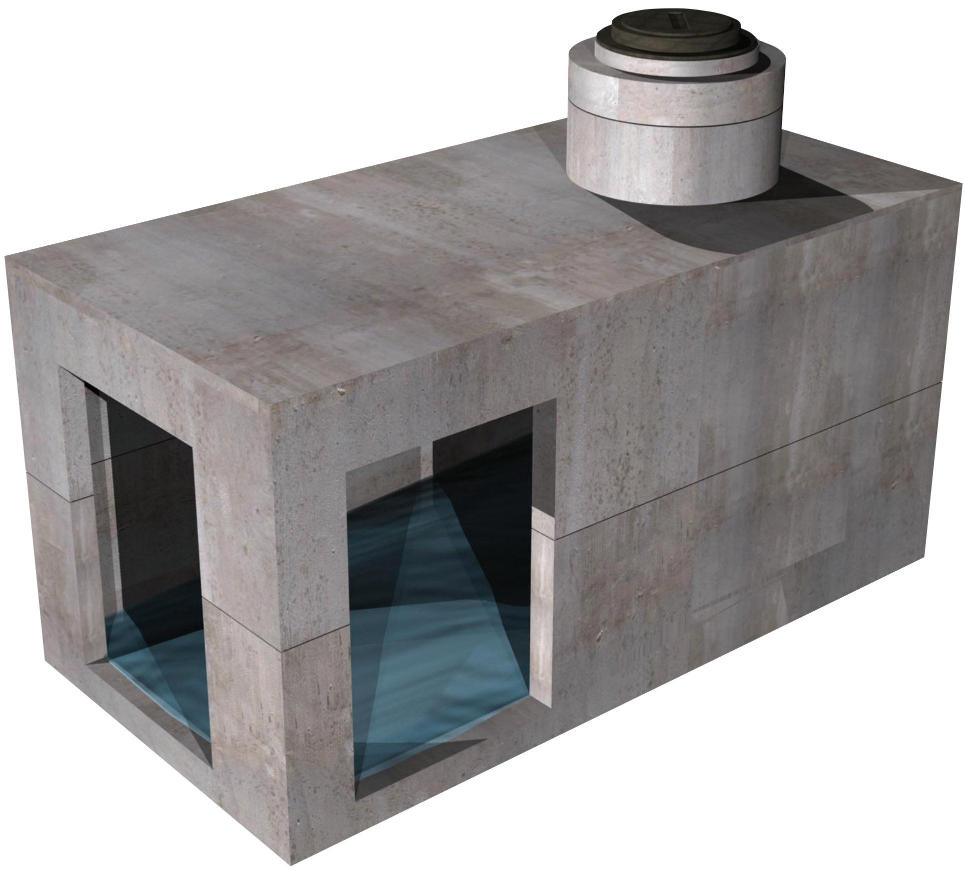
SHEET NO. 11 OF 30 SHEETS D-21701

D-21701

Appendix E – Product Information

TOTAL STORMWATER MANAGEMENT SYSTEM

From Oldcastle Stormwater Solutions Comes Storm Capture, A Modular Stormwater Management System for Infiltration, Detention, Retention, and Treatment.

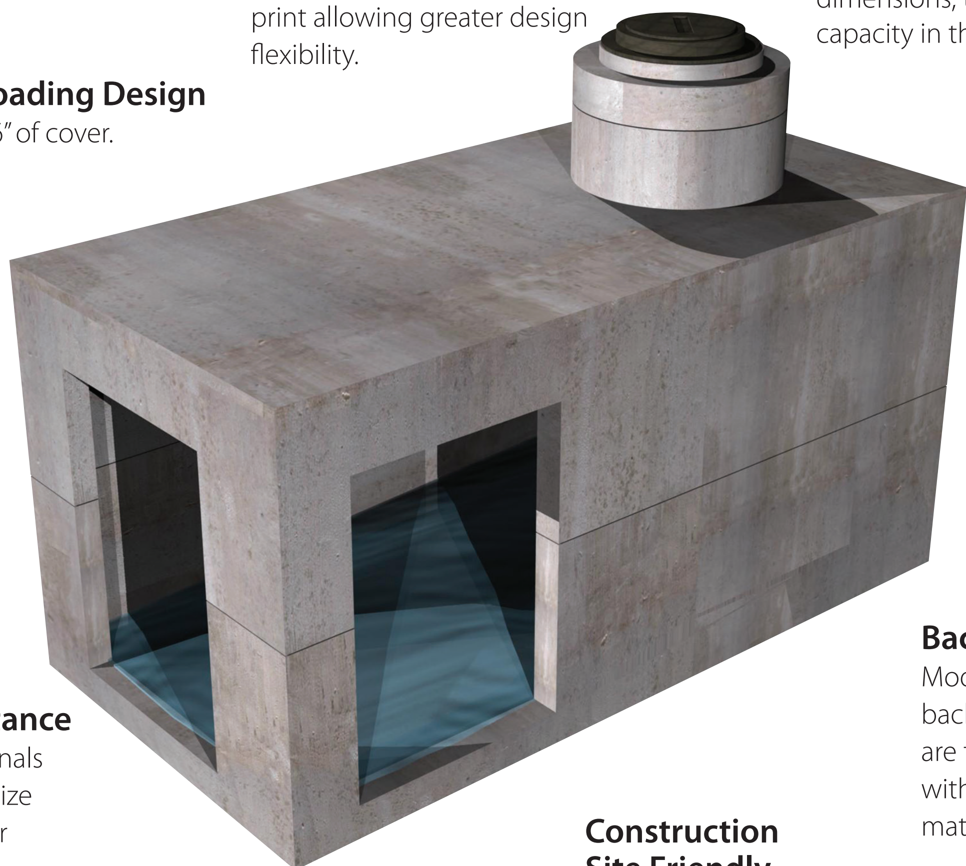


Storm Capture Module

Description
7′ x 15′ with a 14′ maximum/adjustable height inside dimensions, the largest capacity in the industry.

Large Storage Capacity
results in smaller system footprint allowing greater design flexibility.

Traffic Loading Design
with only 6″ of cover.



Easy to Install
modules for fast installation.

Flexible Heights
Available in heights from 2′ to 14′ to best-fit site needs.

Backfill
Modules do not rely on backfill for storage, and are typically backfilled with existing site materials.

Design Assistance
Let our professionals help you customize an application for your needs.

Construction Site Friendly
Contractor does not have to give up any of the site once the Storm Capture system is installed.

Treatment Train
Available with treatment train capability, pretreatment, post treatment, or both.

Same day staging and installation of StormCapture project.

StormCapture Project using Linkslab design.

StormCapture modules are designed for HS20 traffic loading.

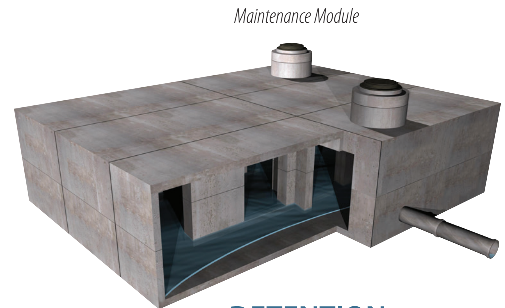
StormCapture infiltration system.

Storm Capture Benefits

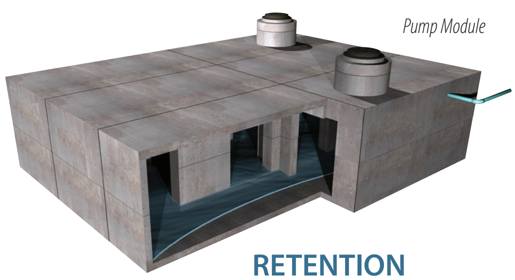
- **Fast service** - Quick and easy project help by our national engineering team with layouts and specifications to meet each project's requirements.
- **Cost savings** - Highly competitive installed and life-cycle costs.
- **Manufactured** to the rigid standards of the Oldcastle quality control program at Oldcastle facilities around the country.
- **Codes** - Designed to the latest codes for HS-20-44 (full truck load plus impact).
- **Sustainability** - The system is maintainable for long-term sustainability.
- **LID** - Ideal for Low Impact Development (LID).
- **LEED** - Manufactured locally with recycled material for potential LEED credits. *LEED 2009 for New Construction & Major Renovation, US Green Building Council: Sustainable Sites (5.1, 5.2, 6.1, 6.2), Materials & Resources (4.1, 4.2, 5.1, 5.2), Water Efficiency (1.1, 1,2, 3.1, 3.2)*

Applications

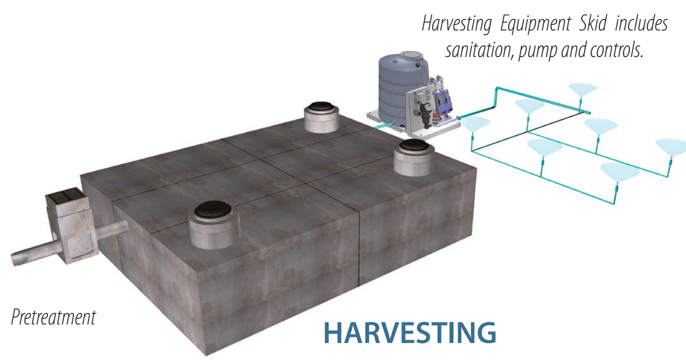
Storm Capture has many solutions for detention, retention, treatment, and harvesting that involve a combination of many parts designed to solve your stormwater management needs. Let us show you how we can design and customize a solution for you.



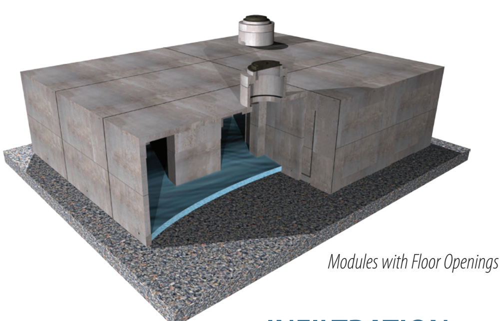
DETENTION



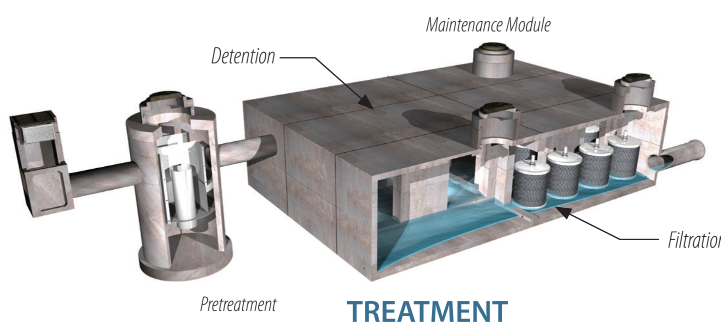
RETENTION



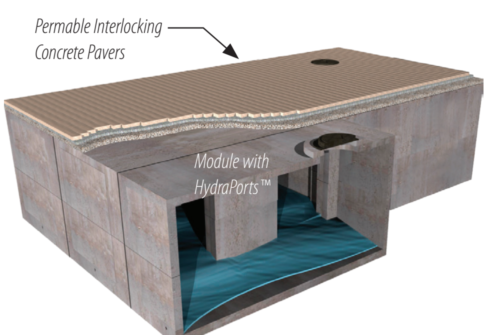
HARVESTING



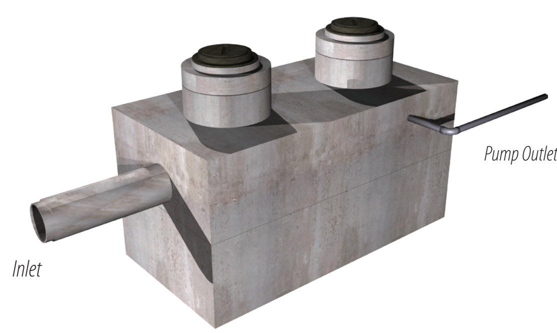
INFILTRATION



TREATMENT



PERMECAPTURE

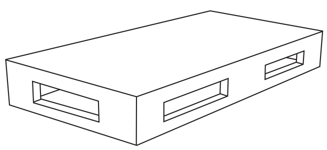


CISTERNS

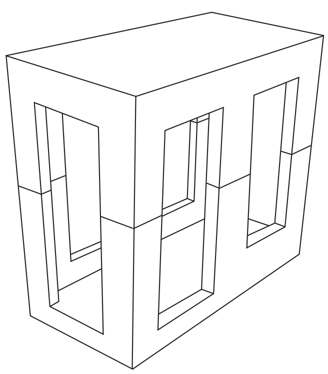



INSTALLED IN ONE DAY

Module Sizes



SC1 – one piece modules can be used for applications from 2' to 7' tall. These are appropriate for cisterns, infiltration, detention, and retention systems. SC1 modules are typically installed on a minimal compacted gravel base, dependent on specific project requirements.

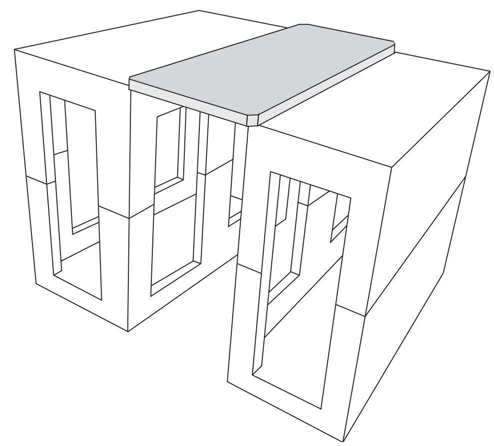


SC2 – two piece modules can be used for applications from 7' all the way up to 14' tall for maximum storage capacity in the smallest footprint. These are appropriate for cisterns, infiltration, detention, and retention systems. SC2 modules are typically installed on a compacted native subgrade.

Module Capacity

Size (ft.)	Capacity (ft^3.)	Size (ft.)	Capacity (ft^3.)
7x15x2	226	7x15x9	1027
7x15x3	343	7x15x10	1144
7x15x4	460	7x15x11	1257
7x15x5	577	7x15x12	1374
7x15x6	690	7x15x13*	1491
7x15x7	807	7x15x14*	1608
7x15x8	910		

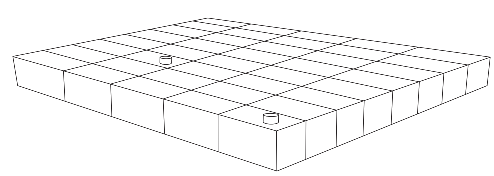
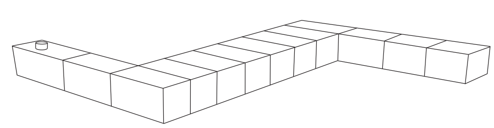
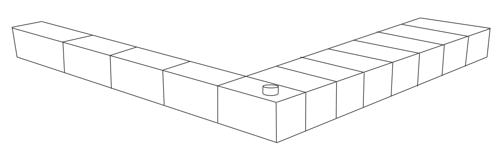
* Special design considerations required and limited availability
All dimensions are inside dimensions



Link Slab – for large storage assemblies, the unique link slab design allows significant reduction in the quantity of modules and associated costs, while providing the maximum in storage capacity.

Endless Configurations

Contact us today to start designing your system!

Oldcastle
Stormwater Solutions™

(800) 579-8819

www.oldcastlestormwater.com
www.stormcapture.com

KRISTAR

Humes
Water Solutions

Strength. Performance. Passion.

StormTrap® system Installation guide

SingleTrap™ model

Contents

The StormTrap® system

The StormTrap® system is a purpose-built stormwater detention and infiltration solution which provides a fully trafficable, below ground on-site detention system (OSD).

The system takes a unique design approach by connecting individual precast concrete modules into a single layer configuration that meets each project's requirements. This delivers a simple and flexible design solution without compromising above ground land use.

The growing popularity of the StormTrap® system is not only driven by its unique design and performance benefits, but by the significant installation economies it can provide. The modular design of the system means large detention volumes are delivered with the installation of each module. And because installers are able to use traditional construction processes, the installation can be completed in minimal time. Generally, it is expected that an individual StormTrap® module can be set in position in less than 10 minutes.

The StormTrap® system is available in two configurations to provide conventional detention, high early discharge or infiltration to ground water. The SingleTrap™ system and DoubleTrap™ system provide design solutions to meet volume requirements. This guide refers to the installation of the SingleTrap™ system.

The SingleTrap™ system is either founded on a strip footing to create a large infiltrative surface area, or founded on a conventional concrete slab for use as either a traditional detention basin or a basin with high early discharge.

The installation of the StormTrap® system is very simple:

1. Establish a suitable foundation.
2. Place modules row-by-row.
3. Apply StormWrap™ mastic tape across the top of the module joins.
4. Backfill.

There are a number of time-lapse videos available from humeswatersolutions.com.au which demonstrate the construction sequence and methodologies undertaken during the installation of a StormTrap® system. The library of videos includes a variety of project sizes and configurations.

As the system is made from precast concrete it is extremely strong and trafficable to AS 5100 traffic loadings (light duty designs are also available). Once the system has been installed there is no requirement for any further structural work in the trafficable pavement. The system will not deflect during construction loading, which allows rapid backfilling, and it won't suffer creep, as can be experienced with some lightweight systems.

Design and installation standards

The StormTrap® system is designed and installed in accordance with the requirements of the following Australian standards:

- AS 3600-2001 – Concrete Structures Code
- AS 5100-2004 – Bridge Design Code
- AS 5100.2-2004 – Bridge Design – Design Loads
- AS 1597.2-1996 – Precast Reinforced Concrete Box Culverts - Large Culverts
- AS/NZS 1170.1-2002 – Structural Design Actions – Part 1: Permanent, Imposed and other Actions.

Specifications

Module details

There are a number of different StormTrap® modules available and their use and placement will depend on design requirements and site layout (refer to Figure 1).

While the length and width of the modules remains constant, the height, and subsequently the mass, will vary according to the leg height for the system. The leg height varies from 600 mm to 1,500 mm, and is adjustable at 25 mm increments within this range.

Some modules will contain openings to allow for stormwater pipes or culverts and maintenance access points. Inlets and outlets may be placed at varying inverts and positions around the perimeter of the structure.

Depending on the overall size, each StormTrap® system will generally be designed with either 600 mm or 1,050 mm diameter openings for access through the roof at either end of the system. However, access openings may be in any location to fit in with specific site requirements. Designs can be modified to accommodate 900 mm x 900 mm grates.

Masses and dimensions

SingleTrap™ modules have a maximum internal leg height of 1,500 mm. The maximum mass of each module is shown in Table 1.

Table 1 – Masses and dimensions (1,500 mm height)

Module type	Mass (kg)	Length x width (mm)
I	6,730	4,000 x 2,350
II	4,320	2,000 x 2,350
III	7,660	4,000 x 2,350
IV	4,810	2,000 x 2,350
V	4,810	2,000 x 2,350
VI	8,590	4,000 x 2,350
VII	5,280	2,000 x 2,350
Light duty I	4,400	4,000 x 2,350

Figure 1 – A sample layout of a SingleTrap™ system

V	III	III	IV
II	I	I	II
II	I	I	II
IV	III	III	V

Standard type I

Standard type II

Standard type III

Standard type IV

Standard type V

Standard type VI

Standard type VII

Light duty type I

Handling and installation

Safety

Safety is a priority for Humes. It is important for all parties to observe safety requirements and regulations during transportation, handling, storage and installation, including wearing appropriate personal safety protection equipment.

It is the responsibility of the main contractor or installation contractor to produce a Safe work method statement; we recommend that this statement complies with both the National Code of Practice for Precast Tilt-up and Concrete Elements in Building Construction, and local and state codes (where they exist). Personnel should follow any safety advice provided by the main contractor/installation contractor.

The precast concrete component should only be lifted using the appropriate lifting clutches which are fitted into the designated lift points via the cast-in anchors. All lifting equipment must be certified to lift the specific mass and approved for lifting heavy components. The mass of the StormTrap® modules will vary depending on its geometry; weights will be clearly marked on the precast units and in the relevant project drawings.

All lifting and placement must proceed with caution and strictly in accordance with all relevant occupational health and safety standards. Bumping or impact of modules can cause damage and should be avoided.

The advice in this publication is of a general nature only. Where any doubt exists as to the safety of a particular lift or installation procedure, seek the guidance of a professional engineer or contact Humes for advice.

Pre-delivery

To ensure the safe and efficient installation of the StormTrap® system it is important to undertake sufficient planning prior to its arrival on site.

Equipment requirements

The following list of equipment is required for a safe and efficient installation:

- tape measure
- a can of marking spray
- chalk line/masonry string
- pinch/crowbar
- stanley knife
- two ladders
- broom
- level
- four chains
- four five-tonne Swiftlift® clutches
- Swiftlift® clutches for manhole covers or risers
- swivel for chains
- 20 mm spacers or gap gauge (available from Humes)
- safety harness for working at height
- StormMastic™ sealant
- StormWrap™ mastic tape.

Left:
Gap gauge

Site preparation

Before the StormTrap® system is installed, the concrete foundation must be poured (refer to the approval drawings supplied by Humes). The foundation details will depend on whether the system is required to provide stormwater detention or infiltration (refer to Figure 2 and Table 2 for an example).

Once the foundation is cured mark the outside edges of the system on the slab (as per the layout dimensions of the approval drawings).

Figure 2 – Example of a foundation plan

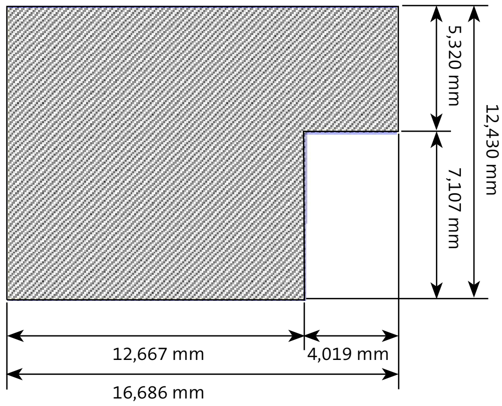
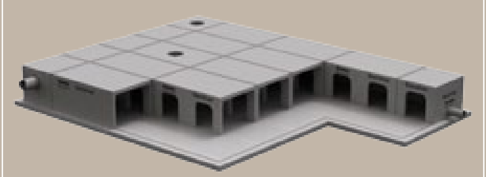
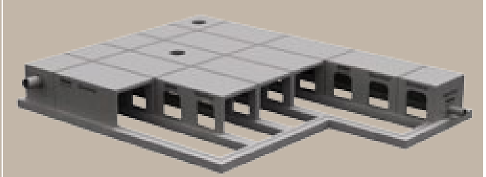
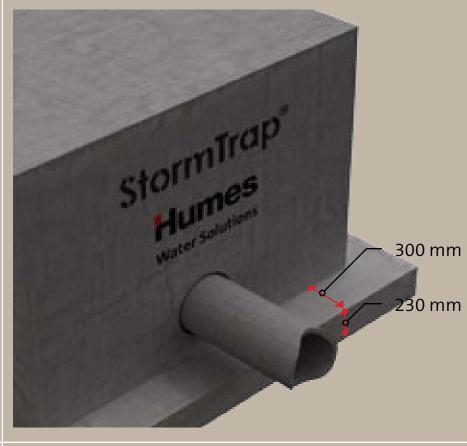
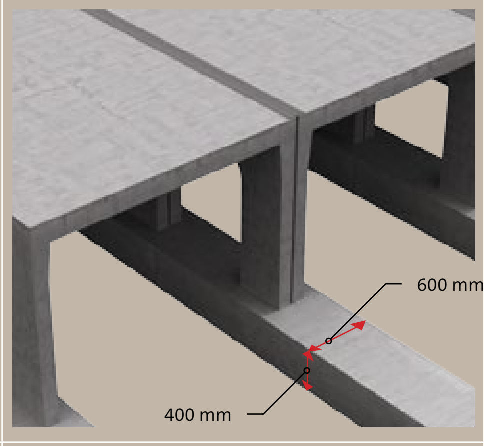


Table 2 – Foundation details

System type	Detention	Infiltration
		
Foundation	Continuous concrete slab	Strip footing
Dimensions	Slab is 230 mm thick* and extends 300 mm past outer edge of the system. 	Slab 'strips' are 400 mm thick and 600 mm wide running underneath the line of StormTrap® feet. 
Recommended cure period	7 days	7 days

Note:
*Slab design is based on in-situ material having a bearing capacity of 150 KPa; this may differ according to engineer's specifications.

Delivery

Prior to deliveries commencing, a pre-installation site meeting will occur with the contractor to finalise shipping plans including the sequencing of deliveries and the order of unloading and installing each of the modules.

The shipping plan will help to alleviate the double-handling of modules; save time and effort, make more efficient use of the crane, and reduce site congestion. The shipping plan will be provided to both the specifying engineer and contractor for sign off prior to commencing the delivery of modules to site (refer to Figure 3).

The StormTrap® modules will be delivered to site either on a semi-trailer or B-double depending on site access and the number of modules to be delivered. Each truck will typically contain 3-6 modules depending on the particular module type and mass. The first truck will typically take about 45 minutes to unload, the second truck about 30-45 minutes, and then each subsequent truck about 20-30 minutes.

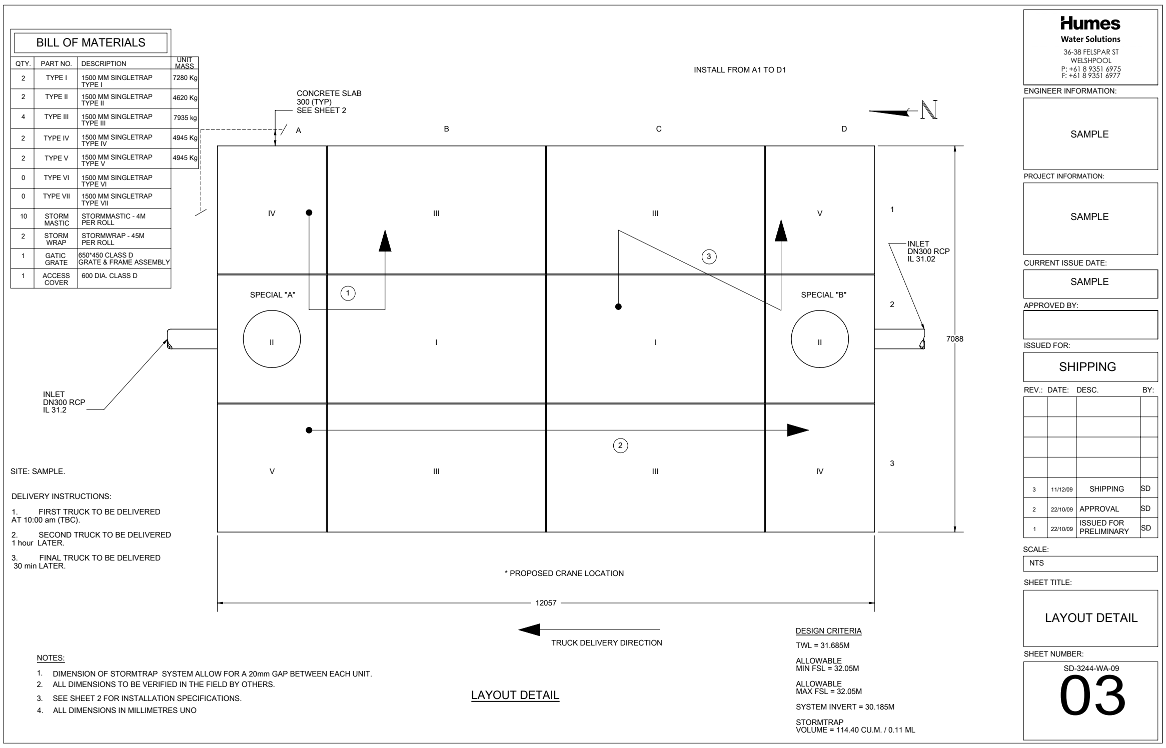
Lifting

All the precast units are supplied with cast-in lifting anchors to enable safe handling. To prevent stress and possible concrete cracking, all units must be handled using the cast-in lifting anchors and associated lifting clutches (lifting clutches can be obtained from the crane contractor or Humes). Installers should use tagged lifting equipment only. It is the installation contractor's responsibility to ensure the lifting clutches are available on site. The lifting points of anchors are clearly shown on the Humes drawings.

Wherever possible, all modular components should be lifted from the delivery truck and set directly onto the prepared substructure. Each module will take approximately 5-10 minutes to unload and set into position.

If for some reason temporary storage of the modules is required on site, they should be placed carefully on level, even ground, free of rocks and uniformly supported across the entire leg surface by using timbers. Modules should not be stacked on top of each other.

Figure 3 – Example of a shipping plan



Module installation

Top:
Step one

Middle:
Step two

Bottom:
Step three

A representative of Humes Water Solutions will be present on site at the commencement of the installation (as required) to provide support to the contractor and observe deliveries and installation.

The StormTrap® system is typically installed as follows:

1. Sweep the concrete slab/footings clean of dirt and debris.

2. Lay a bead of StormMastic™ sealant on the slab approximately 60 mm inside the perimeter line marking.

3. Secure the first module with four Swiftlift® anchors. Take care not to strike the modules together when you are unloading and lowering them. Be aware of pinch hazard at all times and don't walk or work under suspended loads.

4. When lowering the first module into position, pause 50 mm above the concrete slab, then gradually lower it into position once it is aligned with the perimeter markings. Ensure the unit is square and the bottom of the module is on the foundation before you remove the lifters.

Top:
Step four

Middle:
Step five

Bottom:
Step six

5. Align the next module with the edge markings and position it adjacent to, but no more than 20 mm from the first block (check with a gap gauge). Use a pinch or crowbar to assist with the finer adjustment of the modules.

6. Continue to install the modules row-by-row, in the order shown on the shipping plan.

Top:
Step seven

Bottom:
Step eight

7. Once two rows of modules have been laid and checked, apply StormWrap™ tape across the joins.

8. When four rows of modules have been laid, checked and sealed, backfilling can then occur (refer per note F. on page 2 of the approval drawings).

Note: During the installation check the overall dimensions of the system to make sure creep is not occurring. Adjust the laying gap when necessary to recover any discrepancies.

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THE ADVANCED CONCRETE PAVEMENT TECHNOLOGY (ACPT) Products Program is an integrated, national effort to improve the long-term performance and cost-effectiveness of the Nation's concrete highways. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, the goals of the ACPT Products Program are to reduce congestion, improve safety, lower costs, improve performance, and foster innovation.

The ACPT Products Program identifies, refines, and delivers for implementation available technologies from all sources that can enhance the design, construction, repair, and rehabilitation of concrete highway pavements. The ACPT Marketing Plan enables technology transfer, deployment, and delivery activities to ensure that agencies, academia, and industry partners can derive maximum benefit from promising ACPT products in the quest for long-lasting concrete pavements that provide a safe, smooth, and quiet ride.

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U.S. Department of Transportation
Federal Highway Administration

TechBrief

DECEMBER 2012 | FHWA-HIF-13-006

Pervious Concrete

This TechBrief presents an overview of pervious concrete and its use in pavement applications. General information on the composition of pervious concrete is provided, along with a summary of its benefits, limitations, and typical properties and characteristics. Important considerations in mix proportioning, hydrological design, structural design, construction, and maintenance are also described.

Introduction

Pervious concrete, sometimes referred to as no-fines, gap-graded, permeable, or enhanced porosity concrete, is an innovative approach to controlling, managing, and treating stormwater runoff. When used in pavement applications, pervious concrete can effectively capture and store stormwater runoff, thereby allowing the runoff to percolate into the ground and recharge groundwater supplies.

Pervious concrete contains little or no fine aggregate (sand) and carefully controlled amounts of water and cementitious materials. The paste coats and binds the aggregate particles together to create a system of highly permeable, interconnected voids that promote the rapid drainage of water (Tennis et al. 2004; ACI 2010). Typically, between 15 and 25 percent voids are achieved in the hardened concrete, and flow rates for water through the pervious concrete are generally in the range of 2 to 18 gal/min/ft^2 (81 to 730 L/min/m^2), or 192 to 1,724 inch/hr (488 to 4,379 cm/hr) (ACI 2010). Figure 1 shows a typical cross section of a pervious concrete pavement.

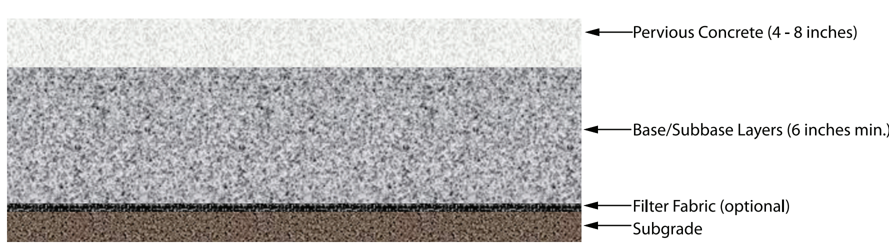

FIGURE 1. Typical pervious concrete pavement cross section (adapted from EPA 2010).

Benefits and Limitations

Table 1 summarizes some of the major benefits and limitations associated with pervious concrete. As described above, perhaps the most significant benefit provided by pervious concrete is in its use as a stormwater management tool. Stormwater runoff in developed areas (often the result of or exacerbated by the presence of conventional impervious pavement) has the potential to pollute surface and groundwater supplies, as well as contribute to flooding and erosion (Leming et al. 2007).

Pervious concrete can be used to reduce stormwater runoff, reduce contaminants in waterways, and renew groundwater supplies. With high levels of permeability, pervious concrete can effectively capture the "first flush" of rainfall (that part of the runoff with a higher contaminant concentration) and allow it to percolate into the ground where it is filtered and "treated" through soil chemistry and biology (Tennis et al. 2004; ACI 2010).

Other major benefits provided by pervious concrete include reduction in heat island effects (water percolating through the pavement can exert a cooling effect through evaporation, and convective airflow can also contribute to cooling (Cambridge 2005)), reductions in standing water on pavements (and associated hydroplaning and splash/spray potential), and reduced tire–pavement noise emissions (due to its open structure that helps absorb noise at the tire–pavement interface) (ACI 2010). In addition, pervious concrete can contribute toward credits in the LEED® (Leadership in Energy and Environmental Design) rating system for sustainable building construction (Ashley 2008).

Along with its many benefits, there are some limitations associated with the use of pervious concrete. First and foremost, pervious concrete has typically been used on lower trafficked roadways, although there are a number of installations on higher volume facilities, and research is being conducted on the structural behavior of pervious concrete slabs (see, for example, Suleiman et al. 2011; Vancura et al. 2011). In addition, pervious concrete exhibits material characteristics (primarily lower paste contents and higher void contents) and produces hardened properties (notably density and strength) that are significantly different from conventional concrete; as a result, the current established methods of quality control/quality assurance (e.g., slump, strength, air content) are in many

TABLE 1. Summary of Pervious Concrete Benefits and Limitations (Tennis et al. 2004; ACI 2010)

Benefits/Advantages	Limitations/Disadvantages
• Effective management of stormwater runoff, which may reduce the need for curbs and the number and sizes of storm sewers. • Reduced contamination in waterways. • Recharging of groundwater supplies. • More efficient land use by eliminating need for retention ponds and swales. • Reduced heat island effect (due to evaporative cooling effect of water and convective airflow). • Elimination of surface ponding of water and hydroplaning potential. • Reduced noise emissions caused by tire–pavement interaction. • Earned LEED® credits.	• Limited use in heavy vehicle traffic areas. • Specialized construction practices. • Extended curing time. • Sensitivity to water content and control in fresh concrete. • Lack of standardized test methods. • Special attention and care in design of some soil types such as expansive soils and frost-susceptible ones. • Special attention possibly required with high groundwater.

cases not applicable (ACI 2010). Moreover, a number of special practices, described later, are required for the construction of pervious concrete pavements. And, while there have been concerns about the use of pervious concrete in areas of the country subjected to severe freeze–thaw cycles, available field performance data from a number of projects indicate no signs of freeze–thaw damage (Delatte et al. 2007; ACI 2010).

Applications

Pervious concrete has been used in pavement applications ranging from driveways and parking lots to residential streets, alleys, and other low-volume roads (Tennis et al. 2004). Within these applications, pervious concrete has been used as the surface course, as a drainable base course (often in conjunction with edge drains to provide subsurface drainage), or as a drainable shoulder (to help provide lateral drainage to a pavement and prevent pumping). The focus in recent years has been on its use as a surface course as a means of providing stormwater management.

Typical Properties and Characteristics

As noted previously, many of the properties of pervious concrete are different from those of conventional concrete. These properties are primarily a function of the porosity (air void content) of the pervious concrete, which in turn depends on the cementitious content, the water-to-cementitious materials (w/cm) content, the compaction level, and the aggregate gradation and quality (ACI 2010). Table 2 summarizes some of the typical material properties associated with pervious concrete. These properties and characteristics must be considered during the structural design and pavement construction.

The cost of pervious concrete may be 15 to 25 percent higher than conventional concrete, but cost can vary significantly depending on the region, the type of application, the size of the project, and the inclusion of admixtures.

Mixture Proportioning

Like conventional concrete, pervious concrete is a mixture of cementitious materials, water, coarse aggregate, and possibly admixtures, but it contains little or no fines; however, note that a small amount of fine aggregate, typically 5 to 7 percent, is required for freeze–thaw durability (Schaefer et al. 2006; Kevern et al. 2008). Table 3 shows the typical range of materials proportions that have been used in pervious concrete. Commentary on the components of a pervious concrete is provided below (Tennis et al. 2004; Delatte et al. 2007; ACI 2010):

Cementitious materials. As with conventional concrete mixtures, conventional portland cements or blended cements are used as the primary binder in pervious concrete, although supplementary cementitious materials may also be used.

TABLE 2. Typical Pervious Concrete Properties (Tennis et al. 2004; Obla 2007)

Property	Common Value / Range
Plastic Concrete	
Slump	N/A
Unit weight	70% of conventional concrete
Working time	1 hour
Hardened Concrete	
In-place density	100 to 125 lb/ft^3
Compressive strength	500 to 4,000 lbf/in^2 (typ. 2,500 lbf/in^2)
Flexural strength	150 to 550 lbf/in^2
Permeability	2 to 18 gal/ft^2/min (384 to 3,456 ft/day)

1 in = 25.4 mm; 1 lb/ft^3 = 16 kg/m^3; 1 lbf/in^2 = 6.89 kPa; 1 gal/ft^2/min = 40.8 L/m^2/min

Coarse aggregate. Coarse aggregate is kept to a narrow gradation, with the most common gradings of coarse aggregate used in pervious concrete meeting the requirements of ASTM C33/C33M—aggregate sizes of 7, 8, 67, and 89. Coarse aggregate size 89 (top size 0.375 inch (9.5 mm)) has been used extensively for parking lot and pedestrian applications. Rounded and crushed aggregates, both normal and lightweight, have been used to make pervious concrete.

Water. The control of water is important in the development of pervious concrete mixtures, and the selection of an appropriate w/cm value is important for obtaining desired strength and void structure in the concrete. A high w/cm can result in the cement paste flowing off of aggregate and filling the void structure, whereas a low w/cm can result in mixing and placement difficulties and reduced durability. Commonly, w/cm values between 0.27 and 0.34 are used.

Admixtures. As with conventional concrete, chemical admixtures can be used in pervious concrete to obtain or enhance specific properties of the mixture. In particular, set retarders and hydration stabilizers are commonly used to help control the rapid setting associated with many pervious concrete mixtures. Air-entraining admixtures are required in freeze–thaw environments although no current method exists to quantify the amount of entrained air in the fresh paste. Air entrainment can be determined on hardened samples according to ASTM C457.

Mix proportioning for pervious concrete is based on striking a balance between voids, strength, paste content, and workability (ACI 2010). As such, the development of trial batches is essential to determining effective mix proportions using locally available materials. Detailed information on mix proportioning is available from ACI (2010).

Some limited work has been done investigating the freeze–thaw characteristics of pervious concrete and mix design for cold weather climates (NRMCA 2004; Schaefer et al. 2006). The freeze–thaw resistance of pervious concrete appears to be dependent on the saturation level of the voids; consequently a drainable base layer with a minimum thickness of 6 inches (150 mm) is recommended to help keep the pervious concrete layer from becoming saturated. Furthermore, as previously noted, the freeze–thaw resistance of pervious concrete has been shown to improve when sand is included in the pervious concrete mixture (Schaefer et al. 2006; Kevern et al. 2008).

Design of Pervious Pavements

Two primary considerations enter into the determination of the thickness of pervious concrete pavements: 1) hydrologic design to meet environmental requirements and 2) structural design to withstand the anticipated traffic loading applications (Leming et al. 2007; ACI 2010). These design considerations are briefly described below.

TABLE 3. Typical Pervious Concrete Materials Proportions (ACI 2010)

Mix Constituent or Design Parameter	Range
Coarse aggregate	2,000 to 2,500 lb/yd^3
Cementitious materials	450 to 700 lb/yd^3
Water-to-cementitious ratio	0.27 to 0.34
Aggregate-to-cementitious ratio (by mass)	4 to 4.5:1

1 lb/yd^3 = 0.59 kg/m^3

Hydrologic Design

In evaluating the hydrologic design capabilities of a pervious pavement, the approach is to determine whether the characteristics of the pervious concrete pavement system are sufficient to infiltrate, store, and release the expected inflow of water (which

includes direct rainfall and may also include excess runoff from adjacent impervious surfaces). As such, information required in a hydrologic analysis includes the precipitation intensity levels, the thickness and permeability characteristics of the pervious concrete pavement, cross slopes and geometrics, and permeability properties and characteristics of the underlying base, subbase, and subgrade materials.

Many hydrological design methods exist that can be used when designing pervious concrete pavement systems, including the Natural Resources Conservation Service Curve Number Method and the Rational Method (Leming et al. 2007). In essence, the hydrologic design of pervious concrete pavements should consider two possible conditions to ensure that excess surface runoff does not occur (Leming et al. 2007):

1. Low permeability of the pervious concrete material that is inadequate to capture the "first flush" of a rainfall event.

2. Inadequate retention provided in the pervious concrete structure (slab and subbase).

Often, the thickness of a pervious concrete pavement is first determined based on structural requirements and then analyzed to determine its suitability to meet the hydrologic needs of the project site. If the thickness is found to be insufficient, adjustments can be made to the thickness of the pervious pavement or the underlying base course. Details on hydrologic design are beyond the scope of this document but are available in the literature (Leming et al. 2007; Wanielista et al. 2007; Rodden et al. 2011).

Structural Pavement Design

Pervious concrete pavements can be designed using virtually any standard concrete pavement procedure (e.g., American Association of State Highway and Transportation Officials, Portland Cement Association, StreetPave) (Delatte 2007). The American Concrete Pavement Association has recently developed a comprehensive program, PerviousPave, that can be used to develop both structural and hydrological designs for pervious pavements (Rodden et al. 2011). Regardless of the procedure used, there are critical factors to consider in the design of pervious concrete pavements (ACI 2010):

Subgrade and subbase. In the design of pervious pavements, foundation support is typically characterized by a composite modulus of subgrade reaction, which should account for the effects of both the subgrade and the subbase. An open-graded subbase is commonly used beneath pervious concrete pavements not only to provide an avenue for vertical drainage of water to the subgrade, but also to provide storage capabilities. Special subgrade conditions (such as frost susceptibility or expansive soils) may require direct treatment.

Concrete flexural strength. The flexural strength of concrete is an important input in concrete pavement structural design. However, testing to determine the flexural strength of pervious concrete may be subject to high variability; therefore, it is common to measure compressive strengths and to use empirical relationships to estimate flexural strengths for use in design (Tennis et al. 2004).

Traffic loading applications. The anticipated traffic to be carried by a pervious pavement is commonly characterized in terms of equivalent 18,000-lb (80 kN) single-axle load repetitions, which many procedures compute directly based on assumed truck-traffic distributions. Most pervious concrete pavements are used in low-truck-traffic applications.

Currently there are no thickness standards for pervious concrete pavements, but many pervious pavements for parking lots are constructed 6 inches (150 mm) thick, whereas pervious pavements for low-volume streets have been

constructed between 6 and 12 inches (150 and 300 mm) thick (ACI 2010).

Construction Considerations

Because of its unique material characteristics, pervious concrete has a number of special construction requirements. Key aspects of pervious concrete construction include the following (Tennis et al. 2004; ACI 2010):

Placement and consolidation. Most pervious concrete is placed using fixed-form construction. For smaller projects, a hand-held straightedge or vibrating screed may be acceptable for placement, whereas for larger projects an A-frame, low-frequency, vibrating screed may be used. A few projects have used laser screeds and concrete slipform equipment. Consolidation is generally accomplished by rolling the concrete with a steel roller. Overall, the low water content and porous nature of pervious concrete require that delivery and placement be completed as quickly as possible.

Finishing. Pervious concrete pavements are not finished in the same manner as conventional pavements. In essence, the final surface finish is achieved as part of the consolidation process, which leaves an open surface. Normal concrete finishing procedures, such as with bull floats and trowels, should not be performed.

Jointing. Jointing is commonly done on pervious concrete to control random crack development. These joints are commonly formed (using a specially designed compacting roller-jointer) to a depth between one-fourth and one-third of the slab thickness.

Curing and protection. After the concrete has been jointed, it is important that the concrete be effectively cured; this is commonly achieved through the placement of thick (typically 6 mil (0.15mm)) plastic sheeting over all exposed surfaces. The plastic sheeting should be applied no later than 20 minutes following discharge of the concrete, and should remain in place for at least 7 days (longer times may be required under cold weather placement conditions or if supplementary cementitious materials are used in the mix). Liquid membrane curing compounds are not commonly used because they prevent surface moisture loss and do nothing to prevent evaporation from within the pervious concrete (Kevern et al. 2009).

Inspection and testing. The American Concrete Institute has prepared a summary of recommended inspection and testing activities that should be performed during construction of pervious concrete pavements (ACI 2010), as well as a specification for pervious concrete construction (ACI 2008). Acceptance testing for pervious concrete is typically limited to density (ASTM C1688) and thickness (ASTM C42). Test methods specific to pervious concrete are listed below:

- ASTM C1688, *Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.*
- ASTM C1701, *Standard Test Method for Infiltration Rate of In Place Pervious Concrete.*
- ASTM C1747, *Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion.*
- ASTM C1754, *Standard Test Method for Density and Void Content of Hardened Pervious Concrete.*

In recognition of the special construction requirements of pervious concrete, the National Ready Mixed Concrete Association has developed a program designed to educate, train, and certify contractors in pervious concrete placement (see http://nrmca.org/Education/Certifications/Pervious_Contractor.htm).

Maintenance

Over time, sand, dirt, vegetation, and other debris can collect in pervious concrete's voids and reduce its porosity, which can negatively affect

the functionality of the system. Thus, periodic maintenance may be needed to remove surface debris and restore infiltration capacity. Two common maintenance methods are pressure washing and power vacuuming (ACI 2010).

Performance

The performance of pervious concrete pavements may be assessed in a number of ways, including monitoring changes in the permeability/porosity of the system (which would indicate clogging of the void structure), the presence of distress (both structural and surficial), and resistance to freeze–thaw damage. Unfortunately, there are limited long-term performance data on pervious concrete, but generally performance is considered satisfactory. For example, a study in Florida indicated that pervious concrete pavements that were 10 to 15 years old were operating in a satisfactory manner without significant amounts of clogging (Wanielista et al. 2007). In another study, field inspections of 22 projects located in freeze areas were conducted, with reported good performance and no visual signs of freeze–thaw damage (although all projects were less than 4 years old at the time of inspection) (Delatte et al. 2007).

Where the performance of pervious concrete pavements has not been satisfactory, poor performance is often attributed to contractor inexperience, higher compaction of soil than specified, and improper site design (ACI 2010).

Summary and Future Needs

The use of pervious concrete has increased significantly in the last several years, perhaps largely because it is considered an environmentally friendly, sustainable product. The use of pervious concrete provides a number of benefits, most notably in the effective management of stormwater runoff. Other significant benefits include reducing contaminants in waterways, recharging groundwater supplies, reducing heat island effects, and reducing pavement–tire noise emissions.

Still, there are a number of areas that need additional developmental work to improve or enhance the capabilities of pervious concrete pavements. One area is the continued monitoring of the performance of pervious concrete so that long-term performance trends can be documented; this will also help in evaluating the suitability of pervious concrete for other applications, such as overlays. Tied in with this is the assessment of the suitability of current structural design approaches to provide competent designs, particularly regarding the fatigue behavior of pervious concrete. Finally, a third area is in the testing and evaluation of pervious concrete, as current test methods for conventional concrete are not generally applicable to pervious concrete.

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Sam Tyson, P.E.—sam.tyson@dot.gov

ACPT Implementation Team
Shiraz Tayabji, Ph.D., P.E., Fugro Consultants, Inc.—stayabji@aol.com

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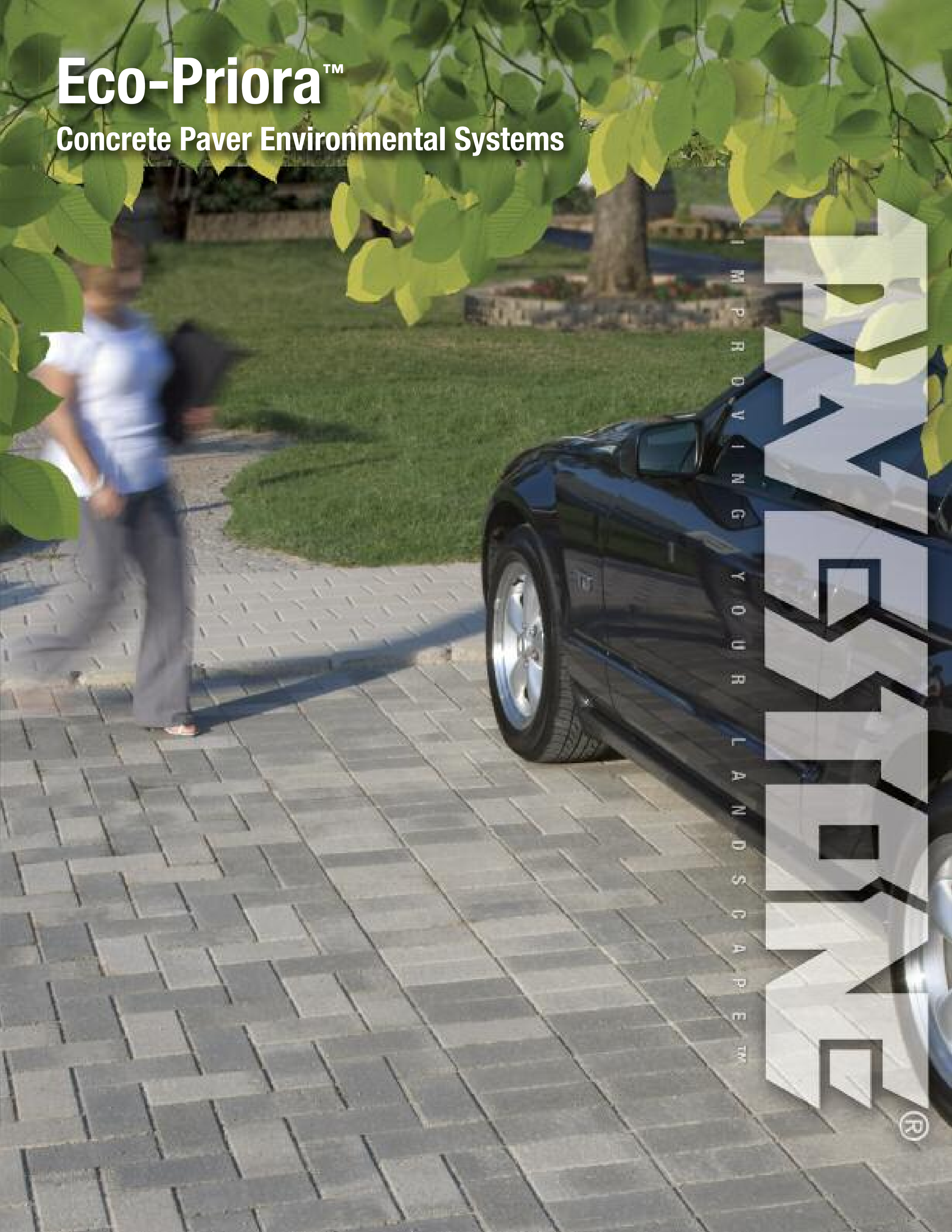
Key Words—concrete pavement construction, design, drainage, LEED® credit, maintenance, pavement design, pavement construction, permeability, pervious concrete, porous concrete, stormwater, sustainability

Eco-Priora™

Concrete Paver Environmental Systems



IMPROVING YOUR LANDSCAPE™

Eco-Priora™

Pavestone Eco-Priora™ is the sustainable solution for permeable pavements. Eco-Priora™ is produced in a 120mm x 240mm rectangular module that is 80mm in thickness with a patented interlocking joint and a micro-chamfered top edge profile. This ingenuity is singular to the Pavestone Eco-Priora™ product and insures optimum pavement performance unequaled in the permeable paver industry. The unique Eco-Priora™ joint profile allows surface water to infiltrate into the pavement and its sub-layers. With initial permeability average flow rates of over 100 inches per hour, the Eco-Priora™ product, even with a clogging factor, will still meet the majority of current storm water management plans (SWMP). The structural interlocking capability is achieved by the paving unit having interlocking joints with a minimum of two vertically aligned horizontal interlocking spacer bars on each of its sides. These spacer bars interlock throughout the depth of the block and nest adjacently with neighboring paving units. This interlocking function resists lateral and vertical displacement when the unit is exposed to load. The dynamics of pavement stress are better distributed providing a structurally superior permeable paving system.

The micro-chamfered top edge profile produces a horizontal edge to edge dimension that is nominally 7mm including installation gapping. This small joint complies dimensionally with current ADA requirements for walking surfaces with spaces no greater than 1/2 inch. This narrow jointed surface diminishes vibration for wheelchairs and shopping carts when compared to all other permeable paving products. Eco-Priora™ can assist in meeting current EPA storm water regulations and LEED certification. The Eco-Priora™ product best achieves the balance of aesthetic segmental paving and the function of permeable pavement.

APPLICATIONS

Parking Lots • Driveways • Patios • Entrance Areas • Sidewalks
Terraces Garden Pathways • Pool Decks • Pedestrian Malls • Roof Gardens • Streets

COMPOSITION AND MANUFACTURE

Eco-Priora™ is available in one size. Height = 80mm. Eco-Priora™ is made from a "no slump" concrete mix made under extreme pressure and high frequency vibrations. Eco-Priora™ has a compressive strength greater than 8000 psi, a water absorption maximum of 5% and will meet or exceed ASTM C-936. Note: Requires modifying the ASTM C 140 - Paver Annex A4 - "The test specimen shall be 60 ± 3 mm thick and, if necessary, cut to a specimen size having a Height/Thickness (width) [H/T] aspect ratio of 0.6 ± 0.1

INSTALLATION

1. Excavate unsuitable, unstable or unconsolidated subgrade material. Compact the area, which has been cleared as per the engineer's of record (EOR) requirements. Backfill and level with open graded aggregates as per the EOR's structural and hydraulic design.
2. Place bedding course of hard and angular material conforming to the grading requirements of ASTM No. 8 or No. 9 to a uniform minimum depth of 1 1/2" -2". (38mm) screeded to the grade and profile required.
3. Install Eco-Priora™ with joints approximately 1/4". (7mm).
4. Where required, cut pave stones with an approved cutting device to fit accurately, neatly and without damaged edges.
5. Tamp pave stones with a plate compactor, uniformly level, true to grade and free of movement.
6. Spread a thin layer of hard angular material conforming to the grading requirements of ASTM No. 8 or No. 9 aggregate over entire paving area.
7. Make one more pass with plate compactor to nest the aggregate and fill joints to the top.
8. Sweep and remove surplus joint material.

Complete installation & specification details are available by contacting your Pavestone Sales Representative.

Note: ✔ Permeable pavements require both civil and hydraulic engineering. All final pavements design shall be approved by a licensed engineer familiar with local site conditions, building codes and storm water management plans.

PRODUCT INFORMATION

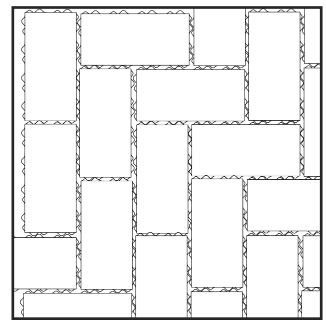
Eco-Priora™ is available in one size. Height = 80mm

ECO-PRIORA™
(120mm x 240mm)

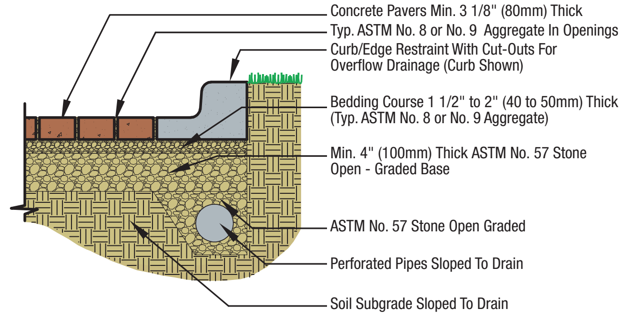
Eco-Priora™

Dimensions:	4 3/4" W x 9 7/16" L x 3 1/8" H
Wt./Stone:	11.5 lbs.
Stones/Pallet:	280
Approx. Wt./Pallet:	3,255 lbs.
Sq. Ft./Pallet:	88
Product Number:	699

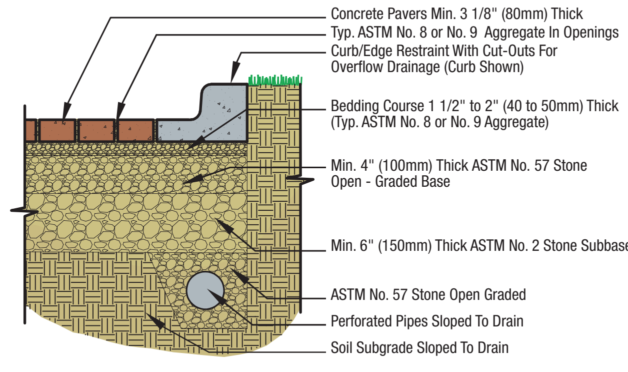
INSTALLATION PATTERN

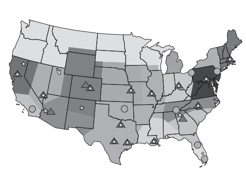


PERMEABLE PAVERS TREATMENT



PERMEABLE PAVERS TREATMENT AND DETENTION





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• Hagerstown, MD:	(240) 420-3780		

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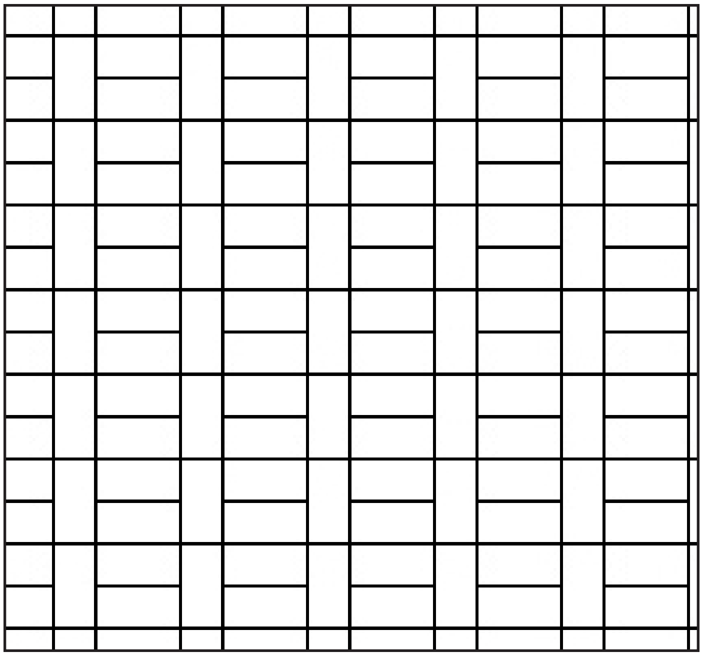
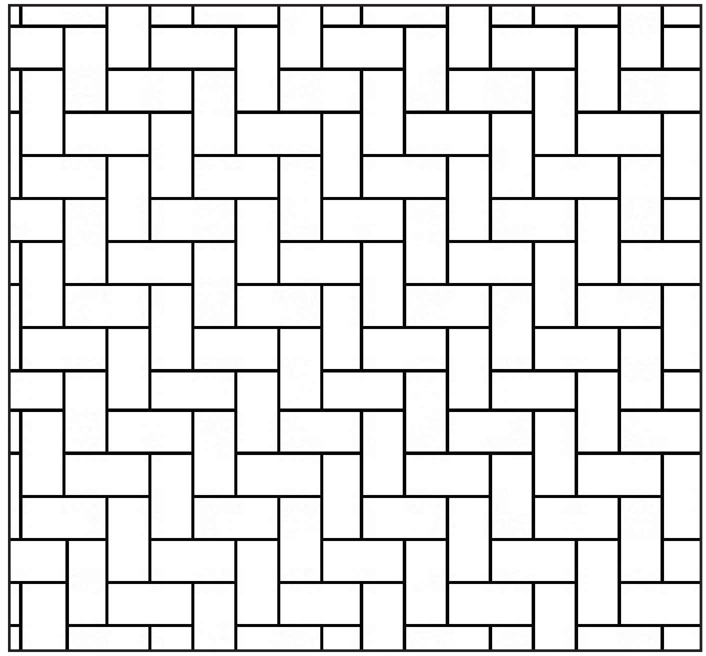
Eco-Priora™ 699 Installation Patterns



BASKETWEAVE (1)



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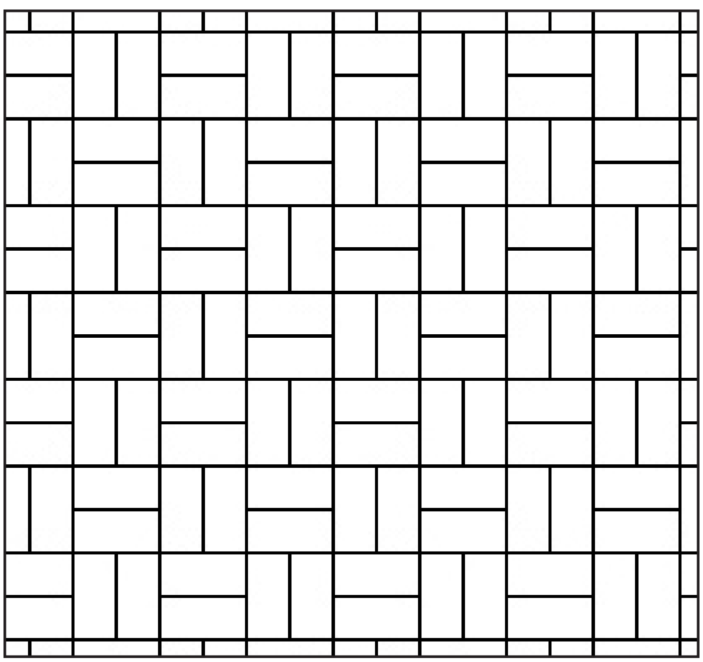
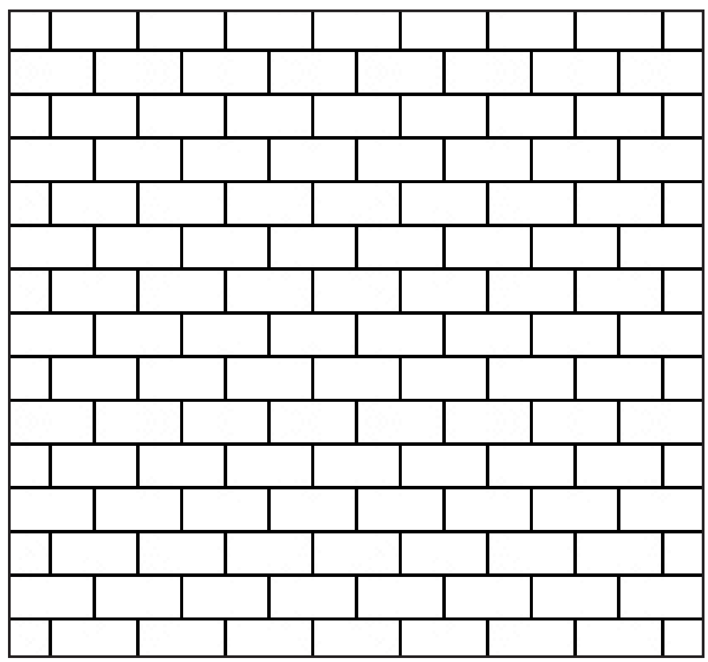


PARQUET (5)

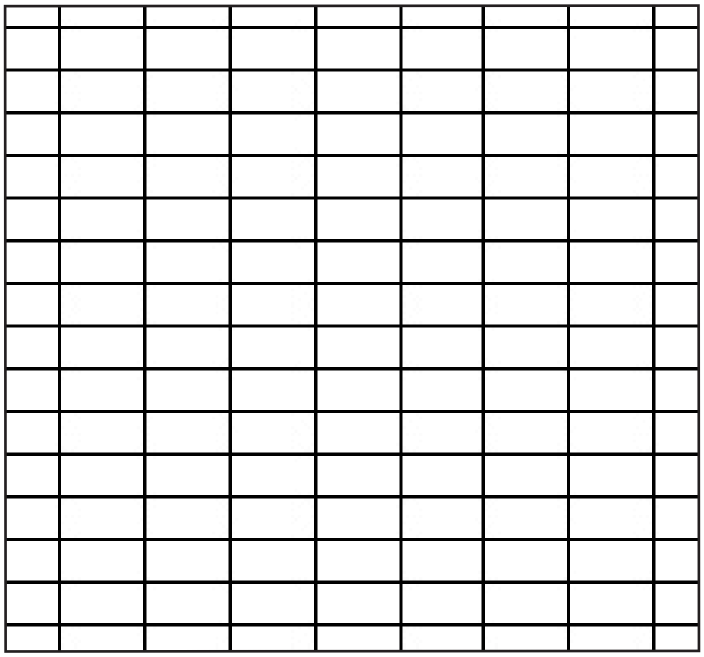


RUNNER BOND (7)

PAVESTONE®

CREATING BEAUTIFUL LANDSCAPES℠

Eco-Priora™ 699 Installation Patterns



STACK (8)

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CREATING BEAUTIFUL LANDSCAPES™

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AquaLine™ L-stone Multi-Cobble
Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial AquaLine™ paver series, while the innovative design features of L-shape make it the perfect pavement choice for plazas, sidewalks, parking lots, alleys and small roadways. It is available in a variety of nationally offered colors, finishes and surface textures, including Texturgard™ - an ultra-durable wearing course that virtually eliminates the appearance of aging.

ADA COMPLIANT | HEAVY VEHICULAR—100MM | VEHICULAR—80MM | MECHANICAL INSTALLATION

Designed to provide an aesthetically pleasing large format permeable surface that is pedestrian friendly and functional for vehicular traffic. AquaLine combines structural joints and infiltrating voids to optimize system performance. Easier to install due to the additional interlock provided by the L-shape. It is the result of years of research on existing permeable paver products.

Benefits of AquaLine™ L-stone Multi-Cobble

STRENGTH
Manufactured to exceed the minimum standards specified in ASTM C936. Test results from an independent third party are available upon request.

ECOLOGICAL SOLUTIONS
Engineered to infiltrate up to 140 inches per hour which greatly exceeds even the heaviest storms. Where water quality improvements are required, select aggregates can be used in the voids to optimize contaminant removal.

ECONOMICAL
Permeable Pavement Systems serve as both the driving surface and stormwater management system, eliminating the need for traditional infrastructure, allowing more property to be used for revenue generation. Pavers have also been proven to last in excess of 50 years, greatly benefitting life cycle costs.

LOW MAINTENANCE
Maintenance is similar to what is commonly required for other pavement surfaces. If voids become plugged, aggregate and debris can be vacuum extracted and new aggregate material inserted, restoring the original infiltration rate.

AFFORDABILITY
Packaged for mechanical installation, resulting in a cost effective installed price.

COMFORT
ADA compliant walking surface that is high-heel and pedestrian friendly. Causes low-vibration for strollers, bikes, shopping carts and wheelchairs.

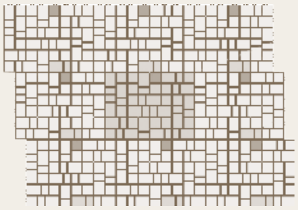
LEED POINTS
Can contribute to credits for stormwater quality and quantity, recycled materials, heat island effect, and innovation in design, among others.

AquaLine™ L-stone Multi-Cobble

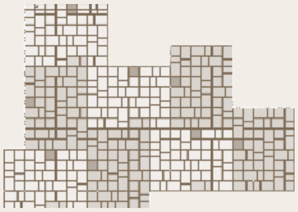
Size: 12” x 12” x 3 1/8” (or 12” x 12” x 4”)
Colors: 9 national colors, local custom colors available upon request
Finishes: Smooth, Shot Blast, Ground Face
Processes: Colorgard, Texturgard
Chamfer: 2mm
Spacers: Dual positive-interlocking integrated bars
Joint/Void: Maximum 8 mm non-structural voids
Appearance: Random 3 size cobble

BELGARD AQUALINE™ L-SHAPE	
Dimensions	12” x 12” x 80mm
sold by	sf
sf/plt	96
lbs/plt	3380
layers/plt	8
lf/plt	96*
units/plt	128
sf/layer	12
sf/unit	0.75
lf/unit	0.75
lbs/unit	26.4

*Linear feet measured when used as 12” soldier course installed in pairs (see front photo).



Stitched Pattern



Non-Stitched Pattern

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Eco Dublin™ Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial brand, and our Environmental Collection of permeable pavers is no exception. Belgard permeable pavers combine the best of Belgard with innovative stormwater management for a superior product line that provides sustainable solutions and aesthetically appealing designs.

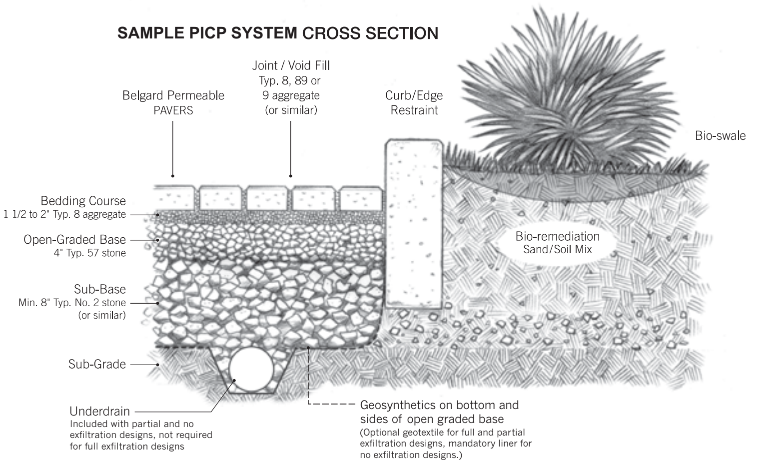
ADA COMPLIANT | LT. VEHICULAR—80MM | MECHANICAL INSTALLATION

Eco Dublin™

Smart-looking style meets smart science. The classic look of cut stone and contemporary materials technology combine in Eco Dublin™, the latest addition to Belgard's Environmental Series of permeable pavers.

Benefits of Belgard® Permeable Paving Stone Systems

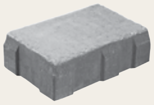
- On the US Environmental Protection Agency's (EPA) menu for structural Low Impact Development (LID) BMPs
- Can contribute toward several LEED NC-2009 points
- Reduces stormwater runoff by up to 100%
- Can be used to achieve total maximum daily load (TMDL) limits for a range of pollutants
- Certified SRI colors reduce heat island effect
- Can reduce or eliminate the need for traditional drainage and detention requirements, saving space and money
- Can be designed to accommodate all native soil types
- 50-year design life based on proven field performance



The availability of specific aggregate will often vary from region to region. In cases where it becomes necessary to substitute a similar size, your project engineer should always be consulted.

3 7/16" x 6 7/8" x 3 1/8"
(87.78mm x 174.57mm x 80mm)

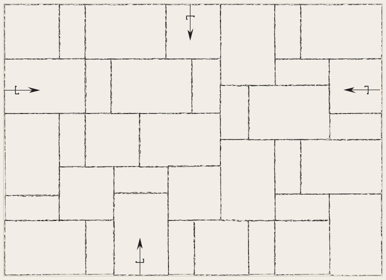
6 7/8" x 6 7/8" x 3 1/8"
(174.57mm x 174.57mm x 80mm)



Large Rectangle
6 7/8" x 10 1/4" x 3 1/8"
(174.57mm x 261.35mm x 80mm)

Shapes

(All three shapes come in each bundle.)



Mechanical Installation Laying Pattern

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Aqua Roc™
Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial brand, and our Environmental Collection of permeable pavers is no exception. Belgard permeable pavers combine the best of Belgard with innovative stormwater management for a superior product line that provides sustainable solutions and aesthetically appealing designs.

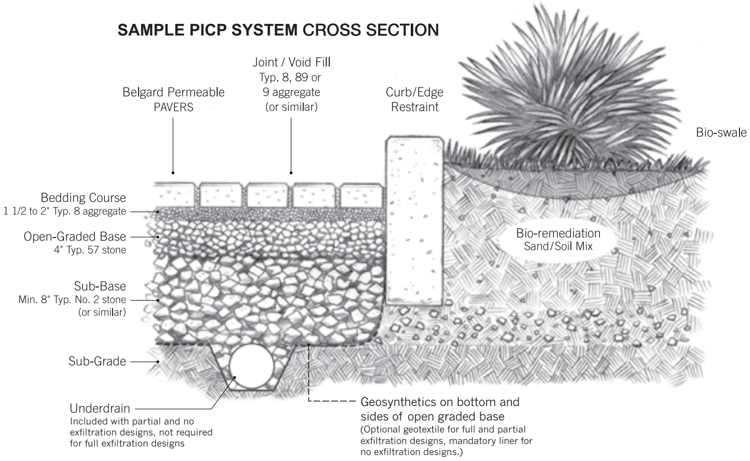
ADA COMPLIANT | VEHICULAR—80MM | LT. VEHICULAR—80MM | MECHANICAL INSTALLATION

Aqua Roc™

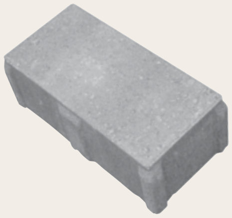
Aqua Roc is a versatile paver featuring not only the environmentally-friendly benefits of a permeable paver, but also high visual appeal, low maintenance, and proven durability. Aqua Roc's versatile pattern range allows for flexible design options, making it an excellent choice for vehicular use.

Benefits of Belgard® Permeable Paving Stone Systems

- On the US Environmental Protection Agency's (EPA) menu for structural Low Impact Development (LID) BMPs
- Can contribute toward several LEED NC-2009 points
- Reduces stormwater runoff by up to 100%
- Can be used to achieve total maximum daily load (TMDL) limits for a range of pollutants
- Certified SRI colors reduce heat island effect
- Can reduce or eliminate the need for traditional drainage and detention requirements, saving space and money
- Can be designed to accommodate all native soil types
- 50-year design life based on proven field performance

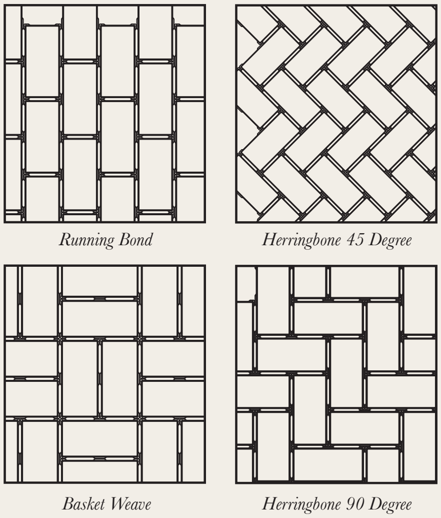


The availability of specific aggregate will often vary from region to region. In cases where it becomes necessary to substitute a similar size, your project engineer should always be consulted.



Shape

4 1/2" x 9" x 3 1/8"
(114.3mm x 228.6mm x 80mm)



Laying Patterns

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Interlocking Concrete Pavement Institute Certified Installer	City	State
California Outdoor Living	Anaheim	CA
Marina Landscape, Inc.	Anaheim	CA
VERSAI Design and Development, Pavers Division	Beverly Hills	CA
Pacific Coast Pavers	Brea	CA
Peterson Brothers Construction	Brea	CA
AJ's Landscaping	Brentwood	CA
Paver Decor Masonry, Inc.	Calimesa	CA
System Pavers - San Diego	Carlsbad	CA
OLVERA MASONRY INC.	Carpinteria	CA
Landmark Site Contractors	Corona	CA
Stepping Stone Landscape	Coronado	CA
Castlelite Block, LLC	Dixon	CA
Paver Plus, Inc.	Downey	CA
Paving Stone of San Diego, Inc.	El Cajon	CA
Coyote Construction - Pavers	Escondido	CA
Claddagh Paving	Fallbrook	CA
Aloha Pavers, Inc.	Huntington Beach	CA
I.M. Masonry Construction, Inc.	Lancaster	CA
Precision Contractors, Inc.	Lancaster	CA
Earth Shelter Developers	Lodi	CA
Go Pavers	Los Angeles	CA
Stowe Contracting, Inc.	Marina	CA
Stowe General Construction	Modesto	CA
Sierra Madre Landscape	Monrovia	CA
Systems Paving - Dallas	Newport Beach	CA
System Pavers - Novato	Novato	CA
Haney Landscape Inc.	Ojai	CA
System Pavers - Inland Impire	Ontario	CA
Alan Smith Pools	Orange	CA
Farley Interlocking Paving	Palm Desert	CA
Sunshine Landscape	Palm Desert	CA
DMA Construction	Paso Robles	CA
Edsons Pavers, Inc.	Perris	CA
Viking Pavers Inc.	Point Richmond	CA
System Pavers - Sacramento	Rancho Cordova	CA
McEntire Landscaping, Inc.	Redding	CA
INSTALL IT DIRECT	San Diego	CA
Landscapes West	San Diego	CA
Pavers 4 Less	San Diego	CA
Bauman Landscape and Construction	San Francisco	CA
Black Diamond Paver Stone and Landscape, Inc	San Jose	CA
European Paving Designs, Inc.	San Jose	CA
JCMS Landscaping	Santee	CA
Prime Gardens, Inc.	Sherman Oaks	CA
Alford's English Gardens INC	Signal Hill	CA
JFK Pavestone, Inc.	Simi Valley	CA

Tahoe Outdoor Living DBA Tahoe Paving Stones	South Lake Tahoe	CA
Pacific Pavingstone, Inc.	Sun Valley	CA
Weiland & Associates, Inc.	Swall Meadows	CA
System Pavers - Northern California	Union City	CA
System Pavers - Northern California	Union City	CA
Scarlett's Landscape, Inc.	Ventura	CA
System Pavers - Ventura	Ventura	CA
Southwest Specialties of California, Inc.	Walnut	CA
Southwest Specialties of California, Inc.	Walnut	CA

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
Anthonie		Smith		T.B. Penick	San Diego	CA	92128	Pervious Concrete Craftsman	6/3/2016
Bill		Beeson		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Craftsman	2/5/2019
Danny		Stewart		T.B. Penick	San Diego	CA	92128	Pervious Concrete Craftsman	6/3/2016
David		Liguori		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Craftsman	11/14/2019
Dennis	M.	Collins		Enviro-Crete, Inc.	Orangevale	CA	95662	Pervious Concrete Craftsman	10/1/2017
Guy		Collignon		Enviro-Crete, Inc.	Orangevale	CA	95662	Pervious Concrete Craftsman	6/13/2016
Steven	J.	Carrera		S 7 J Carrera Construction, Inc.	Watsonville	CA	95076	Pervious Concrete Craftsman	2/24/2016
Wayne		Jenness		T.B. Penick	San Diego	CA	92120	Pervious Concrete Craftsman	6/3/2016

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
Alejandro		Ruiz Villalobos		Robert A. Bothman	Salinas	CA		Pervious Concrete Installer	10/26/2017
Alexander		Renteria		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Arturo		Rosas		Beeson Masonry	Lake Hughes	CA	93532	Pervious Concrete Installer	8/6/2019
Daniel		Rodriguez Avalos		Robert A. Bothman, Inc.	Salinas	CA		Pervious Concrete Installer	10/26/2017
Edward		Ramirez		GPF Concrete	Perris	CA	92574	Pervious Concrete Installer	1/16/2017
Hector		Vela Villagrana		Robert A. Bothman Inc.	Antioch	CA	94509	Pervious Concrete Installer	10/26/2017
Humberto		Tovalin		T.B. Penick	San Diego	CA	92128	Pervious Concrete Installer	6/3/2016
Isaias		Ruiz		Melo Concrete Construction	Gilroy	CA		Pervious Concrete Installer	10/26/2017
Jaime		Sanitillan		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Jaime		Villegas		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
James		Lamping		T.B. Penick	San Diego	CA	92128	Pervious Concrete Installer	6/3/2016
Joey		Lankford		Beeson Masonry	Lake Hughes	CA	93532	Pervious Concrete Installer	8/6/2019
Jose		Ceron		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Installer	11/8/2015
Juan		Munoz		Galvan's Place and Finish	Perris	CA	92574	Pervious Concrete Installer	1/16/2017
Luis		Castellanos		Robet A. Bothman Inc.	San Jose	CA		Pervious Concrete Installer	10/26/2017
Mario		Ortiz		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Michael		Orosz		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Mike		Beczak		T.B. Penick	San Diego	CA	92128	Pervious Concrete	6/3/2016

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
								Installer	
Piedad		Menchara Solorio		Robert A. Bothman Inc.	Salinas	CA	93905	Pervious Concrete Installer	10/26/2017
Ricardo	R.	Galvan		Galvan's Place and Finish	Perris	CA	92571	Pervious Concrete Installer	1/16/2017
Robert		Estrada		Bay Area Pervious Concrete	San Carlos	CA	95040	Pervious Concrete Installer	5/4/2017
Ron		Parietti			Pilot Hill	CA	95664	Pervious Concrete Installer	6/30/2015
Salvador		Rosas		Robert A. Bothman Inc.	San Jose	CA	95116	Pervious Concrete Installer	10/26/2017
Sergio		Grageda		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Installer	11/8/2015
Victor		Santana		Robert A. Bothman Inc.	Salinas	CA	93906	Pervious Concrete Installer	10/26/2017

Appendix F – Soil Report

S15310002
CITY OF LOS ANGELES
BUREAU OF STANDARDS

140— 3305

LOG OF TEST HOLE NO. 2 DRILLED: 8-26-87

DRILL RIG: CME-75 using 8" diameter auger

LOCATION: 195' S/o SCF Burton St. & 21' W/o ℄ Sepulveda Place

ELEVATION: BY: McElroy

VERTICAL SCALE: 1"=5'

Depth	HYD. PRESS.	BLOW COUNT	DRY DENS.	FIELD MOIST.	SAMPLES	FIELD DESCRIPTION	UNIFIED SOIL CLASSIF.
2" 0						2" of sand and gravel base materials overlying brown fine to medium-grained poorly graded sand with a trace of clay fines. Slightly damp and fairly loose. Color changed to light tan at 8 ft. and below.	SP
5		8	107	6.5	■		
10, 10½		6	108	9.0	■	Brown clayey sand. Slightly damp and firm.	SC
13						Brownish tan fine to medium-grained poorly graded sand with some clay fines. Some small subrounded grounded gravel at 13 ft.	SP
15						NO WATER L.E.L. Readings at 5' and 10' were zero	

SAMPLES
REPRESENT.
SHELBY
SPLIT SPOON
PISTON

DEPTH IN FEET

FORM NO. 403 B

140- 3701

LOG OF TEST HOLE NO. 1 **DRILLED:** 3-8-91

CITY OF LOS ANGELES
BUREAU OF STANDARDS

904700001 ✓

DRILL RIG: CME-75 USING 6" DIAMETER AUGER

LOCATION: 3' E/o ECF Oxford Ave. & 35' N/o ¢ Melrose Ave. (In parkway by sidewalk)

ELEVATION: 302.0 Feet **BY:** Redlin

VERTICAL SCALE: 1" = 5'

Depth	Hyd. Press.	Blow Count.	Dry Dens.	Field Moist.	Samples	FIELD DESCRIPTION	UNIFIED SOIL CLASSIF.
0							
1	350		89	28.0	S	Dark brown, silt. Moist and firm. Color changed to light tan at 2½ ft. with an increase in silt content.	ML
3	650		104	26.0	S		
6						NO WATER	

LOG OF TEST HOLE NO. 2 **DRILLED:** 3-8-91

904700002

DRILL RIG: CME-75 USING 6" DIAMETER AUGER

LOCATION: 3' N/o SCF Melrose Ave. & 30' E/o ¢ Oxford Ave.

ELEVATION: 300.0 Feet **BY:** Redlin

VERTICAL SCALE: 1" = 5'

Depth	Hyd. Press.	Blow Count.	Dry Dens.	Field Moist.	Samples	FIELD DESCRIPTION	UNIFIED SOIL CLASSIF.
0 (9½")							
1	400		101	20.5	S	9½" AC pavement in poor condition with some settlement overlying light greenish brown silty sand/clayey sand. Moist and firm.	SM-SC
3	400		85	22.0	S		
6						NO WATER	

Depth In Feet

Samples

- ☒ Represent
- [S] Shelby
- ■ Split Spoon
- [P] Piston
- ☐

S15300001
CITY OF LOS ANGELES
BUREAU OF STANDARDS

140— 3305

LOG OF TEST HOLE NO. 1 DRILLED: 8-26-87

DRILL RIG: CME-75 using 8" diameter auger

LOCATION: 7' S/o ℄ Alley S/o Burton St. & 58' E/o ECF Sepulveda Place

ELEVATION: BY: McElroy

VERTICAL SCALE: 1" = 5'

DEPTH IN FEET	HYD. PRESS.	BLOW COUNT	DRY DENS.	FIELD MOIST.	SAMPLES	FIELD DESCRIPTION	UNIFIED SOIL CLASSIF.
4½" 0						4½" AC pavement (fair condition) overlying brown lean clay with some very fine-grained sand. Damp and firm	CL
5		5	102	9.0	■		
10							
12		7	109	8.5	■		
13						Light tan to brown clayey sand. Dry and firm. Clay decreasing with depth and progressing toward poorly graded sand at 17 ft.	SC to SP
15							
17						NO WATER L.E.L. Readings at 5' and 12' were zero	

SAMPLES
- REPRESENT.
- SHELBY
- SPLIT SPOON
- PISTON

FORM NO. 402 B

Appendix 4.D.3

Upgrades to Pump Plants and Associated Stormwater Treatment Opportunities in the City of Los Angeles Upper Los Angeles River Watershed

Implementation Strategy for Pump Plant 647

Upgrades to Pump Plants and Associated Stormwater Treatment Opportunities in the City of Los Angeles Santa Monica Bay Watershed

Implementation Strategy for Pump Plant 647

Jointly prepared by:

Tetra Tech
3475 East Foothill Boulevard
Pasadena, CA 91107

Black & Veatch Corporation
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Los Angeles, CA 90017

City of Los Angeles
LA Sanitation
Watershed Protection Division
1149 S Broadway, 10th Floor
Los Angeles, CA 90015-2213

June 11, 2015

Contents

1. Introduction

Multiple pollutants currently impair the beneficial uses of the Los Angeles beaches along the Pacific Ocean. To address these impairments, the City of Los Angeles (City) must comply with the water quality requirements presented in the Municipal Separate Storm Sewer System (MS4) Permit) and State-mandated total maximum daily loads (TMDLs). Recently prepared Drafts for the Enhanced Watershed Management Programs (EWMPs) prescribe collaborative and adaptive strategies for the City to attain compliance with these requirements; however, the scale of implementation is extraordinary.

The draft EWMPs currently forecast implementation of over 4,600 acre-feet of green infrastructure and regional control measures by the City (totaling $6 billion in capital cost) in the Upper Los Angeles River (ULAR) and Ballona Creek EWMP areas. At this scale, cost-effective implementation will be challenging in many locations, particularly when the suitable opportunities for stormwater treatment are *not* located near runoff and pollutant sources. One solution is to divert runoff to the highest efficiency opportunities using existing infrastructure.

EWMP Requirement:
Implement >4,600 acre-feet of BMPs in the Ballona Creek basin before 2021

There are multiple aging pump plants located strategically throughout the City of Los Angeles – each intended to alleviate or prevent flooding in low lying areas where gravity flow is not feasible (Figure 1). If upgrades to these pumps can be leveraged to provide water quality benefits (Figure 2), the advantages are two-fold:

1. ***Creating* High-Efficiency Treatment Opportunities:** The efficiency (pollutant reduction per dollar) is maximized by routing runoff to areas with high treatment potential and maximizing the treated drainage area using existing infrastructure.
2. **Improving Resilience:** Control measures sited upstream from pumps can reduce pump cycle frequency, energy use, and maintenance burden by intercepting and retaining runoff volume from small storm events.

This conceptual design describes recommended upgrades to the aging infrastructure at Pump Plant 647 along with integrating multi-benefit stormwater treatment strategies into the plant upgrades. A cost-effective solution that addresses Permit water quality requirements in tandem with flood control functions will be recommended. These solutions would also provide multiple other benefits for residents and businesses in the area, and promote a greener, healthier, and more sustainable urban landscape. The concepts will justify incorporating water quality components into future infrastructure upgrades, and will have wider implications when considering leveraging existing infrastructure to support integrated water planning (OneWater) in the Los Angeles region.

TYPICAL EXISTING CONDITIONS

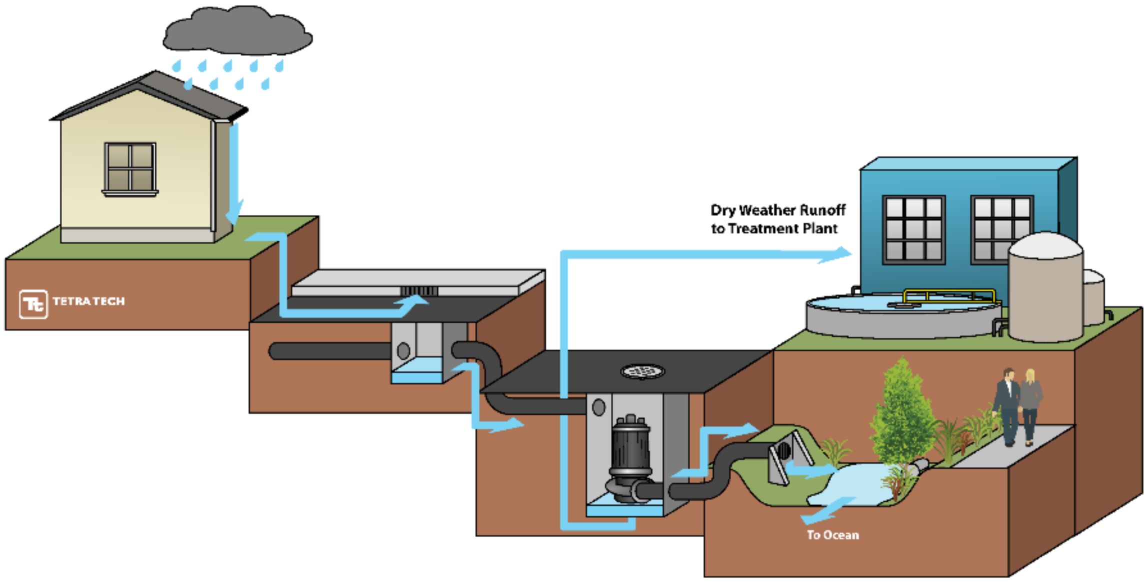


Figure 1. Conceptual diagram illustrating a typical infrastructure design. Pumps in low-lying areas use energy to convey runoff directly to the receiving water without treatment. In some instances, dry weather flows are diverted to the sanitary sewer for treatment.

POTENTIAL SYNERGY: LEVERAGING INFRASTRUCTURE UPGRADES

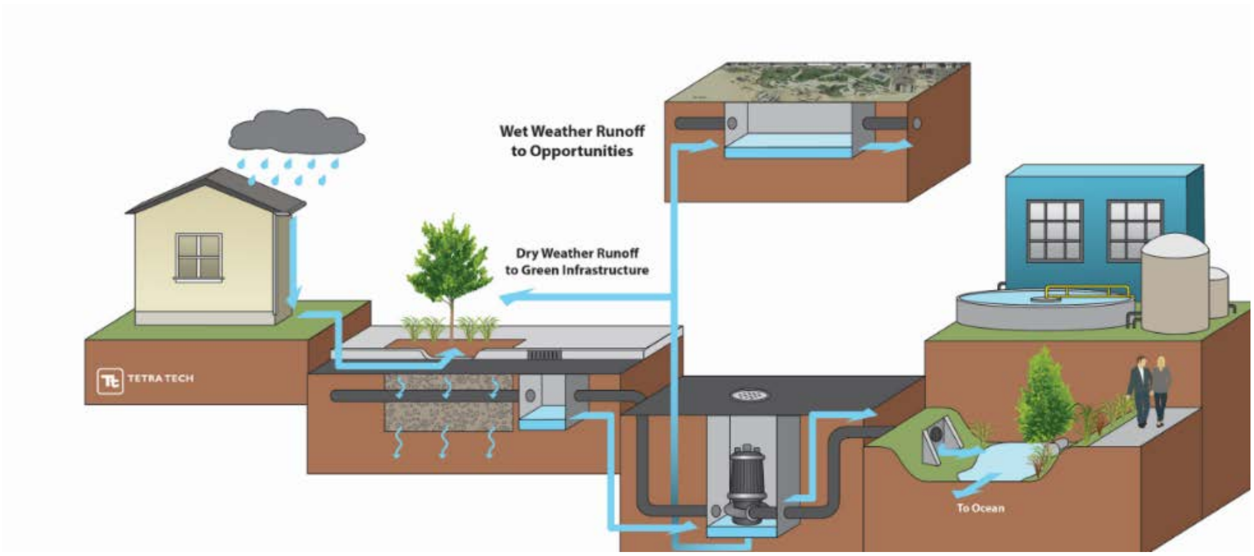


Figure 2. Conceptual diagram illustrating the potential benefits of integrating water quality design into future upgrades. Integrating water quality and flood control can lead to cost-effective treatment by taking advantage of existing facilities to move runoff to BMP opportunities. Upstream control measures can also reduce the burden on pumps by intercepting runoff near the source.

2. Background

This conceptual design focuses on the rehabilitation and green infrastructure modification of Pump Plant 647. Key background information, such as regulatory context and a description of the project site is provided in the following paragraphs.

2.1. Stormwater Regulations and Work to Date

Santa Monica Bay is on the *Clean Water Act 303(d) List of Water Quality Limited Waterbodies* for bacteria, DDT (tissue and sediment), PCBs (tissue and sediment), debris/plastic pellets, sediment toxicity, and lead. To address these impairments, the State has developed TMDLs for bacteria, PCB/DDT, and trash, which contain compliance schedules for the City to reduce impacts from stormwater discharges. The Santa Monica Bay Beaches Bacteria TMDL has a wet-weather compliance date of 2021. Moreover, compliance of these TMDLs would also address the pollutant reduction requirements of the 2012 MS4 (MS4) Permit (Order No. R4-2012-0175; NPDES Permit No. CAS004001). The stormwater project described herein would be a key component of the bacteria Load Reduction Strategies for TMDL compliance of the Santa Monica Bay Beaches Bacteria TMDL, and would address many other stormwater pollutants from the targeted subwatershed during wet weather events.

2.2. Project Location and Site Description

The targeted drainage area, mainly located in subwatershed SWS 1173, is bordered by Pacific Avenue to the west, Venice Boulevard to the east, Electric Avenue to the north, and Mildred Avenue to the south, shown in Figure 3. SWS 1173 is serviced by approximately 79 catch basins that drain to a network of both city and county storm drains that discharge to the Pacific Ocean (Figure 3 and Table 1). At the southern end of Main Street, Pump Plant 647 receives stormwater runoff from an approximately 128-acre subwatershed.

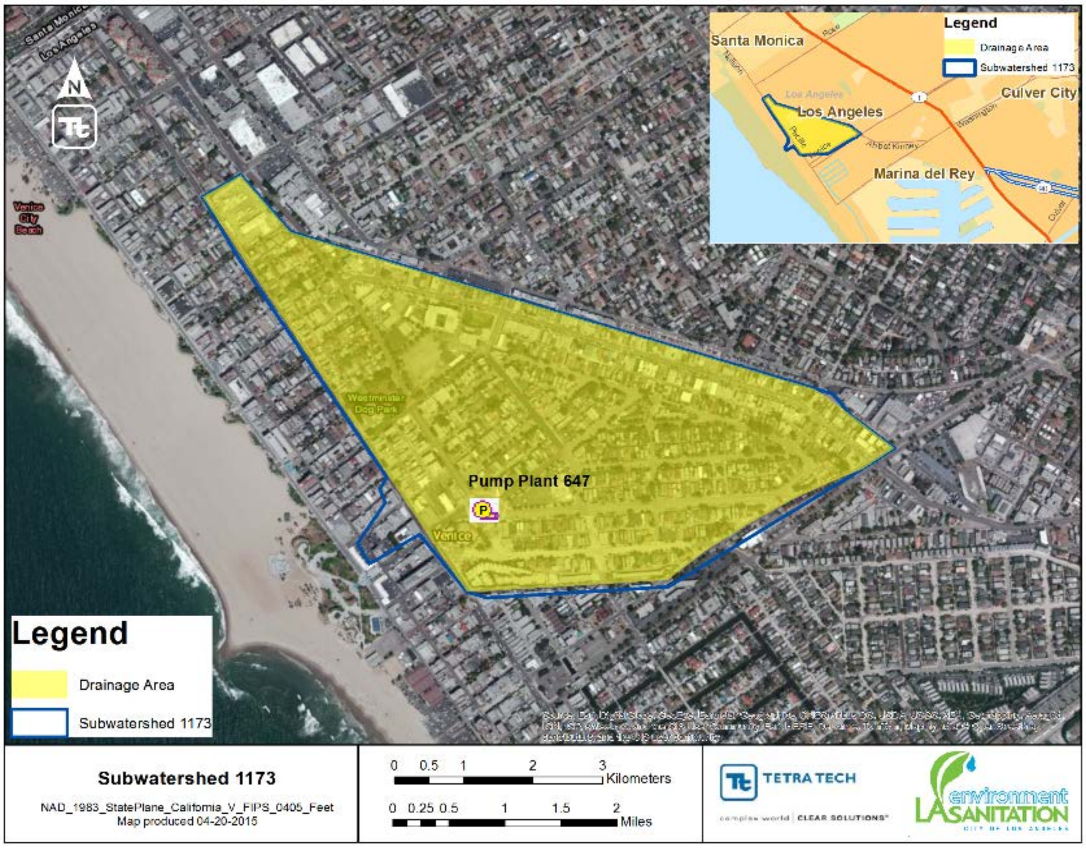


Figure 3. Subwatershed 1173.

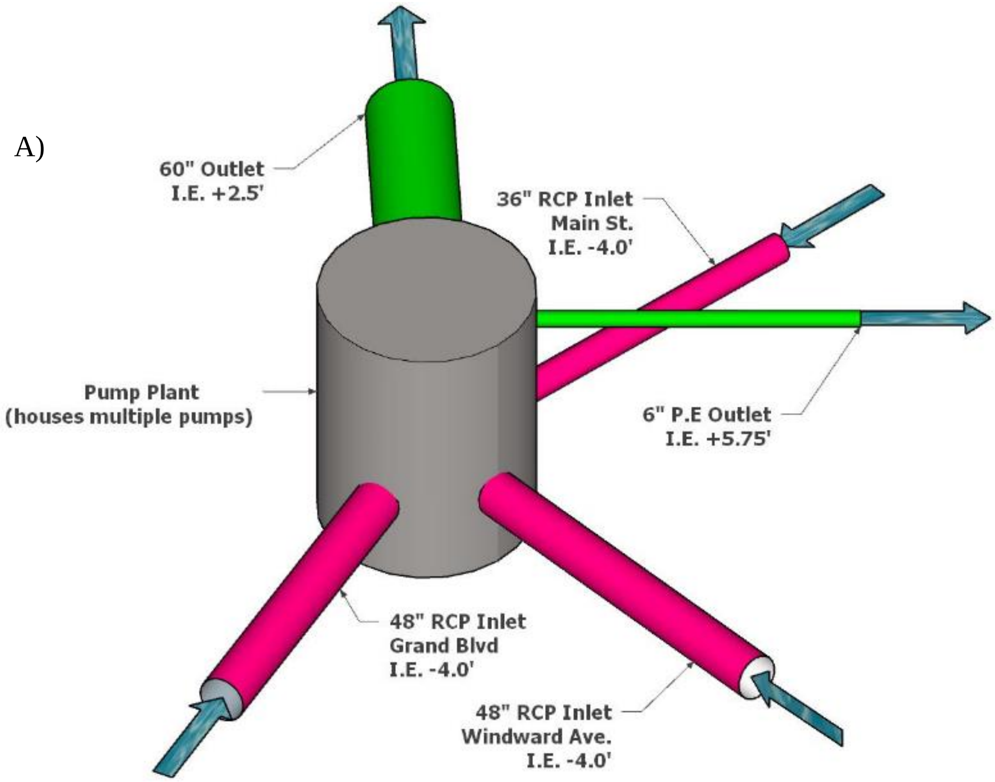
Table 1. Site summary

Site attribute	Value
Watershed	Santa Monica Bay
Subwatershed	SWS 1173
Total Pump Plant Drainage Area	127.7 acres

3. Proposed Pump Plant Upgrades

Pump Plant 647 is intended to provide flood protection to an area roughly bounded by Electric Avenue, Venice Boulevard, Mildred Avenue, and Pacific Avenue in the Venice area of the City. It does so by lifting storm water flows from underground storm drain pipes in Grand Avenue, Windward Avenue, and Main Street up to a surge box/outlet arch-culvert storm drain that flows to the west. This outlet arch culvert eventually ties into a 66-inch diameter Los Angeles County storm drain and Santa Monica Bay. The current configuration of the pump plant piping is shown in Figure 4.

A)



B)

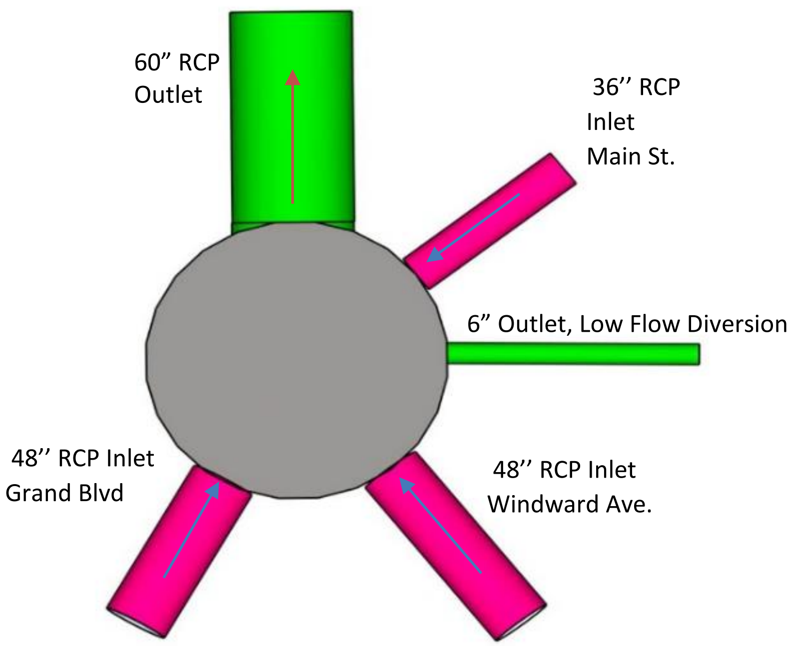


Figure 4. A) Isometric Configuration of Pump Plant 647. B) Plan Configuration of Pump Plant 647.

Note: Green indicates outlet pipes and pink indicates inlet pipes.The characteristics of the Pump Plant 647 are summarized in the following sections. This information was obtained through a review of the as-built plans, a site visit to the plant, and other information obtained from LA Sanitation.

3.1. General Description of Pump Plant No. 647

The following is a summary of field observation made during site visit conducted with Leila Talebi, Tim Joyce from Tetra Tech, and Robert Mcquay from LABOS of 03/05/2015.

- Street address: 1600 Main Street, Venice, CA.
- Plant is located in the middle of a traffic circle where Windward Avenue, Main Street, and Grand Avenue cross.
- Constructed in 1927.
- Underground, single level, 50-foot inside diameter reinforced concrete structure with a wet well, drywell, and surge chamber.
- Steel stairs provide access to the interior of the dry well section of the pump plant from the ground surface.
- Miscellaneous metal items are damaged or not to current standard including railings, platforms, and ladders.
- The 10-ton gantry-crane has a damaged chain and a "DO NOT OPERATE" tag.
- Lighting is original and inadequate for many maintenance operations.
- The plant includes five service pumps, a draw-down pump, and three low-flow diversion pumps in the wet-well. The service pumps appear to be original to 1927 and exhibit rust and leaking oil and grease.
- The plant's wet well storage is approximately 80,000 gallons.
- Inlet pipes are as follows:
    - 48" ID RCP from Grand Avenue with an invert elevation of -5.0.
    - 36" ID RCP from Main Street with and invert elevation of -4.0.
    - 48" ID RCP from Windward Avenue with an invert elevation of -5.0.
- The dry-well pumps discharge to a surge chamber with an invert elevation of +2.36.
- The wet-well low flow diversion pumps discharge to a 54" ID RCP sanitary sewer located under Main Street with an invert elevation of -10.2.
- A backup generator is not located on-site. A 125 KW Onan trailer mounted portable backup generator is located at Pump Plant 646.
- Based on discussions with maintenance staff, flooding of the area occasionally occurs. It is unclear to City staff if the flooding is caused by storm drain/plant capacity, clogging of the Los Angeles County outlet pipe with sand, or both.

3.2. Existing Pumps and Proposed Upgrades

This section describes the existing and proposed pump types and capacities for Pump Plant 647.

3.2.1. Existing Duty Pumps

Based upon information provided by operations staff, the five duty pumps located in the dry-well are Fairbanks Morse horizontal turbine pumps with a total pumping capacity of 45,000 gpm (100 cfs) with a total design head (TDH) of 50'. Based upon our preliminary analysis, it does not appear that the TDH should be that high of a value, but detailed existing pump information is not available.

A 4" Fairbanks Morse draw-down pump is also in place. According to Staff, the purpose of this pump was to drain the water from the wet well from below the low water elevation of the duty pumps. According to Staff, this pump is not operational but this function has been replaced by the Low Flow Diversion (LFD) pumps.

Per the City of Los Angeles Storm Drain Design Manual, sump areas like this are to be sized for the 50-year storm. The 50-year storm for this this area was calculated to be approximately 163 cfs in Appendix B. The pump capacity of Plant 647 is 100 cfs, approximately 40% less than the 50-year storm and has no redundancy. Pump stations are usually designed for 100% redundancy.

3.2.2. Existing Low Flow Diversion Pumps

Based upon information provided by operations staff, the LFD consists of three submersible ABS pumps. The purpose of these pumps is to divert low-flows to the sanitary sewer. This pump plant experiences a high amount of dry-weather flows, approximately 13,000 gallons per day.

3.2.3. Proposed Duty Pumps

Due to the age, condition, and flow capacity, the duty pumps should be replaced and upgraded to meet the 50-year storm of 163 cfs and provide redundancy for the plant in the event of a single pump failure. Because of the flow requirements and available space within the existing plant, three dry-pit submersible pumps (2 duty and 1 standby) are considered for this application.

The preliminary pumps selected for this application are three Flygt model Flygt CT 3800/905 solids handling pump with 350 HP motors. To reduce the power load demand on motor start-up, solid state soft starters should be considered for the motor control center. Since the proposed pumps are considerably larger than the existing pumps, the interaction of the new pumps with the existing infrastructure, including the wet well and the outlet surge box, should be studied in greater detail during the design phase. The pump system curve for these pumps is included in Appendix C.

3.2.4. Proposed Low Flow Diversion Pumps

The existing LFD pumps seem to be acceptable and may remain in place if a connection to the sanitary sewer is desired. However, these pumps are not large enough to divert the 85^{th} percentile flow of 12 cfs (as discussed in Section 4) to the BMP. To convey the 85^{th} percentile flow to the BMP, the preliminary pump selected is a Flygt model CP 3306/605 submersible pump with 70 HP motor. To reduce the power load demand on motor start-up, solid state soft starters should be considered for the motor control center. Two pumps will be provided to provide 100% redundancy and to maintain operation during a pump failure maintenance operations. The force main between the BMP pumps and the BMP was preliminarily sized as a 16-inch ductile iron pipe with a length of 1,300 feet. The pump system curve for the BMP pumps is included in Appendix C.

3.2.5. Pump System Summary

The existing and proposed pump system for Pump Plant 647 is summarized in Table 2.

Table 2. Existing and proposed pump system components.

Pump	Pump Type	Pump Capacity (gpm)	TDH (feet)	Motor Size (HP)
Existing Conditions				
Duty Pump #1	NON-OPERABLE Fairbanks Morse – 8" Horizontal Pump	N/A	N/A	N/A
Duty Pump #2	Fairbanks Morse – 14" Horizontal Pump	6,000	50	30
Duty Pump #s 3, 4, and 5	Fairbanks Morse – 20" Horizontal Pump	14,000 (each)	50	75
Draw-down Pump	NON-OPERABLE 4" pump	N/A	N/A	N/A
LFD Pump #s 1 and 2	ABS Submersible	250	N/A	4.7
LFD Pump # 3	ABS Submersible	460	N/A	7.5
Proposed Conditions				
Duty Pump #s 1, 2, and Standby Pump 3	Flygt CT 3800/905	36,600 (each)	18	350
BMP Pump #s 1 and 2	Flygt CP 3306/605	5,400 (each)	45	70

3.3. Structural Integrity

Based upon our cursory visual examination of the pump plant by our structural engineer, David Kuang, on March 5, 2015, which was limited to those portions that were exposed to view (top of roof slab, pump plant dry well interior, and limited areas of the pump plant wet well interior), the structure appeared to generally be in fair to good condition. There are minor concrete spalls and areas of wear in various locations on top of the roof slab (see Figure 5), as well as light to moderate surficial corrosion of the hatch covers. Inside the dry well, moderate corrosion of the underside of the hatch covers was observed, as well as a few minor concrete spalls at the concrete curbs upon which the hatch covers sit. There is a long crack in the bottom of the roof slab that runs perpendicular to the wet well/dry well divider wall (cutoff wall) with minor water stains along its length, indicating a through-crack with some leakage from above (see Figure 6 and Figure 7). The crack extends over the top of the electrical panels and may pose a hazard when water is coming through the crack (see Figure 6). There are water stains on the wall under one of the pipes connected to the surge chamber, indicating minor leakage at the pipe penetration through the wall (see Figure 7). The clearance between the bottom of the ships ladder and the guardrail is substandard and does not meet the CalOsha requirement for aisles of 24" minimum (see Figure 8). Taking photos through one of the wet well access hatches and observing the photos, there appears to be a slab repair that was done to the underside of the roof slab that may be showing signs of delaminating (see Figure 9). At the surge chamber, there is a spall at one of the support columns with exposed column reinforcement, as well as a horizontal crack in the surge chamber wall (see Figure 10).

No structural design data was found or shown on the as-built drawings, so the original design parameters are unknown.

Figure 5. Roof Slab Spall.

Figure 6. Roof Slab Crack (upper left) Over Electrical Panels.

Figure 7. Roof Slab Crack (top) and Water Stains Under Pipe Penetration (far right).

Figure 8. Aisle Between Ships Ladder and Guardrail is Substandard (middle) and Obstructed.

Figure 9. Wet Well Roof Slab Repair Showing Signs of Delamination (top right).

Figure 10. Surge Chamber Support Column Concrete Spall (bottom) and Wall Crack (middle).

3.3.1. Proposed Structural Upgrades

The overall condition of the structure appears to be satisfactory. The wet well should be drained and examined for additional concrete deterioration and concrete reinforcing corrosion. Concrete spalls and cracks should be repaired in order to protect the concrete reinforcement from further corrosion and to prevent further degradation of the concrete. Corrosion of the hatch covers should be monitored, and removal of the corrosion and coating of the covers should be considered. If a current Code analysis/evaluation of the structure is desired, including detailed structural analyses, a geotechnical investigation should be performed to determine design lateral earth pressures, and to determine if seismic earth pressure should be considered. Material properties such as concrete compressive strength and reinforcement yield stress can conservatively be assumed, or materials testing may be performed in order to obtain more accurate material strengths for analysis.

To provide access for construction and maintenance of the three replacement duty pumps, the roof slab over the dry well will need to be redesigned. The existing roof slab will be completely removed, the walls extended vertically about 5 feet, and a new roof slab constructed that will incorporate three pump access hatches, LFD and BMP pump hatches, and one hatch over the access stairs. Additionally, the existing roof support beam, columns, and gantry crane will be removed and not replaced.

Due to the proposed modifications noted below, additional minor structural modifications may be required to accommodate the new equipment.

3.4. Miscellaneous Upgrades

Based upon site observations and discussions with maintenance staff, the following miscellaneous repairs and upgrades should be considered:

- Upgrade the Motor Control Center.
- Upgrade the SCADA / Instrumentation and Control Equipment.
- Replace pump discharge piping and valves.
- Install level control through ultrasonic sensors (primary) with float backup.
- Upgrade railings and ladders.
- Replace damaged hatches.
- Sand blast and paint the interior of the building.
- Replace the ventilation system.
- Upgrade the interior lighting.
- New portable generator dedicated to the plant.
- Replace potable water piping and backflow.
- Implement recommendations from the Arc Flash Study (to be determined).

3.4.1. Conceptual Layout and Design

The concept elements of the Pump Plant are as follows:

- Replace and upgrade the duty pumps, sized to convey the 50-year storm and provide redundancy in the event of a single pump failure.
- Install 100% redundant submersible pumps in the wet well to convey the 85th percentile flow to the BMP.
- Perform miscellaneous upgrades.

3.4.2. Power Requirements

This section describes the power requirements needed to supply Pump Plant 647.

3.4.2.1. Electrical Supply

Per the 2000 Venice Pavillion Low Flow Diversion project as-built plans, the existing pump plant has 600A/480V electrical service. A preliminary review indicates that if the replacement pumps include a solid state soft starter the existing service will need to upgraded to a 1600A/480V services for the replacement pumps.

3.4.2.2. Backup Power Supply

The existing 125 KW backup generator is not of sufficient size to power the replacement pumps. As a replacement to this generator, a new 750 KW Tier 4 compliant portable diesel backup generator should be purchased and dedicated to Plant 647. Due to the exposed public nature of the site, the new generator should be stored at the nearest secure Bureau of Sanitation facility.

3.4.3. Operations and Maintenance

Operations and maintenance (O&M) procedures will be very similar to those currently conducted at Pump Plant 647. Major O&M items include monthly exercising of pumps and generator, as well as annual in-depth inspection, lubrication, and scheduled/worn-out part replacement.

3.5. Preliminary Opinion of Cost

Including a 25% contingency, the preliminary opinion of cost to complete the Pump Plant upgrades is approximately $5.5 million. A more detailed breakdown of costs is included in Section 8.

Due to the preliminary level of this study, this preliminary opinion of cost should be considered suitable for the early planning stage of the project. As the work becomes more defined in the subsequent project stages, it is expected that the opinion of cost will be revised.

3.6. Storm Drainage Network

Current dry weather flows at the pump plant are reported to be approximately 13,000 gallons per day. While continuous dry weather monitoring is not available for this watershed, monitoring was performed in the City of Los Angeles for a watershed of nearly the same size and similar land use (Tetra Tech 2015). This monitoring data was scaled to the watershed and was used as the basis to estimate the expected dry weather flow from the watershed. Dry weather flows for a watershed of this size and land use would be expected to be closer to 4,000 gallons per day. This analysis indicates that there is ground water intrusion into the storm drainage network. It is recommended that significant rehabilitation be performed on the storm drainage infrastructure in addition to the pump station. This could include cured in place pipe, slip lining, or completely replacing the pipe. At a minimum, a closed circuit TV inspection of the pipe system should be performed to determine the sources of this significant level the intrusion. The existing dry weather flows will have a substantial impact on the performance of the pumping plant and the frequency and duration that the pumps operate.

4. Green Infrastructure Alternative Analysis Evaluation for Wet Weather Treatment

Integrating green infrastructure improvements into the rehabilitation of Pump Plant 647 can enhance the overall performance of the system and expand the benefit of Pump Plant beyond its original function as a flood control mechanism. By linking the “gray infrastructure” (i.e. the physical pump plant) with the green infrastructure, multiple objectives can be achieved within a seamless system, reducing the overall cost to achieve each individual objective separately. In addition to the flood control function, this integration can help to achieve EWMP water quality improvement objectives while simultaneously providing the numerous advantages that green infrastructure brings to the City, such as an improvement to the community’s overall well-being, increased property values, enhanced aesthetics, and recreational opportunities.

According to the Santa Monica Bay EWMP, right-of-way along streets are the most extensive opportunity to implement BMPs on public land. In developed areas, curb and gutter in the road provide an opportunity to intercept both dry and wet weather runoff prior to entering the storm drain system and treat it within the extents of the public right-of-way. Green streets have been demonstrated to provide "complete streets" benefits in addition to stormwater management, including pedestrian safety and traffic calming, street tree canopy and heat island effect mitigation. The City of Los Angeles is planning to implement a Great Streets Initiative that seeks to enhance various areas of the City by making changes with temporary treatments such as plazas and parklets, and permanent changes to curbs, street lighting, and street trees (www.lamayor.org/greatstreets). The Great Streets Initiative is being implemented in aims of activating public spaces, providing economic revitalization, increasing public safety, and enhancing local culture. One setback for this area is narrow sidewalks, preventing the street from reaching its full potential. Because bicycle riding is permitted on sidewalks in the City of Los Angeles, a potential solution to narrow sidewalks would be to create a bicycle lane, decreasing sidewalk traffic In addition to the Great Streets initiative, the City of Los Angeles 2010 Bicycle Plan (LDCP 2010) proposes a bike lane for Riviera Ave. from Grand Blvd. to Mildred Ave., Windward Ave. from Park Row to Riviera Ave., Grand Blvd. from Main St. to Venice Blvd., Main St. from Santa Monica City Limits to Venice Blvd., Abbot Kinney Blvd. from Main St. to Washington Blvd. The plan notes that bicycle lanes along streets has been shown to have multiple economics, social, and environmental benefits such as, improvement to the businesses, increased number of riders, and enhanced safety. Utilizing permeable pavement in the bike lane can add an enhancement to water quality to the long list of benefits.

Localized flooding can result from insufficient capacity to drain a site and/or from excessive (and often unanticipated) offsite flows. Many causes of localized flooding can be remedied by repairing or replacing the existing infrastructure; however, it is often more practical to reduce the peak discharge and volume of runoff that are conveyed to the existing storm drainage network. As suggested in Alternative 2 below, retrofitting the study area with green infrastructure could provide a viable strategy to regulate runoff and alleviate localized flooding.

Implementing the green infrastructure concepts presented in the following sections provides an opportunity to integrate multiple initiatives currently proposed and in various stages of implementation across the City, the EWMP, Great Streets Initiative, and the 2010 Bicycle Plan. Combining all of these initiatives into one approach is a key component of the One Water plan approach.

Under existing conditions, stormwater runoff drains to the wet well via three main storm drains located under Windward Ave., Grand Blvd., and Main St. The runoff is then pumped out through five main pumps with total rate of 100 cfs into the existing City and County storm drains. In addition, three low diversion flow pumps are allocated to drain the wet well during periods of dry weather. Under proposed conditions, there are two alternatives for incorporating treatment for wet weather flow into the pump station upgrades that could be implemented in tandem or independently. Water from the pump plant could be diverted into an underground storage gallery (post-pump treatment) or stormwater flows could be treated before flowing into the pump plant (pre-pump treatment), using green infrastructure concepts suited for implementation in street parking lanes, protected bicycle lanes, and landscape areas, including permeable pavement and bioretention. Each alternative proposes incorporating treatment through green infrastructure in an attempt to improve the water quality of stormwater prior to discharge into the Pacific Ocean. Both alternatives incorporate diverting stormwater runoff from the street and the surrounding lands through a series of BMPs and allowing stormwater to either infiltrate or to retain the stormwater for beneficial uses.

Sufficient separation from the groundwater will need to be ensured through a geotechnical investigation. Literature, soil borings and as-builts show the existing groundwater table to be near mean seal level (Elevation 0) in this location (MWD 2007; LADWP 2011). Based on the literature review, alternative 2 assumes that sufficient separation is available and runoff will be permitted to infiltrate to the groundwater. However; for alternative 1 no infiltration is assumed.

Alternative 1 (“**Post-Pump Treatment**”): This alternative is designed to directly pump stormwater runoff into an underground storage gallery implemented underneath the park at the end of Market St. (Figure 11) designed to store the water for beneficial use. Stormwater runoff is routed from three catch basins draining from Windward Ave., Grand Blvd. and Main St., into a wet well in the pump plant. The proposed configuration of the pump plant is shown in Figure 12. The runoff produced by the 85th percentile/24 hour storm will be pumped out of the wet well and directly into the underground storage gallery, at a rate of approximately 11.5 cfs, To achieve this flow would require that the existing low flow diversion pump be upgraded to allow pumping of the peak flow rate for the 85th percentile storm design. A 6-inch outlet pipe would be connected to the existing sump pump and routed through the top of the existing pump outfall junction structure to divert the water to the proposed storage gallery. Treatment of the 85th-percentile runoff volume would constitute compliance with all water quality requirements for the tributary drainage area (based on current interpretation of the MS4 Permit, as discussed in the EWMPs). Utilizing the low flow diversion pump to pump runoff to the underground storage gallery not only can significantly improve water quality but also, could greatly reduce the need for the main pumps to turn on during small storm events and decrease the operation time considerably during larger storm events. This alternative includes two different scenarios that are intended to either use the captured water for irrigation purposes or temporarily store the water during the wet weather event and then send it back to the existing 54-inch sanitary sewer line.

Figure 11. Alternative 1 potential BMP location.

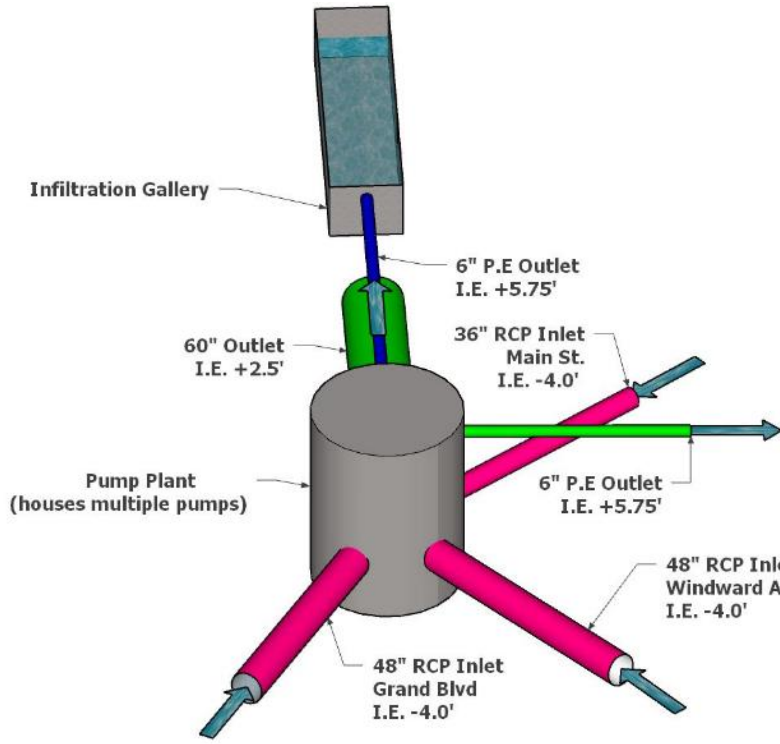


Figure 12. Direct Pumping System for Alternative 1

Alternative 1-Scenario 1: Under this Scenario, the wet weather runoff from the wet-well room would be pumped out at a constant rate of 11.5 cfs. A 6" outlet pipe would then divert the water from the existing low flow diversion pump to an underground storage gallery with an operable valve. The storage gallery will be sized so that it can store the runoff produced by the 85th percentile storm once the valve is closed. Once the storage system is full, excess flow will be gravity bypassed to the Pacific Ocean. This scenario proposes to utilize the stored runoff within the storage gallery for irrigation of the park at the end of Market St. in an attempt to reduce the demand on potable water or reclaimed water for irrigation. They irrigation demand at the park is estimated to average 10,525 gallons per day (ranging from 5,650 in December to 14,768 in July) Utilizing the water in the park, directly above where it is stored, will reduce the demand on potable water, eliminate the need for piping back to the sanitary system and reduces the strain on the treatment plant. There are two options for the park irrigation:

Option 1: Utilizing stored water for spray irrigation in the park.

Since the stored runoff within the storage gallery have variable pollutant concentrations, a treatment system should be used to treat the collected flow prior to spray irrigation in the park. The treatment system should treat the water to meet the guidelines in the Los Angeles County Department of Public Health (CDPH) document titled the *Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-Potable Use* (2011).

Option 2: Utilizing stored water for the subsurface drip line

An alternative to the spray irrigation system is a subsurface drip line that would directly deposit water to the root systems of the plants. The subsurface irrigation system does not require the same level of water treatment as spray irrigation and can be used with minimal treatment.

Alternative 1-Scenario 2: In this scenario, the same as scenario 1, it is assumed that the wet weather flows would be pumped at a rate of 11.5 cfs once the low flow diversion pump has been upgraded from the wet-well and routed to the proposed underground storage gallery. The storage gallery is sized to fully capture the runoff produced by the 85th percentile storm. Once the storage system is full, excess flow will be gravity bypassed to the Pacific Ocean. Under this scenario, wet weather flows will be temporarily stored in the storage gallery. After the wet weather event, the stored runoff will be slowly drained, by gravity, back into the existing 54-inch sanitary sewer system and eventually, to the treatment plant. This scenario allows similar treatment as the current low flow or dry weather flows without overwhelming or exceeding the capacity of the treatment plant. Treating the wet weather runoff would allow that water to be available for use as reclaimed or reuse water.

During the dry season, the storm drain outlet that discharges into the ocean at the end of Market Street can be filled with sand partially blocking the outlet. Storing the water in the park also provides the benefit of allowing time for the outlet to be cleared reducing the strain on the pumps. Water stored in the underground storage gallery can also be pressurized and used to clear the outlet pipe.

Alternative 2, referred to as "**Pre-Pump Treatment**", is intended to treat the wet weather runoff from a 127.7-acre drainage area through permeable pavement and bioretention areas implemented within street parking lanes, protected bicycle lanes, and landscape areas of various streets (**Error! Reference source not found.** and Figure 14) prior to its arrival at the pump plant. To treat this runoff, bioretention areas could be implemented along landscape areas and alongside permeable pavement areas on various streets. Overflow from bioretention and additional runoff should be treated in permeable pavement implemented within street parking lanes or protected bicycle lanes.

Figure 13. Alternative 2 recommended areas near Pump Plant 647 for BMP implementation.

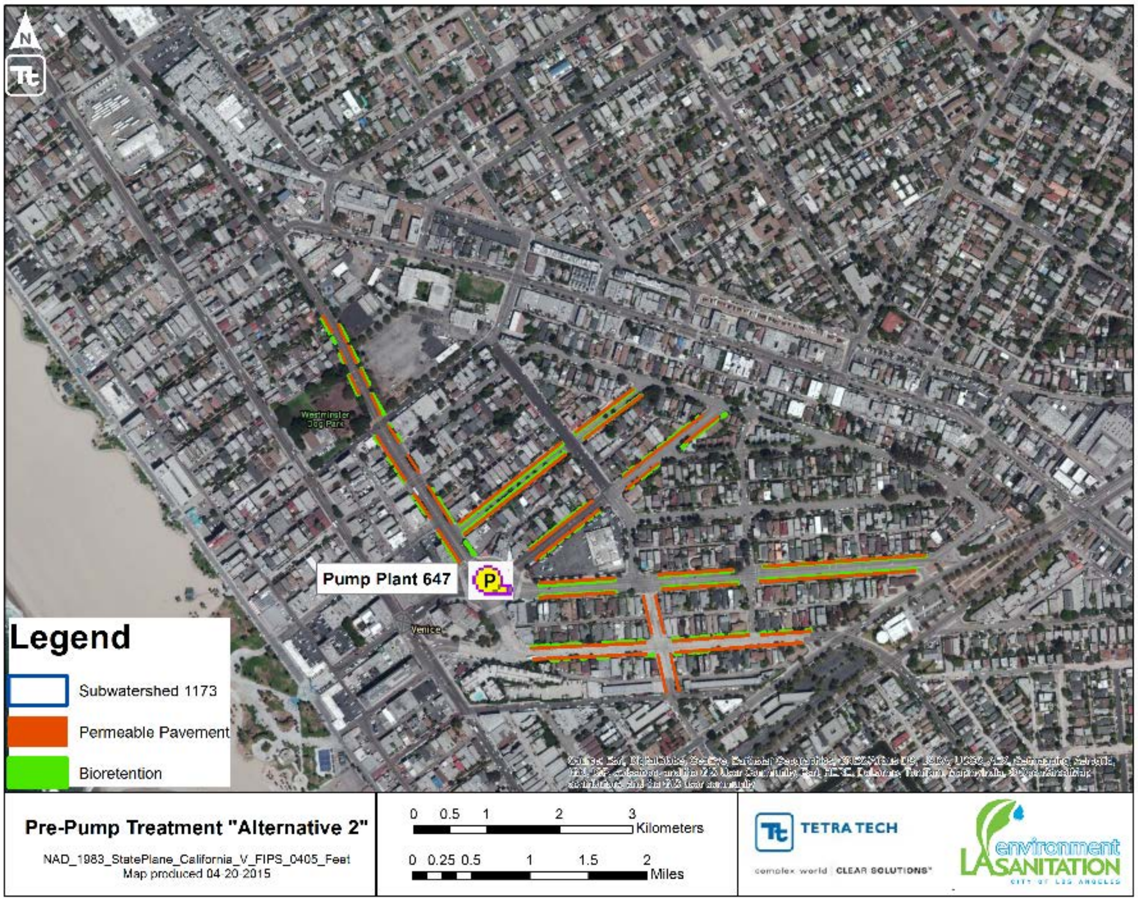


Figure 14. Alternative 2 recommended areas for SWS 1173 Drainage Area for BMP implementation.

Error! Reference source not found. presents a comparison of the configuration of each alternative. Details for the sizing and evaluation of each alternative is presented in Section 4.1.

Table 3. Comparison of Alternatives

BMP Type	Low Flow Diversion Rate (cfs)	Post-Pump Treatment			Pre-Pump Treatment		
		Area (ac)	Depth (ft)	Annual Volumetric Treatment (ft^3)	Area (ac)	Depth (ft)	Annual Volumetric Treatment (ft^3)
Underground Storage Gallery	11.5	1.6	4	2,067,686	N/A	N/A	N/A
Bioretention	N/A	N/A	N/A	N/A	0.37	4.75	2,555,678
Permeable Pavement		N/A	N/A	N/A	2.3	3.75	

4.1. BMP Sizing and Evaluation

The entire drainage area primarily encompasses multi-family residential and secondary roadway land uses, and contains approximately 75 percent impervious surface. Table 4 and Table 5 illustrate the predominant soil texture and the land use types within SWS 1173. The details of the two proposed alternatives are outlined below.

Table 4. SWS 1173 soils summary

Soil Series	Infiltration Rate (in/hr) (Source: USDA Soil Water Characteristics Program)	Hydrologic Soil Group (Source: LA Soils GIS Layer)	Percentage of Watershed
Sand	0.5-8	B	100%

Table 5. SWS 1173 distribution of land use types

Landuse type	Acres	Percent
Low Density Single Family Residential	2.2	1.7%
Multi-family Residential	43.4	34.0%
Commercial	16.6	13.0%
Institutional	8.16	6.4%
Industrial	1.49	1.2%
Transportation	3.39	2.7%
Secondary Roads	52.5	41.1%
Vacant Space	0.03	0.03%
Total	**127.7**	**100%**

4.1.1. Wet Weather Flow

Wet weather flow can vary significantly from storm to storm and from year to year. To analyze the proposed system and determine the potential inflow, a 20-year continuous simulation period from January 1, 1992 to December 31, 2011 was used. Hourly wet weather runoff time series for each contributing land use were obtained from the calibrated Watershed Management Modeling System (WMMS; Tetra Tech 2010a and Tetra Tech 2010b).

4.1.2. Existing Pollutant Loading Assessment

According to the Santa Monica Bay EWMP, bacteria is found to be the limiting pollutant, with a wet-weather compliance date of 2021 for the Santa Monica Bay Beaches Bacteria TMDL. Therefore for this study area, bacteria was used as the basis for removal comparison. The bacteria load entering the storm drain varies depending on the size of the storm and the number of dry days between storms. A 20-year continuous simulation period from January 1, 1992 to December 31, 2011 was used to analyze the bacteria removal and water quality improvement. The long-term time series for bacteria load across the watershed was obtained from the calibrated WMMS at an hourly time step (Tetra Tech 2010a and Tetra Tech 2010b). Other pollutants including copper, lead, nitrogen, phosphorous, and pathogens, long-term time series from the calibrated WMMS were used to analyze the comprehensive water quality benefits for the recommended alternative.

4.1.3. Geotechnical Literature Review

A geotechnical literature review was performed to identify potential geologic or subsurface issues that could affect BMP implementation or configuration. A soil report that was developed by Active Leak Testing, Inc. within the vicinity of pump plant 647 was used to determine the type of soils and suitability for infiltration at BMP sites. Based on the review of 9 soil boring logs, the site soils mostly consist of well graded sand (SW), poorly graded sand (SP), and silty sand (SM) up to the depth of 13 feet. Since sandy soil has high infiltration rate, it indicates that the site soils are suitable for infiltration. According to the soil boring at Main Street and Market Street, the first 10 feet of the silt soils consist of moist light brown silty sand (SM) following by brown silty clay/clayey silt (CL-ML) with sand content increasing with death in the next 3 feet. Groundwater was encountered at the depth of 13 feet and the rest of the site soil consist of light brown well-graded sand with some silt and grave (SW-SM) up to the depth of 30 feet. Soil borings from the area around the pump plant are include in Appendix F.

This review was limited to existing data and should be supplemented with a full, wet well examination, material strength determination, site-specific geotechnical and seismic investigation prior to preliminary designs. Infiltration rates and other subsurface conditions must be verified to ensure project success and public safety.

4.1.4. BMP Optimization and Performance

To optimize the size of the proposed BMPs, a range of possible BMPs sizes for both alternatives were modeled in the EPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) using the 20-year, continuous simulation data to measure the overall impact on the water quality. SUSTAIN was developed by the EPA Office of Research and Development to facilitate selection and placement of BMPs and green infrastructure techniques at strategic locations in urban watersheds. It assists to develop, evaluate, and select optimal BMP combinations at various watershed scales on the basis of cost and effectiveness. In this study, the BMP's effectiveness was measured by its ability to remove total bacteria. Total bacteria was determined to be the limiting pollutant, indicating that if total bacteria is controlled, other pollutants would have similar or greater removal rates.

In addition, identifying appropriate numeric targets is necessary to evaluate and optimize performance of the stormwater facilities. One common hydrologic criterion for integrated water quality, flow reduction, and resources management is retention of the runoff volume generated by the 85^{th} percentile storm event. At the study area, the 85^{th} percentile storm event depth is 0.88 inch, according to the Los Angeles County isohyetal map. As a result, an additional analysis was performed to identify the size required to capture and treat the 85th percentile, 24-hour design storm event. The 20-year continuous time period (from 1992 to 2011) was then modeled through the identified BMP size to measure the overall, long-term expected water quality impacts. Two sets of analyses were performed for different solutions including Alternative 1"Post-Pump Treatment" and Alternative 2 "Pre-Pump Treatment".

Figure 15 shows the 85^{th} percentile 24-hour hydrograph for the drainage area (127.7 acres), derived from the HydroCalc (Version 0.3.0 beta). The peak flow for the 85^{th} percentile storm for the 127.7-acre study area was calculated to be 11.5 cfs, as illustrated in Figure 15.

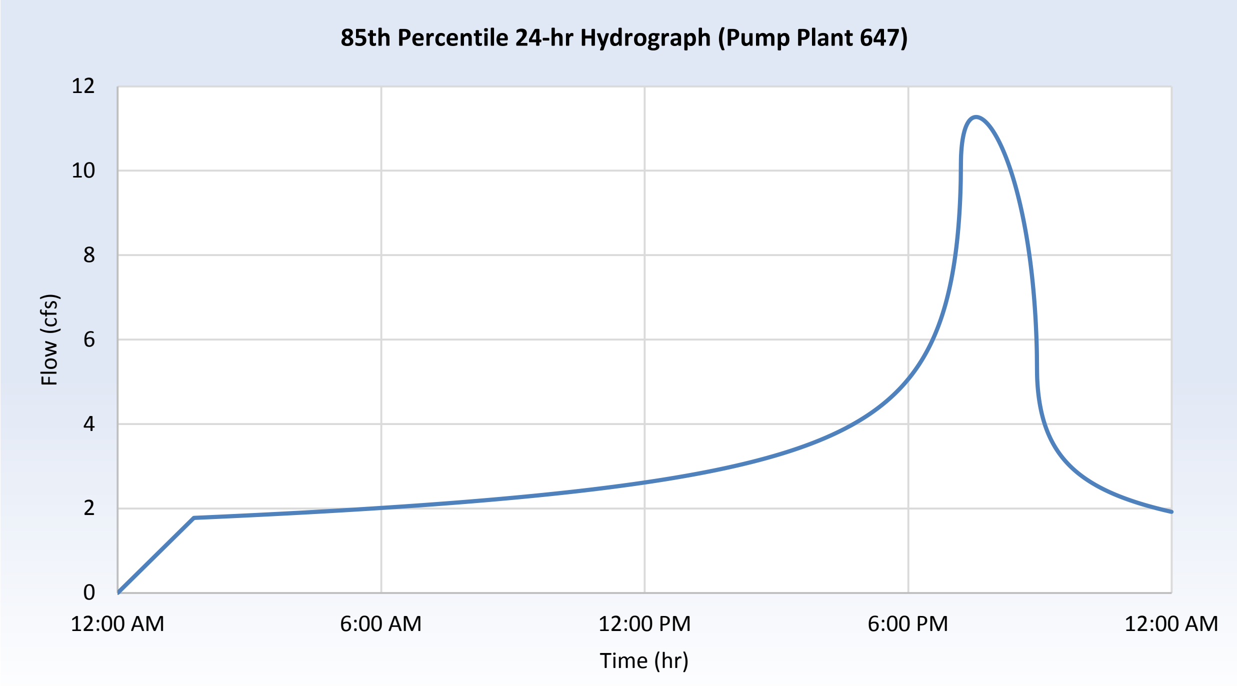


Figure 15. 85th Percentile 24-Hour Hydrograph for the 127.7- acre drainage area with 0.88 inch Rainfall Depth.

For alternative 1, both scenarios it is assumed that the main pumps cycle on when the wet well reaches a certain level. At that point, all of the volume in the wet well is pumped out at a rate of 165 cfs. This pumping scheme results in the pump cycling on and off multiple times throughout the duration of the storm event. Because of the configuration of the pump plant and the elevation of the outlet pipe, it is not feasible to divert even a portion of the 165 cfs flow to a BMP.

For alternative 1, in both scenarios a smaller sump pump would cycle to pump all of the flow entering the pump plant at a rate of 11.5 cfs or less. This pump would operate throughout the duration of the storm providing a consistent flow into the BMP. Diverting flow into a BMP capable of treating the volume of runoff produced by the 85th percentile storm with foot print of 1.6 acre and a capacity of approximately 6.5 acre-ft would provide a 50 percent reduction in bacteria (Figure 16) and a 46 percent reduction in volume (Figure 17).

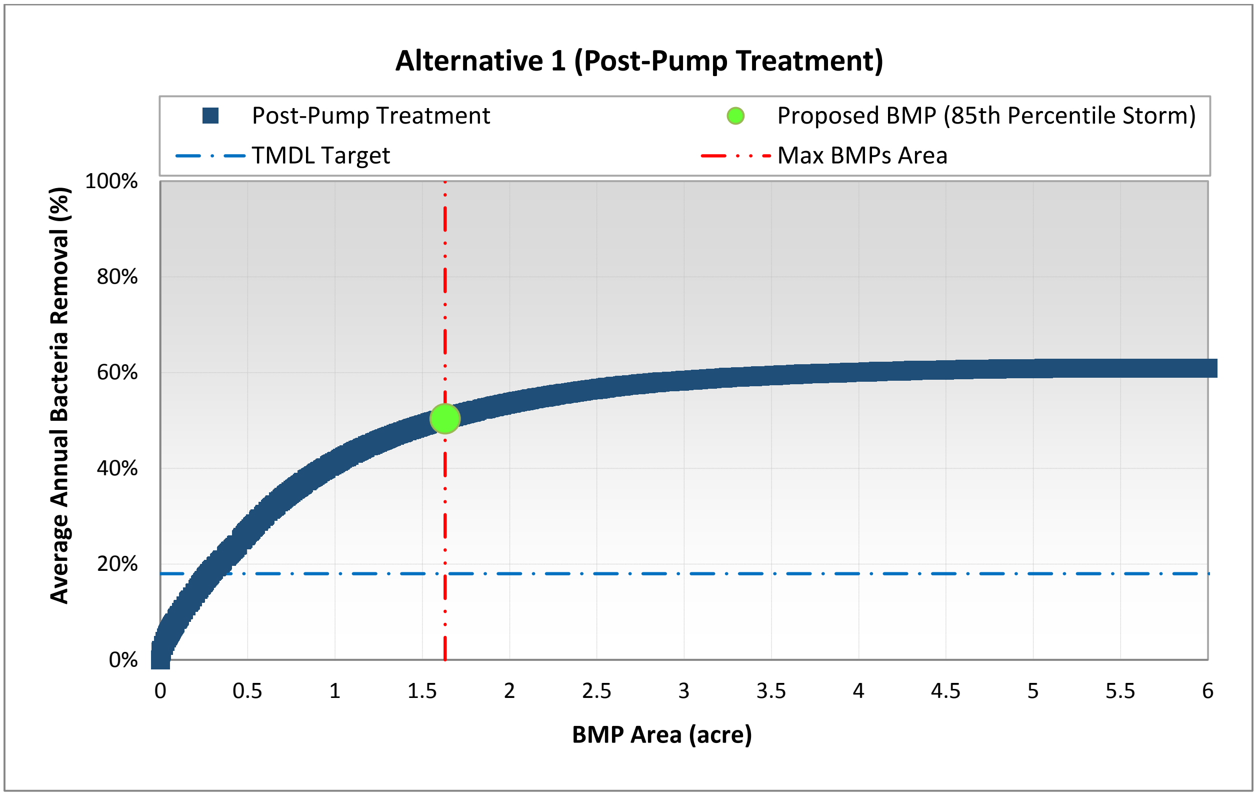


Figure 16. BMPs Capacity vs Average Annual Total Bacteria Reduction.

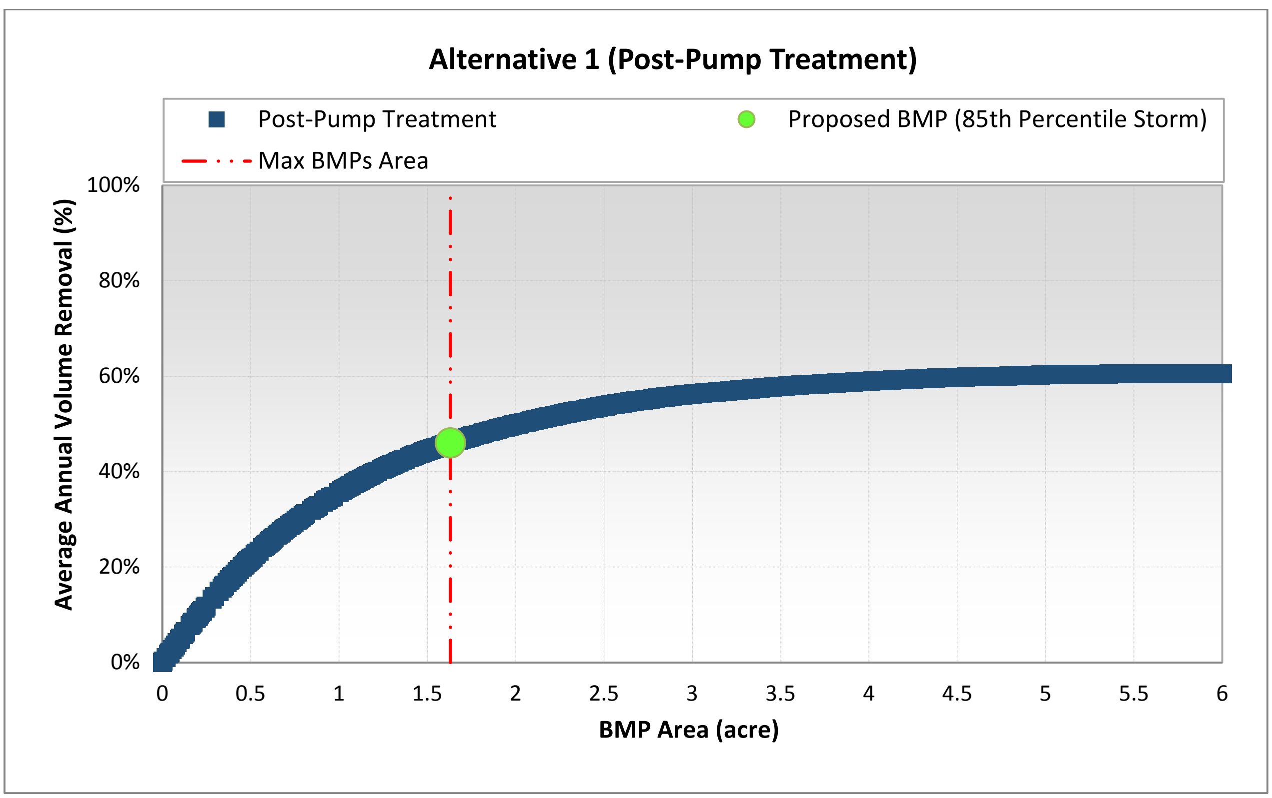


Figure 17. BMPs Capacity vs Average Annual Total Volume reduction.

For alternative 2 the BMPs opportunities would be implemented along several streets to treat wet weather runoff from a 127.7-acre drainage area before reaching the Pumping Plant. The 20-year continuous time period (from 1992 to 2011) is modeled to generate the cost-effectiveness curve and measure the overall, long-term expected water quality impacts (Figure 18 and Figure 19). The result of the analysis showed that the combination of permeable pavement and bioretention with the sizes of 100,800 and 16,000 square feet and retention volumes of 151,200 and 50,600 cubic feet respectively provide the capacity to treat the 85th percentile storm event. The respective BMPs sizes would result in 57 percent flow volume removal and 66 percent bacteria count reduction.

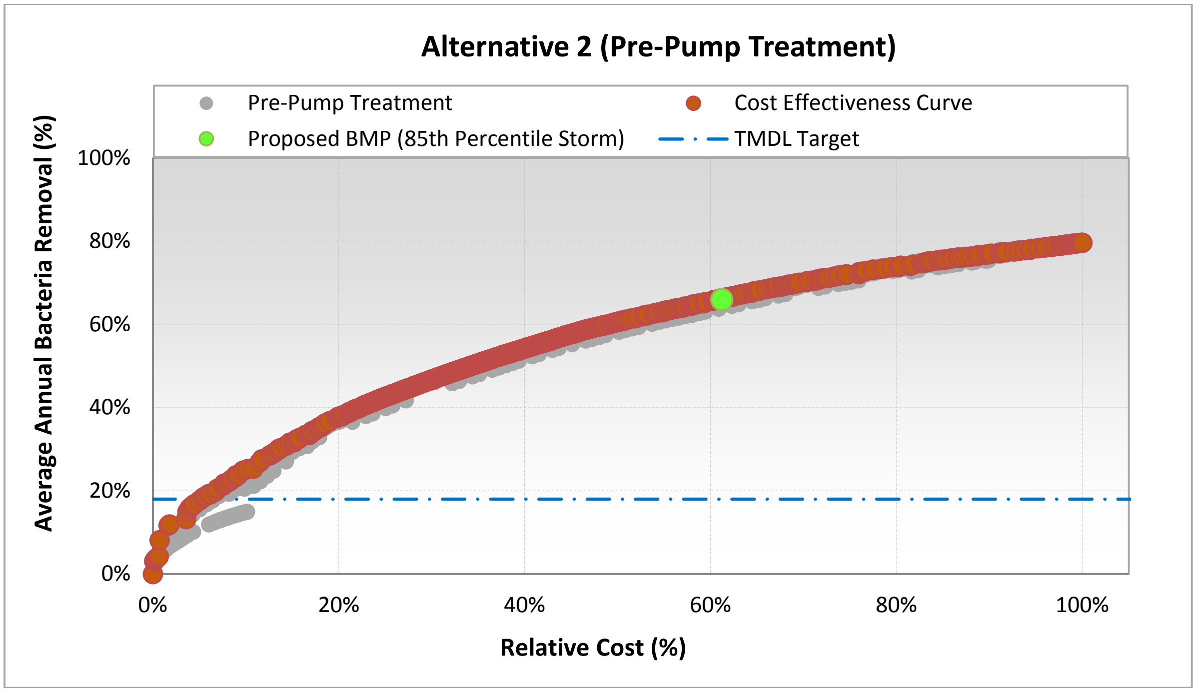


Figure 18. BMPs Capacity vs Average Annual Total Bacteria reduction.

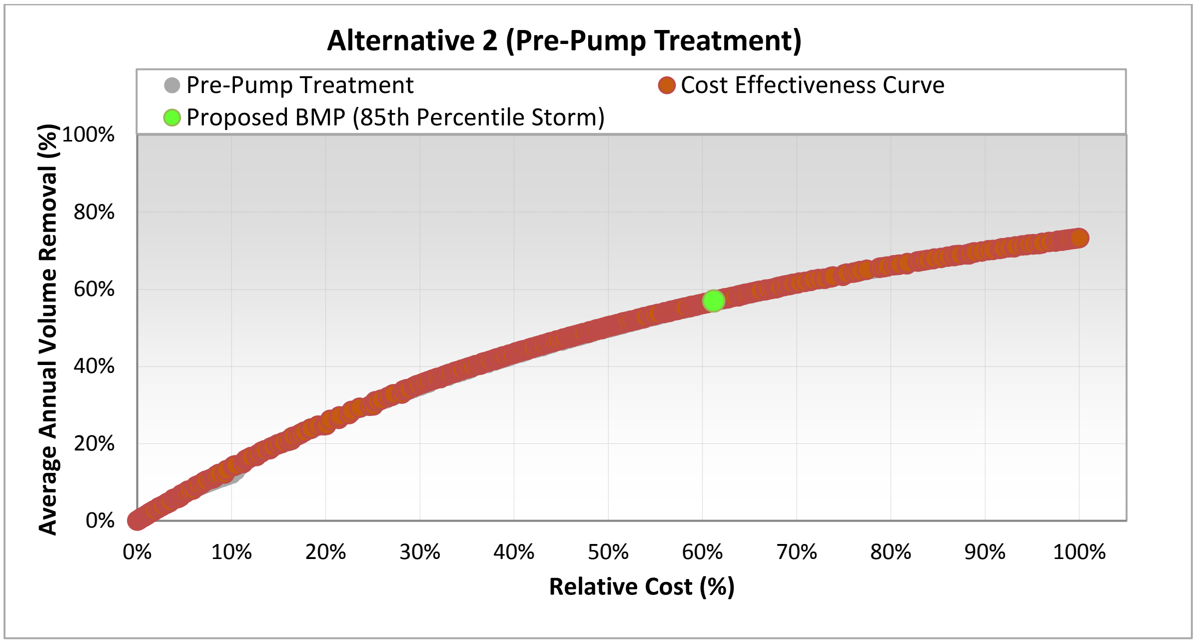


Figure 19. BMPs Capacity vs Average Annual Total Volume Reduction.

4.1.5. Irrigation Demand

As mentioned earlier, Alternative 1 proposes to utilize the stored runoff within the storage gallery for irrigation of the park at the end of Market St. The average daily irrigation demand for each month at the park is estimated using evapotranspiration data from California Irrigation Management Information System (CIMIS) station No.99. The calculated daily and monthly demands by each months are shown in Table 6.

Table 6. Average Daily Irrigation Demands for each month at the Park

Month	Daily Irrigation Demand, Gallons	Monthly Irrigation Demand, Gallons
January	6,123	189,808
February	7,332	205,286
March	9,723	301,413
April	12,763	382,875
May	13,507	418,719
June	14,229	426,865
July	14,768	457,821
August	14,637	453,748
September	11,703	351,105
October	8,935	276,974
November	6,734	202,028
December	5,650	175,145

Utilizing the water in the park, directly above where it is stored, will reduce the demand on potable water, eliminate the need for piping back to the sanitary system and reduces the strain on the treatment plant. The Rainwater Harvester 3.0 model was used to evaluate the relationship between the size of the underground storage gallery and potable water demand offset. The result of analysis indicates that the proposed storage gallery with a storage capacity of 6.5 acre-ft can not only fully capture the 85th percentile storm runoff, but could also offset the potable water demand by 90 percent (Figure 20).

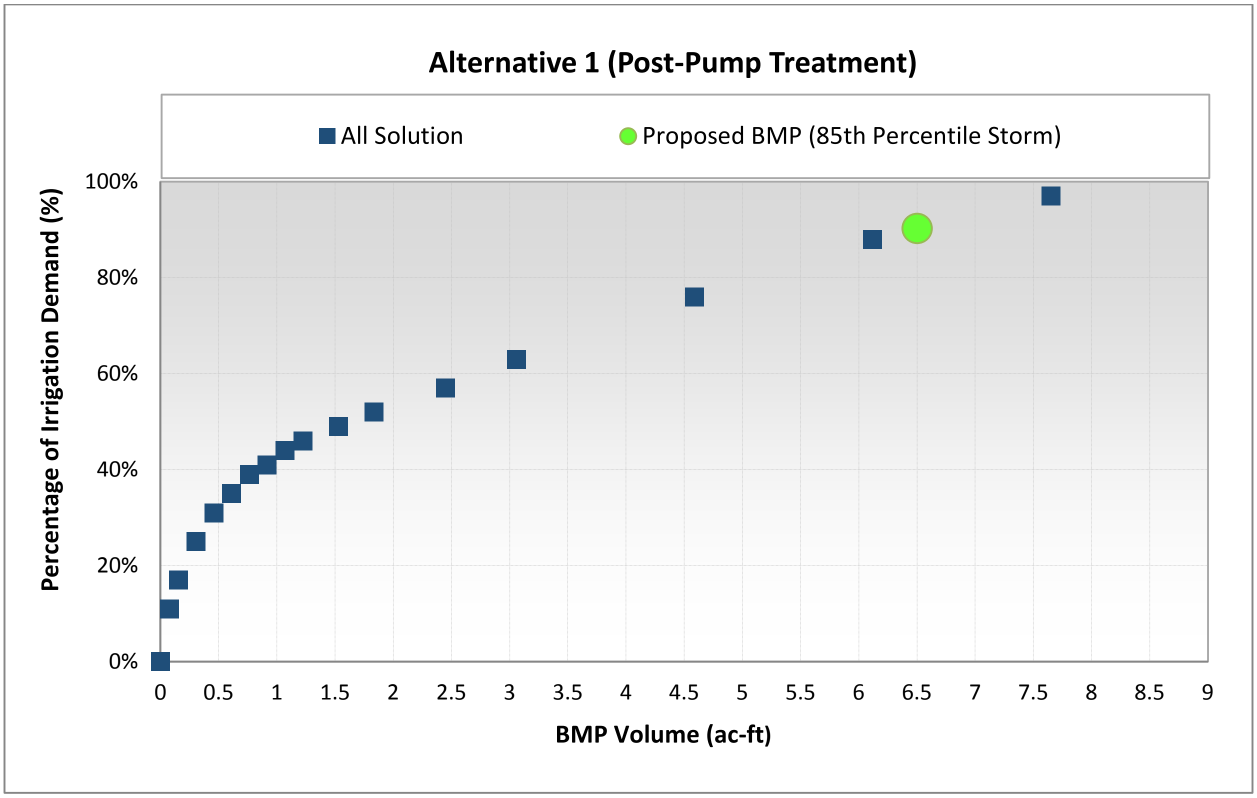


Figure 20. BMPs Capacity vs. Percentage of Irrigation Demand Reduction.

4.1.6. Treatment Alternative Comparison and Conclusions

Based on the comparison of the two alternatives presented in Table 7, Alternative-1 (11.5 cfs direct pumping) will provide the reasonable volume and associated pollutant load reduction. Alternative 1 will require a small upgrade to the current pump plant configuration to provide a larger low flow diversion pump. By using the low flow diversion pump to divert flows to the BMP, the main pumps will not have to operate as often.

Table 7. Average annual expected pollutant reductions and cost.

Constituent	Average annual loads	Average annual reduction					
		Post-Pump Treatment				Pre-Pump Treatment	
		Scenario 1		Scenario 2		Alternative 2	
	Pre-BMP	Reduction	Percentage	Reduction	Percentage	Reduction	Percentage
Volume, (ft^3)	4,491,365	2,067,686	46%	2,067,686	46%	2,555,678	57%
TSS, (lbs)	18006	7241.6	40%	7241.6	40%	11901.7	66%
TN,(lbs)	561	271.6	48%	271.6	48%	364.7	65%
TP, (lbs)	441	214.9	49%	214.9	49%	287.8	65%
Copper, (lbs)	7.3	2.9	40%	2.9	40%	4.8	66%
Lead, (lbs)	6.9	2.8	40%	2.8	40%	4.6	66%
Zinc, (lbs)	68.3	27.6	40%	27.6	40%	45.3	66%
Fecal counts	1.05E+13	5.29E+12	50%	5.29E+12	50%	6.95E+12	66%
Cost	N/A	$8,409,360		$7,546,850		$5,857,670	

Note: TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorous

Implementing Alternative 1, scenario 1 will require installation of an irrigation system to utilize stored water for irrigation of the park. This scenario is more costly because of the treatment system and irrigation method required to be constructed. However, it reduces the demand on potable water or reclaimed water. Alternative 1, scenario 2 will only require construction of a small pipe to slowly drain out the storage gallery to the existing 54-inch storm drain under Main Street. Among all solutions, Alternative 2 is recommended since it requires no alteration to the current low flow diversion pump configuration. This alternative provides maximum resiliency for the main pumps. Treating the volume produced by the 85^{th} percentile storm before the pump plant significantly reduces the amount of time that the main pumps have to operate by approximately 70%.

5. BMP Conceptual Layout, Design, and Performance Specifications

5.1. Post Pumping Alternative 1

The recommended BMP for alternative 1 (Scenario 1 and 2) is an underground storage gallery. A storage gallery is typically an empty storage vessel with either a manually operated valve or a permanently open outlet. If the storage gallery has an operable valve, the valve can be closed to store stormwater runoff for irrigation (Figure 21). Storage gallery can be designed as surface or subsurface units allowing for implementation around paved streets, parking lots, and buildings to provide initial stormwater detention and treatment of runoff. Such applications offer an ideal opportunity to minimize directly connected impervious areas in highly urbanized areas.

Figure 21. Subsurface Storage Gallery. (Source: www.oldcastlestormwater.com)

Typically, this system requires continual monitoring by the grounds crews, but provides greater flexibility in water storage and metering. If a storage gallery is provided with an operable valve and water is stored inside for long periods, the system openings must be covered to prevent mosquitoes from breeding. A storage gallery with a permanently open outlet can also passively regulate the outflow of stormwater runoff. If the system outlet is significantly smaller than the size of the inlet (e.g., ¼- to ½-inch diameter), runoff will build up inside of it during storms, and will empty out slowly after peak intensities subside. Since, no infiltration is allowed at the project site location, stored water will be either used for irrigation or sent to the existing sanitary sewer system. Observation ports and cleanouts should be included at the inlet of the storage gallery and along the length of the system to allow maintenance access and observation of any potential sediment accumulation.

There are multiple systems available designed to provide storage for underground systems. Two of them are StormCapture system developed by OldCastle (Figure 22), and the StormTrap system (Figure 23).

Source: www.oldcastlestormwater.com

Source: www.oldcastlestormwater.com

Figure 22. StormCapture System.

Source: www.stormtrap.com

Source: City of Los Angeles

Figure 23. Typicall StormTrap System.

Utilizing the low flow diversion pump to divert flow into the BMP will allow some flexibility in the configuration and depth of the BMP allowing the underground storage gallery to be close to the surface (approximately two feet below ground surface). This will provide approximately 5 feet of clearance from the groundwater table. Figure 24 shows the relative configuration of the diversion and underground storage gallery. Observation ports and cleanouts are recommended for the purpose of maintenance.

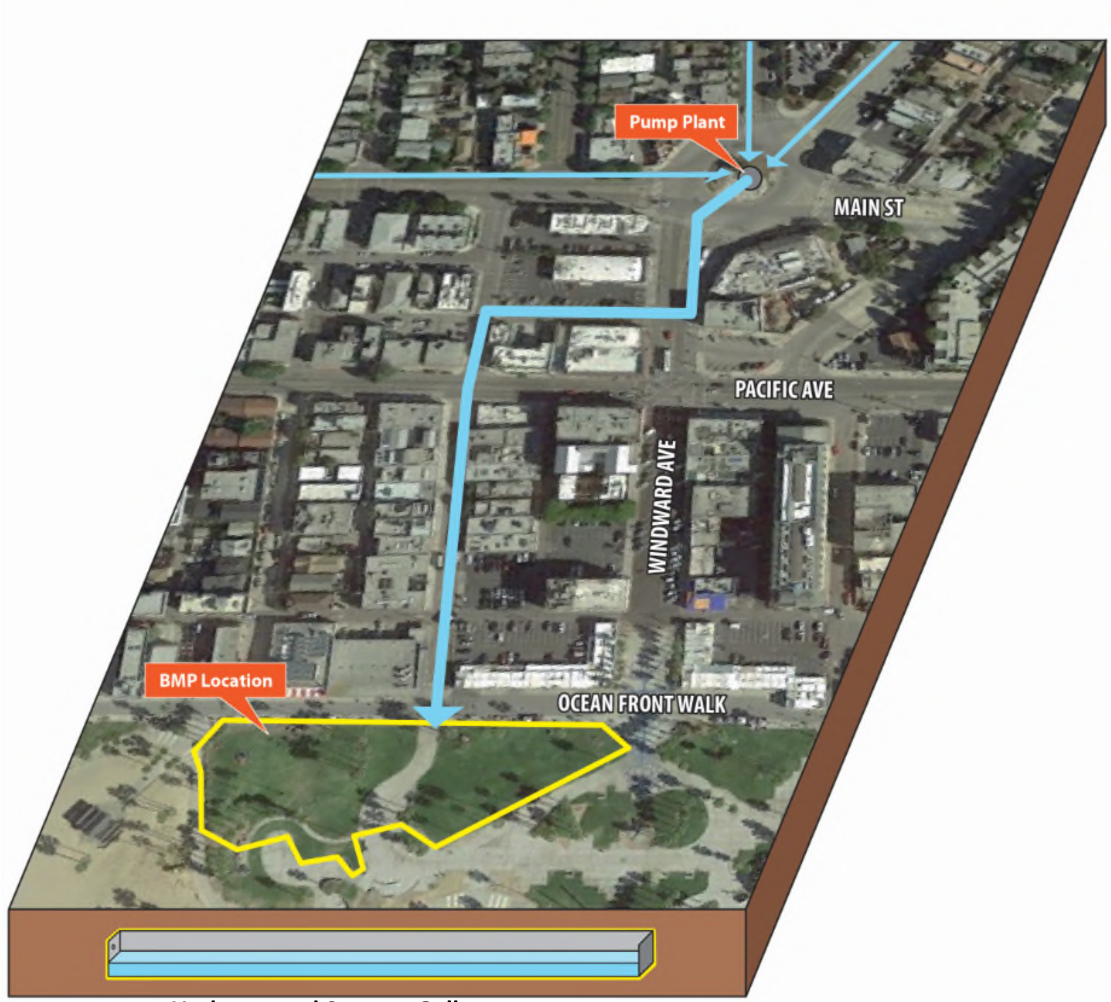


Figure 24. BMP configuration for Alternative 1.

5.2. Pre-Pumping Alternative 2

For alternative 2, the conceptual configuration of the BMPs providing the optimum level of treatment is intended to divert and treat water flowing from the street and surrounding parcels. The designation of each street in the area is shown in Table 8 (details of original street design in Bureau of Engineering ”D” plans, D-1182, D-1184, and D-1186, are provided in Appendix D). Bike lanes are proposed for this area in the 2010 Bicycle Plan (LDCP 2010). BMPs proposed are intended to fit within the typical widths for the designation and the proposed bike lanes and should be coordinated with proposed plans for the area. Runoff from various streets and surrounding parcels within the SWS 1173 drainage area should be treated with a combination of permeable pavement and bioretention areas in accordance with LA Standard Plan S-481 or S-484. The depth of engineered soil layer, storage layer and ponding zone of the bioretention cells should be 2’, 2’-9”, and 2’-6” respectively. The depth of paving surface, and storage layer of the permeable pavement should be also 1”, and 2’-9” respectively. These BMPs can be implemented in a variety of places, such as permeable pavement on protected bicycle lanes and street parking lanes and bioretention alongside permeable pavement areas or on landscape areas. Current conditions are shown in Figure 25.. Example BMP configurations are shown in Figure 26 and Figure 27. Treating the 85th percentile runoff volume by these BMPs would significantly reduce the amount of time that the main pumps have to operate by approximately 70%.

Table 8. Street Classification.

Street	Classification	Typical ROW Width
Main Street	Secondary Highway	90 feet
Windward Avenue	Collector Street	64 feet
Riviera Avenue	Local Street	60 feet
Grand Blvd	Local Street	60 feet
Venice Way	Secondary Highway	90 feet
Market Street	Local Street	60 feet

Figure 25. Existing Main Street conditions.

Figure 26. Conceptual rendering showing protected bike lane with permeable pavement and bioretention.

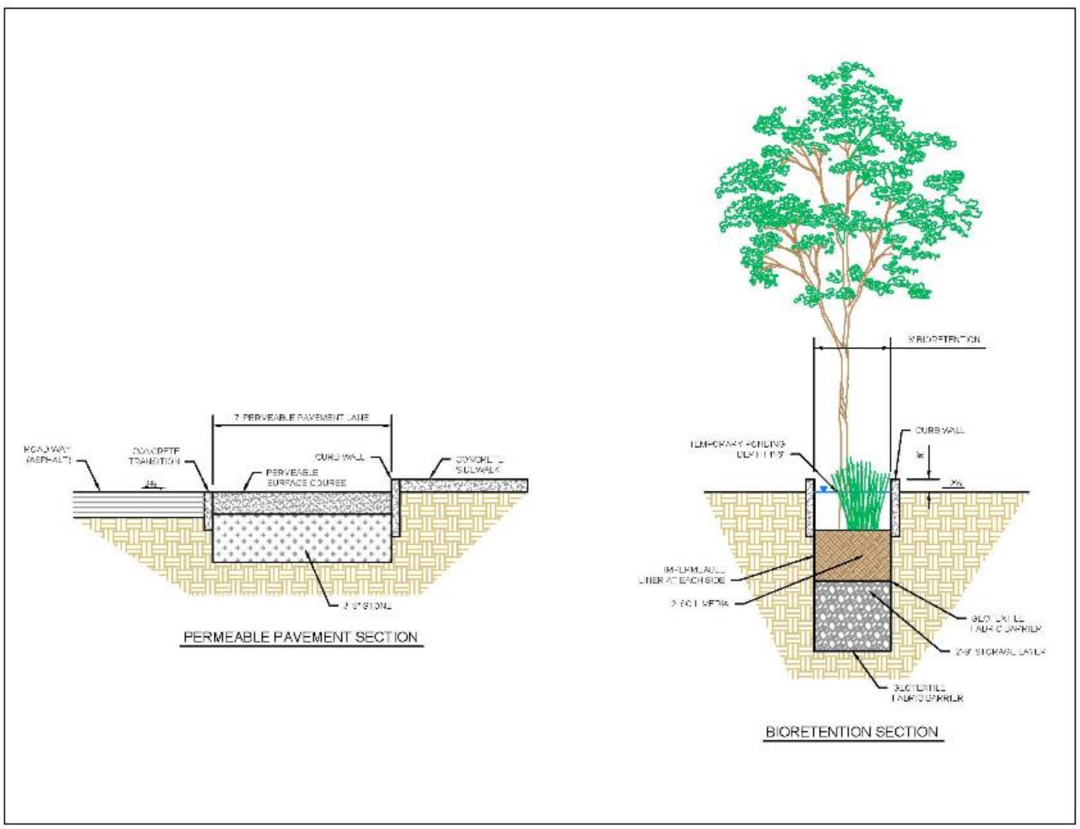


Figure 27. Expected cross section for Alternative 2.

The BMPs recommended in the Alternative 2 Pre Pumping should be designed to meet the following specifications and should comply with LA Standard Plan S-480 (Green Streets):

- Bioretention Areas
    - Ponding depth should be maintained at a minimum of 18 inches.

- Infiltration rate in existing soils should be a minimum of 0.5 in/hr.
- If the infiltration rate is less than 0.5 in/hr or if the site is located adjacent to a building foundation or in a liquefaction zone, underdrains and an engineered soil media should be installed. Bioretention soil media should have a minimum depth of 5 feet and should meet the following criteria:
  - Soil media consists of 85 percent washed course sand, 10 percent fines (range: 8–12 percent, and 5 percent organic matter.
  - The sand portion should consist of concrete sand (passing a one-quarter-inch sieve). Mortar sand (passing a one-eighth-inch sieve) is acceptable as long as it is thoroughly washed to remove the fines.
  - Fines should pass a # 270 (screen size) sieve.
  - Soil media must have an appropriate amount of organic material to support plant growth. Organic matter is considered an additive to help vegetation establish and contributes to sorption of pollutants but should generally be minimized (5 percent). Organic materials will oxidize over time, causing an increase in ponding that could adversely affect the performance of the bioretention area. Organic material should consist of aged bark fines, or similar organic material. Organic material should not consist of manure or animal compost. Newspaper mulch has been shown to be an acceptable additive.
  - pH should be between 6–8, cation exchange capacity (CEC) should be greater than 5 milliequivalent (meq)/100 g soil.
  - High levels of phosphorus in the media have been identified as the main cause of bioretention areas exporting nutrients. All bioretention media should be analyzed for background levels of nutrients. Total phosphorus should not exceed 15 ppm.
- Bioretention areas should be lined on the sides with a 30 mil liner to protect the surrounding infrastructure.
- PVC liners used for the lining of bioretention should meet the requirements of ASTM D-7176. The PVC liner should resist ultraviolet and shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45 degrees Fahrenheit without application of heat. A suitable geotextile fabric shall be placed on the top and bottom of the membrane for puncture protection.
- All geotextile shall comply with the following:

Property	Test Reference	Media Barrier
Grab Strength, lbs (N), Min.	ASTM D-4632	90 (400)
Elongation, Minimum (at peak load) %, Max.	ASTM D-4632	50
Puncture Strength, lbs (N), Min.	ASTM D-3787	65 (290)
Permittivity, Sec., Min.	ASTM D-4491	2.5
Burst Strength, psi (kPa), Min.	ASTM D-3786	225 (1550)
Toughness, lbs (N), Min.	% Elongation x Grab Strength	5500 (24500)
Ultraviolet Resistance % Strength Retained @ 500 Weatherometer Hours	ASTM D-D4355	70
Apparent Opening Size, US Sieve # (mm)	ASTM D-4751	70 (0.210)
Flow Rate, Gal/min/ft^2 (L/min/m^2)	ASTM D-4491	175 (7130)
Trapezoid Tear, lbs (N)	ASTM D-4533	45 (200)

    - A minimum 5 feet of redial clearance between the BMP and any light pole or utility must be provided
    - A minimum of 48 inches wide sidewalk access must be approved at each end of the BMPs from the sidewalk to the street curb.
- Permeable Pavement
    - Bedding material should be a 1- to 2-inch layer of washed no. 8 or 9 stone. It must be completely free of fines.
    - The structural layer below the permeable pavement must have a porosity of 40 percent and should extend to a depth of 3.75 feet below the paver surface. A washed no. 57 stone at a depth of at least 6 inches is recommended as a choker course overlaying no. 2 stone.
    - Installation must have a slope of less than 0.5 percent unless internal check dams are incorporated.
    - Permeable pavement should be lined on the sides with a 30 mil liner to protect the surrounding infrastructure. If geotechnical analyses suggest that infiltration should be restricted, the entire system should be lined and an underdrain installed.
    - PVC liners used for the lining of permeable pavement should meet the requirements of ASTM D-7176. The PVC liner should resist ultraviolet and shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45 degrees Fahrenheit without application of heat. A suitable geotextile fabric shall be placed on the top and bottom of the membrane for puncture protection.

5.2.1. Design Details and Drawing

A photo log, conceptual plans, and cross-sectional details are provided in Appendix A. Example product details along with a list of certified professionals qualified to install pervious concrete and concrete pavers is included in Appendix E.

6. Plant Selection

For the BMPs to function properly for stormwater treatment and blend into the landscape, vegetation selection is crucial. Appropriate vegetation will have the following characteristics:

1. Plant materials must be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 10 to 48 hours.
2. It is recommended that a minimum of three shrubs and three herbaceous groundcover species be incorporated to protect against facility failure from disease and insect infestations of a single species. To match current site landscaping, only one tree has been recommended.
3. Native plant species or hardy cultivars that are not invasive and do not require chemical inputs are recommended to be used to the maximum extent practicable.

A selection of recommended plant species, along with additional details including the recommended landscape position, size at maturity and light requirements, is provided in Table 9 based on the City of Los Angeles' Urban Forestry Division Street Tree Selection Guide (City of Los Angeles Urban Forestry Division 2011) and landscape architect recommendations.

Table 9. Recommended plant list.

Trees		Los Angeles native - LA California native - CA Nonnative– X	Landscape position: 1 - Low[a], 2 - Mid[b], 3 - High[c]	Mature size (height x width)	Irrigation demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light requirements Sun - SU ▪ Shade - SH Part Shade - PS Sun or Shade - SS	Season Evergreen - E, Deciduous - D Semi-Evergreen – SE
***Cercisoccidentalis*[d]**	**Western redbud**	**LA**	**1**	**10-18' x 10-18'**	**M**	**SU, PS**	**D**
***Chilopsislinearis*[d]**	**Desert willow**	**LA**	**1**	**15-30' x 10-20'**	**L-M**	**SU**	**D**
Umbellulariacalifornica	California bay	LA	1	20-25' x 20-25'	L-H	SU, PS, SH	E
Shrubs							
Baccharispilularis 'Pigeon Point'	Dwarf coyote bush	LA	3	1-2' x 6'	L-M	SU	E
Rhamnuscalifornica 'Little Sur'	Dwarf California coffeeberry	LA	2	3-4' x 3'	N-M	SU, PS	E
Heteromelesarbutifolia	Toyon	LA	3	6-10' x 6-10'	M	SU, PS	E
***Baccharissalicifolia*[d]**	**Mulefat**	**LA**	**1**	**4-10'x8'**	**M-H**	**SU, PS, SH**	**SE**
***Rosa californica*[d]**	**California rose**	**LA**	**1**	**3-6' x 6'**	**M-H**	**SU, PS, SH**	**SE**
Grasses and grass-like plants							
***Elymusglaucus*[d]**	**Blue wild rye**	**LA**	**1**	**2-4' x 5'**	**L-M**	**SU, PS**	**SE**
***Muhlenbergiarigens*[d]**	**Deer grass**	**LA**	**1**	**2-4' x 3-4'**	**L**	**SU**	**E**
***Juncuspatens*[d]**	**California gray rush**	**CA**	**1**	**2' x 2'**	**L-H**	**SU, PS**	**E**

Notes

The Landscape position is the lowest area recommended for each species. Plants in areas 1 and 2 might also be appropriate for higher locations. When specifying plants, availability should be confirmed by local nurseries. Some species might need to be contract-grown, and it might be necessary for the contractor to contact the nursery well before planting because some species might not be available on short notice.

[a]Landscape Position 1 (Low): These areas experience seasonal flooding. Seasonal flooding for bioretention areas is typically 9 inches deep, for up to 72 hours (the design infiltration period for a bioretention area). If parts of the bioretention area are to be inundated for longer durations or greater depth, the designer should develop a plant palette with longer term flooding in mind. Several of the species listed as tolerant of seasonal flooding might be appropriate, but the acceptability of each species considered should be researched and evaluated case by case.

[b]Landscape Position 2 (Mid): These areas are low but are not expected to flood. However, they are likely to have saturated soils for extended periods.

[c]Landscape Position 3 (High): These areas are generally on well-drained slopes adjacent to stormwater BMPs. Soils typically dry out between storm events.

[d]**Bolded species** have been observed in the city and are known to be suitable for the recommended landscape position.

7. Green Infrastructure Operations and Maintenance

Maintenance of stormwater BMPs should be incorporated into existing routine maintenance activities. Permeable pavement should be swept during the existing monthly street sweeping schedule and City of LA Bureau of Street Services maintenance personnel should be trained to maintain stormwater BMPs located in the public right-of-way. Maintenance activities for the BMPs should be focused on the major system components, especially landscaped areas. Landscaped components should blend over time through plant and root growth, organic decomposition, and they should develop a natural soil horizon. The biological and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Irrigation might be needed, especially during plant establishment or in periods of extended drought. Irrigation frequency will depend on the season and type of vegetation. Drought tolerant plants require less irrigation than other plants.

Table 10, Table 11, and Table 12 outline the required maintenance tasks, their associated frequency, and notes to expand on the requirements of each task based on recommendations from researchers in the green infrastructure field.

Table 10. Inspection and maintenance tasks for underground storage galleries.

Task	Frequency	Maintenance Notes
Dry season inspection	One time per year	Inspect once during the dry season to ensure volume capacity. Clean if required.
Wet season inspection	Monthly during wet season	Monthly during the wet season to ensure volume capacity. Inspect and confirm level of silt and sediment.
Vault cleaning	Dry season – 1 time Wet season – 1 times	Dry season cleaning to happen just before the start of the wet season.
Valve maintenance	As needed	

Table 11. Bioretention operations and maintenance considerations.

Task	Frequency	Maintenance notes
Monitor infiltration and drainage	1 time/year	Inspect drainage time (12–24 hours). Might have to determine the infiltration rate (every 2–3 years). Turning over or replacing the media (top 2–3 inches) might be necessary to improve infiltration (at least 0.5 in/hr).
Pruning	1 time/year	Nutrients in runoff often cause bioretention vegetation to flourish.
Mulching	1 time/year	Recommend maintaining 1-inch to 3-inch uniform mulch layer.
Mulch removal	1 time/3–4 years	Biodegraded mulch accumulation reduces available water storage volume. Removal of mulch also increases surface infiltration rate of fill soil.
Watering	1 time/2–3 days for first 1–2 months; sporadically after establishment	If drought conditions exist, watering after the initial year might be required.
Soil amendments	1 time initially	One-time spot soil amendments for first year vegetation.
Remove and replace dead plants	1 time/year	It is common for 10% of plants to die during first year. Survival rates tend to increase with time.
Inlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow into the retention area is as designed. Remove any accumulated sediment.
Outlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for erosion at the outlet and remove any accumulated mulch or sediment.
Miscellaneous upkeep	2 times/year	Tasks include trash collection, plant health, spot weeding, and removing mulch from the overflow device.

Table 12. Permeable pavement operations and maintenance considerations.

Task	Frequency	Maintenance notes
Impervious to pervious interface	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow onto the permeable pavement is not restricted. Remove any accumulated sediment. Stabilize any exposed soil.
Street sweeping	Weekly during routine mechanical sweeping and twice a year with vacuum sweeper (or as needed)	Portions of pavement should be swept with a vacuum street sweeper at least twice per year or as needed to maintain infiltration rates.
Replace void fill materials (applies to pervious pavers only)	1-2 times per year (and after any vacuum truck sweeping)	Fill materials will need to be replaced after each sweeping and as needed to keep interstitial bedding material even with the paver surface.
Miscellaneous upkeep	4 times per year or as needed for aesthetics	Tasks include trash collection, sweeping, and spot weeding. Ensure landscaping materials (soil, mulch, grass clippings, etc.) are not stockpiled on permeable pavement surfaces.

8. Cost Estimate

The estimated cost of the pump station upgrades are included in Table 13 and the costs of implementing each of the alternative described above are included in Table 14 through Table 16. This cost estimate is a guide only and should be updated at the time of preliminary design to account for fluctuation in cost of material, labor, or components, or unforeseen contingencies.

Table 13. Pump Plant Upgrade Costs.

Item No.	Description	Estimated Qty	Unit	Unit Cost	Total
1	Mobilization and Demobilization	1	LS	$365,000	$365,000
2	Demolition/Removal of Existing Pumps and Discharge Piping	1	LS	$30,000	$30,000
3	Furnish and Install 5,100 GPM Submersible Pump (For BMP)	2	EA	$60,000	$120,000
4	Furnish and Install 36,600 GPM Dry Pit Submersible Pump (For 50 year Storm)	3	EA	$450,000	$1,350,000
5	Furnish and Install 16-inch Discharge Piping to BMP	1300	LF	$250	$325,000
6	Furnish and Install 30-inch Discharge Piping to Surge Chamber	1	LS	$20,000	$20,000
7	Furnish and Install 30-inch Check Valve on Pump Discharge Piping	3	EA	$50,000	$150,000
8	Furnish and Install 40-inch Pump Suction Piping	1	LS	$20,000	$20,000
9	Furnish and Install 40-inch Plug Valves on Suction Piping	3	EA	$50,000	$150,000
10	Furnish and Install Level Control	1	LS	$10,000	$10,000
11	Replace Ventilation System	1	LS	$30,000	$30,000
12	Sandblast and Paint Interior Walls and Piping	1	LS	$50,000	$50,000
13	Structural Upgrades to Building	1	LS	$600,000	$600,000
14	New Portable Diesel Generator	1	LS	$800,000	$800,000
15	Upgrade the Interior Lighting	1	LS	$10,000	$10,000
16	Electrical Upgrades	1	LS	$250,000	$250,000
17	Furnish and Install SCADA/I&C	1	LS	$100,000	$100,000
18	Replace Potable Water System	1	LS	$5,000	$5,000
Subtotal Cost					**$4,385,000**
19	Construction contingency (25% of subtotal)				$1,100,000
Total Cost					**$5,500,000**

Table 14. Alternative 1 Scenario 1: Post-Pump Treatment 11.5 cfs Direct Pumping Cost Estimate.

Item No	Description		Unit	Unit Cost	Total
	Preparation				
1	Temporary Construction Fence	1,400	LF	$2.50	$3,500
2	Silt Fence	1,400	LF	$3.00	$4,200
	Site Preparation				
3	Excavation and Removal	15,778	CY	$45.00	$710,010
	Structures				
4	Structural Layer (washed no 57 or no 2 stone)	2,630	CY	$50.00	$131,500
5	Utility Conflicts	1	LS	$10,000	$10,000
6	Connection to Existing Wet-Well	1	LS	$350.00	$350
7	Force Main 16" DI	1,300	LF	$60.00	$78,000
	Underground Storage				
8	Fine Grading	71,002	SF	$0.72	$51,121
9	Underground Storage Gallery	10,519	CY	$378.00	$3,976,182
10	Maintenance/Observation Access to the Underground Infiltration Basin	9		$5,000.00	$45,000
11	Junction Structure	1		$8,000.00	$8,000
	Irrigation				
12	Stormwater lift station/wet well (200 gpm)	1	EA	$200,000	$200,000
13	Water treatment system (UV)	1	EA	$300,000	$300,000
14	Landscaping	71,002	SF	$2.00	$142,004
15	Electrical/control integration	1	EA	$3,000.00	$3,000
Construction Subtotal					**$5,662,870**
16	Bond (5% of subtotal)				$283,140
17	Mobilization (10% of subtotal)				$566,290
18	Construction contingency (20% of subtotal)				$1,132,570
Construction Total					**$7,644,870**
19	Design (10% of Construction Total)				$764,487
Total Cost					**$8,409,360**

Table 15. Alternative 1 Scenario 2: Post-Pump Treatment 11.5 cfs Direct Pumping Cost Estimate.

Item No	Description		Unit	Unit Cost	Total
	Preparation				
1	Temporary Construction Fence	1,400	LF	$2.50	$3,500
2	Silt Fence	1,400	LF	$3.00	$4,200
	Site Preparation				
3	Excavation and Removal	15,778	CY	$45.00	$710,010
	Structures				
4	Structural Layer (washed no 57 or no 2 stone)	2,630	CY	$50.00	$131,500
5	Utility Conflicts	1	LS	$10,000.0 0	$10,000
6	Connection to Existing Wet-Well	1	LS	$350.00	$350
1	Force Main 16" DI	1,300	LF	$60.00	$78,000
	Junction Structure	1		$8,000.00	$8,000
	System Control	1	EA	$4,188	$4,188
	Force Main 12" DI	1,000	LF	$60.00	$60,000
	Underground Storage				
8	Fine Grading	71,002	SF	$0.72	$51,121
9	Underground Storage Gallery	10,519	CY	$378.00	$3,976,182
10	Maintenance/Observation Access to the Underground Infiltration Basin	9		$5,000.00	$45,000
Construction Subtotal					**$5,082,050**
11	Bond (5% of subtotal)				$254,100
12	Mobilization (10% of subtotal)				$508,210
13	Construction contingency (20% of subtotal)				$1,016,410
Construction Total					**$6,860,770**
14	Design (10% of Construction Total)				$686,077
Total Cost					**$7,546,850**

Table 16. Alternative 2: Pre-Pump Green Infrastructure Treatment cost estimate.

Item No	Description	Estimated Qty	Unit	Unit Cost	Total
	Preparation				
1	Traffic Control	120	Day	$1,000.00	$120,000
2	Temporary Construction Fence	44,818	LF	$2.50	$112,045
3	Silt Fence	44,818	LF	$3.00	$134,454
	Site Preparation				
4	Curb and Gutter Removal	8,000	LF	$3.30	$26,400
5	Saw Cut Existing Asphalt	100,800	LF	$5.12	$73,728
6	Asphalt Removal	8,400	SF	$3.36	$338,688
7	Excavation and Removal	17,704	CY	$45.00	$796,680
	Structures				
8	Curb and Gutter	8,000	LF	$22.00	$176,000
9	Permeable Pavement	100,800	SF	$12.00	$1,209,600
10	Structural Layer (washed no 57 or no 2 stone)	10,888	CY	$50.00	$544,400
11	Concrete Transition Strip	14,400	LF	$4.00	$57,600
12	Utility Conflicts	1	LS	$80,000.00	$80,000
	Bioretention				
13	Fine Grading	16,000	SF	$0.72	$11,520
14	Drainage Stone (washed no 57 stone)	1,629	CY	$50.00	$81,450
15	Hydraulic Restriction Layer (30 mil liner)	32,008	LF	$0.60	$19,205
16	Soil Media Barrier (washed sand)	99	CY	$40.00	$3,960
17	Soil Media Barrier (choking stone, washed no 8)	99	CY	$45.00	$4,455
18	Mortared Cobble Energy Dissipater	400	SF	$2.25	$900
19	Curb Opening with Grate	80	LS	$350.00	$28,000
	Landscaping				
20	Soil Media	1,185	CY	$45.00	$53,325
21	Vegetation	16,000	SF	$4.00	$64,000
22	Mulch	148	CY	$55.00	$8,140
	Construction Subtotal				$3,944,550
23	Bond (5% of subtotal)				$197,230
24	Mobilization (10% of subtotal)				$394,460
25	Construction contingency (20% of subtotal)				$788,910
	Construction Total				$5,325,150
26	Design (10% of Construction Total)				$532,515
	Total Cost				**$5,857,670**

9. Additional Considerations

9.1. Monitoring Plan

Performance monitoring of stormwater BMPs is an important component of a BMP implementation program. Monitoring provides the BMP's designer a mechanism to validate certain design assumptions and to quantify compliance with pollutant-removal performance objectives. Specific monitoring objectives should be considered early in the design process to ensure that BMPs are adequately configured for monitoring. Detailed monitoring guidance is provided by the EPA (USEPA 2012). The instrumentation and monitoring configuration will vary from site to site, but a monitoring approach using an inlet/outlet sample location setup is recommended for this site.

9.1.1. Monitoring Hydrology

An inlet/outlet sampling setup is suggested as the most effective monitoring approach to quantify flow and volume in stormwater BMPs. The runoff source and type of BMP will dictate the configuration of inflow monitoring. A weir or flume (Figure 28) is typically installed at the inlet of a BMP. Outflow can be monitored using similar techniques as inflow by installing a weir or ADV at the point of overflow/outfall (Figure 29). Outlet samples can also be collected from systems configured with underdrains utilizing specially designed v-notch weirs such as the one shown in Figure 30. Figure 31 shows an example of potential monitoring points.

Figure 28. Inlet curb cut with an H-flume.

Figure 29. Outlet of a roadside bioretention equipped with a V-notch weir for flow monitoring.

Figure 30. Typical weir for monitoring flow in an underdrain.

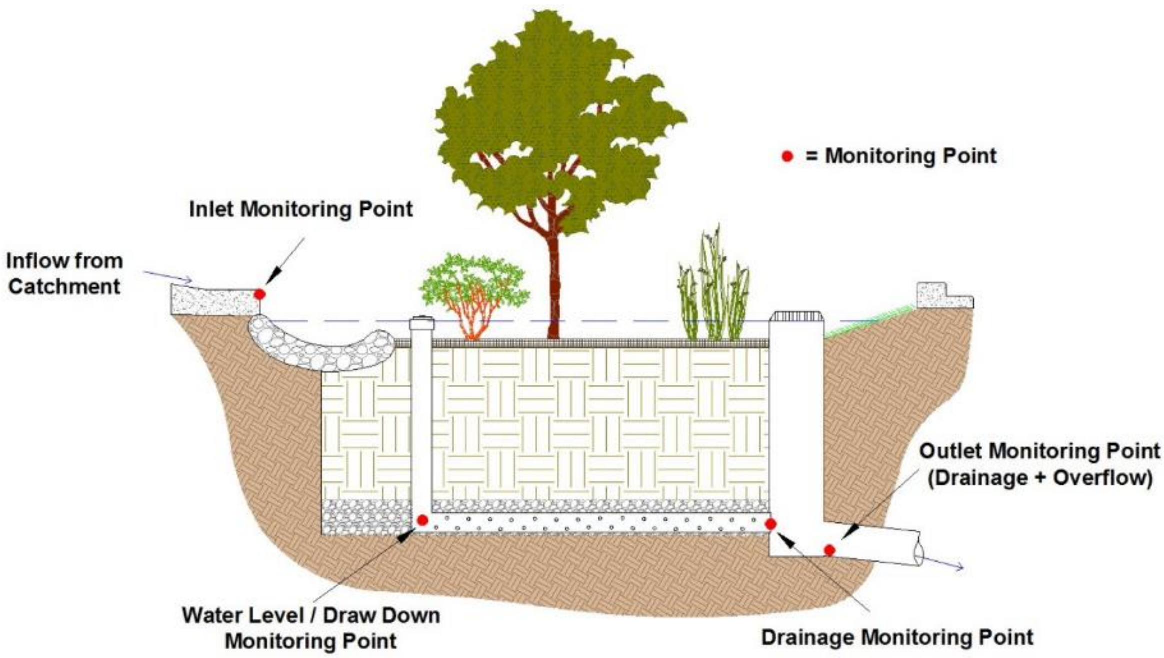


Figure 31. Typical monitoring points.

In addition to monitoring inflow and outflow, rainfall should be recorded on-site. Rainfall data can also be used to estimate inflow to BMPs that receive runoff only by sheet flow or direct rainfall (e.g., permeable pavement or green roofs). The type of rain gauge depends on monitoring goals and frequency of site visits. An automatic recording rain gauge (e.g., tipping bucket rain gauge), used to measure rainfall intensity and depth, is often paired with a manual rain gauge for data validation (Figure 32). For more advanced monitoring, weather stations can be installed to simultaneously monitor relative humidity, air temperature, solar radiation, and wind speed; these parameters can be used to estimate evapotranspiration.

Figure 32. Example of manual (left) and tipping bucket (right) rain gauges.

Water level (and drawdown rate) is another useful hydrologic parameter. Depending on project goals, perforated wells or piezometers can be installed to measure infiltration rate and drainage. Care should be taken when installing wells to ensure that runoff cannot enter the well at the surface and *short circuit* directly to subsurface layers; short circuiting can result in the discharge of untreated runoff that has bypassed the intended treatment mechanisms. It might be useful to pair soil moisture sensors with water level loggers in instances where highly detailed monitoring performance data are required (such as for calibration and validation of models).

9.1.2. Monitoring Water Quality

Although hydrologic monitoring can occur as a standalone practice, water quality data must be paired with flow data to calculate meaningful results. Flow-weighted automatic sampling is the recommended method for collecting samples that are representative of the runoff event and can be used to calculate pollutant loads (total mass of pollutants entering and leaving the system). Simply measuring the reduction in pollutant concentrations (mass per unit volume of water) from inlet to outlet can provide misleading results because it does not account for load reductions associated with infiltration, evapotranspiration, and storage.

Influent water quality samples are typically collected just upstream of the inlet monitoring device (e.g., weir box, flume) just before the runoff enters the BMP. The downstream sampler should be at the outlet control device just before the overflow enters the existing storm drain infrastructure. A strainer is usually installed at collecting end of the sampler tubing to prevent large debris and solids from entering and clogging the sampler. Automatic samplers should be programmed to collect single-event, composite samples according to the expected range of storm flows. Depending on the power requirements, a solar panel or backup power supply might be needed.

In addition to collecting composite samples, some water quality constituents can be monitored in real-time. Some examples include dissolved oxygen, turbidity, conductivity, and temperature.

9.1.3. Sample Collection and Handling

Quality assurance and quality control protocols for sample collection are necessary to ensure that samples are representative and reliable. The entire sample collection and delivery procedure should be well documented, including chain of custody (list of personnel handling water quality samples) and notes regarding site condition, time of sampling, and rainfall depth in the manual rain gauge. Holding times for water quality samples vary by constituent, but all samples should be collected, placed on ice, and delivered to the laboratory as soon as possible (typically 6 to 24 hours) after a rainfall event. Some water quality constituents require special treatment upon

collection, such as acidification, to preserve the sample for delivery. Appropriate health and safety protocols should always be followed when on-site, including using personal protective equipment such as safety vests, nitrile gloves, and goggles.

9.2. Public Education and Outreach

The green infrastructure BMPs will provide learning opportunities for community residents who frequent the area. A demonstration project will provide an example of how BMPs can be implemented in existing infrastructure and will serve as a consistent reminder of their impact on stormwater quality. When the project is completed, educational signage describing the BMPs and indicating the BMPs role in maintaining healthy water quality should remain on-site.

9.3. Future Retrofit Opportunities

The 127.7 acre drainage area of SWS 1173 was the focus of these wet weather treatment conceptual designs because of the required upgrade of Pump Plant 647. These results can be used to guide future stormwater retrofit projects in the area.

10. References

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Appendix A - Fact Sheets

Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–Appendix A.1
SITE: Pumping Plant No. 647

Site Location			
Landowner	City of Los Angeles	Latitude	33°59'16.72"N
Date of Field Visit	03/05/2015	Longitude	118°28'15.55"W
Field Visit Personnel	TJ, LT, RM	Street Address	1600 Main St Venice, CA 90291
Major Watershed	Santa Monica Bay		

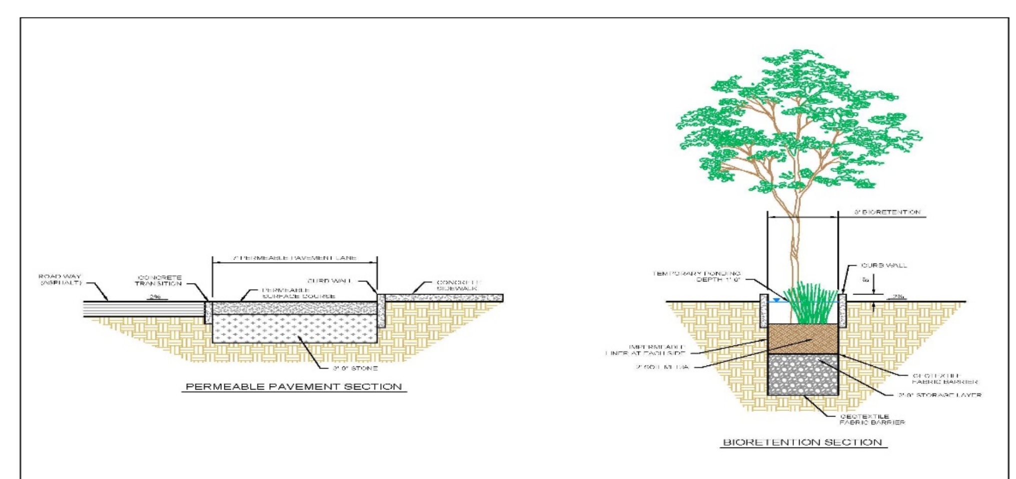
Existing Site Description: The conceptual design centers around the existing Pump Plant 647 near the intersection of Main Street and Windward Avenue. The pump plant is intended to provide flood protection to an area roughly bounded by Electric Avenue, Venice Boulevard, Mildred Avenue, and Pacific Avenue in the Venice area of the City. Storm water flows from underground storm drain pipes in Grand Avenue, Windward Avenue, and Main Street are pumped up to a surge box/outlet arch-culvert storm drain that flows to the west.

Watershed Characteristics		Retrofit Characteristics		
Drainage Area, acres	127.7	Proposed Retrofit		Green Street
Hydrologic Soil Group	B	BMP footprint, ft^2	Bioretention Permeable Pavement	100,800 16,000
Total Impervious, %	75	Ponding Depth, ft	Bioretention Permeable Pavement	1.5 0.01
Design Storm Event, in	85th	Media Depth, ft	Bioretention Permeable Pavement	3.75 4.75

Proposed Retrofit Description: : The proposed retrofit would reduce flows to the pump plant by installing bioretention areas and permeable pavement in the right-of-way along multiple residential streets. Curb cuts could convey runoff to bioretention areas installed along the curb line to provide treatment. A protected bike lane will increase safety for bicyclists and pedestrians while protecting permeable pavement in the bike lane from vehicular traffic.

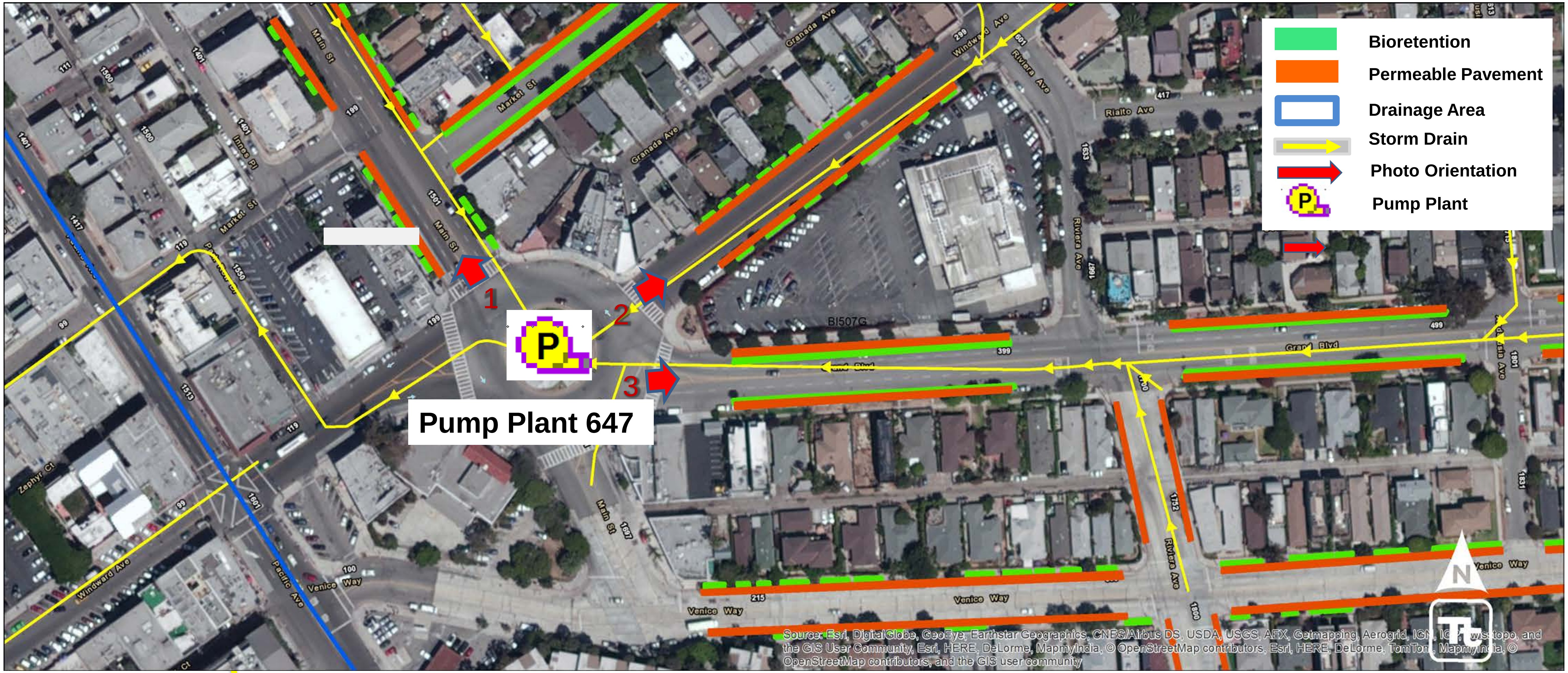
Current Street View

Rendered Street Improvement



Example Cross Section

Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–Appendix A.2
SITE: Pumping Plant No. 647

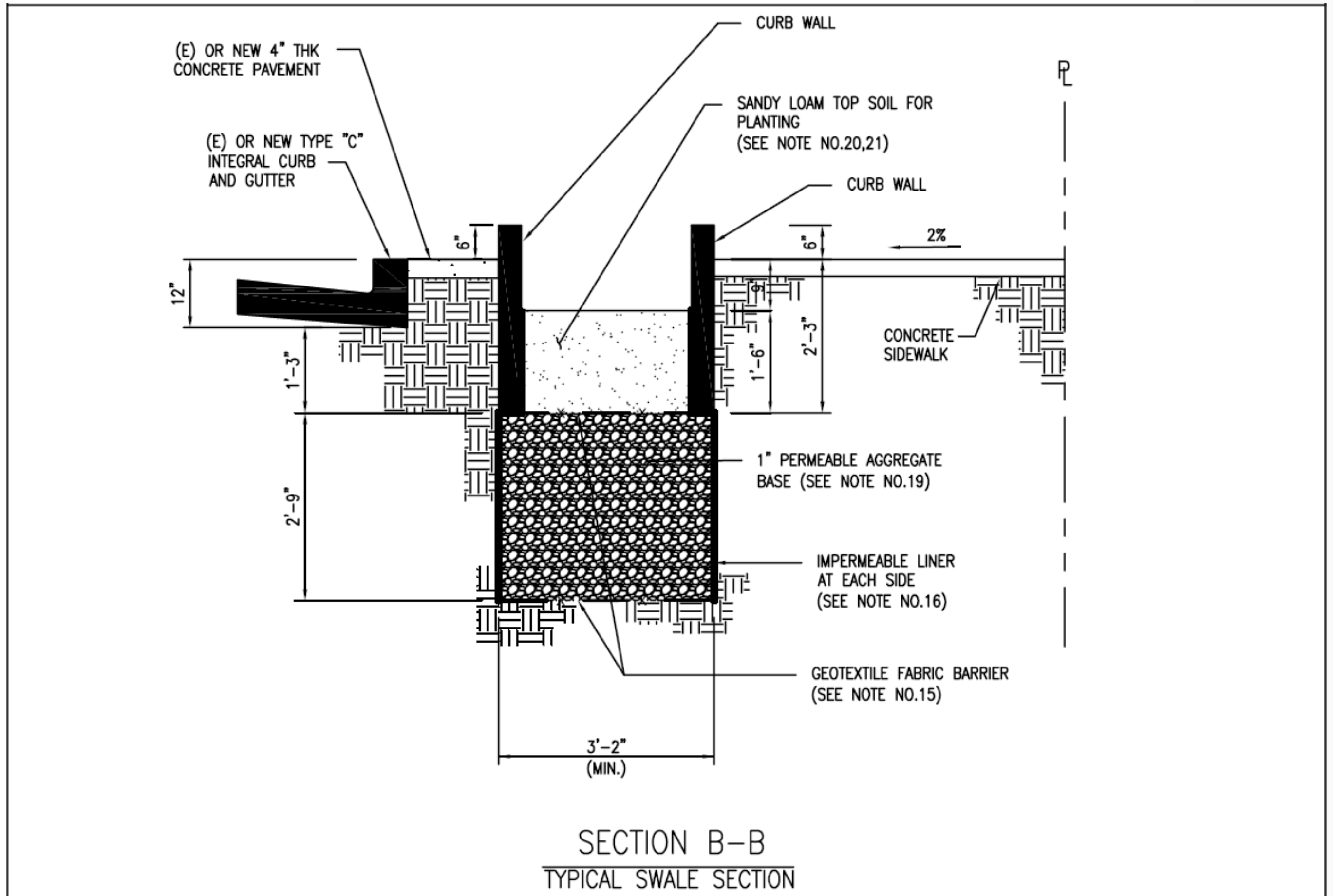


Best Management Practice Conceptual Designs for Upper Los Angeles River

CONCEPTUAL PLAN–Appendix A.3

SITE: Pumping Plant No. 647

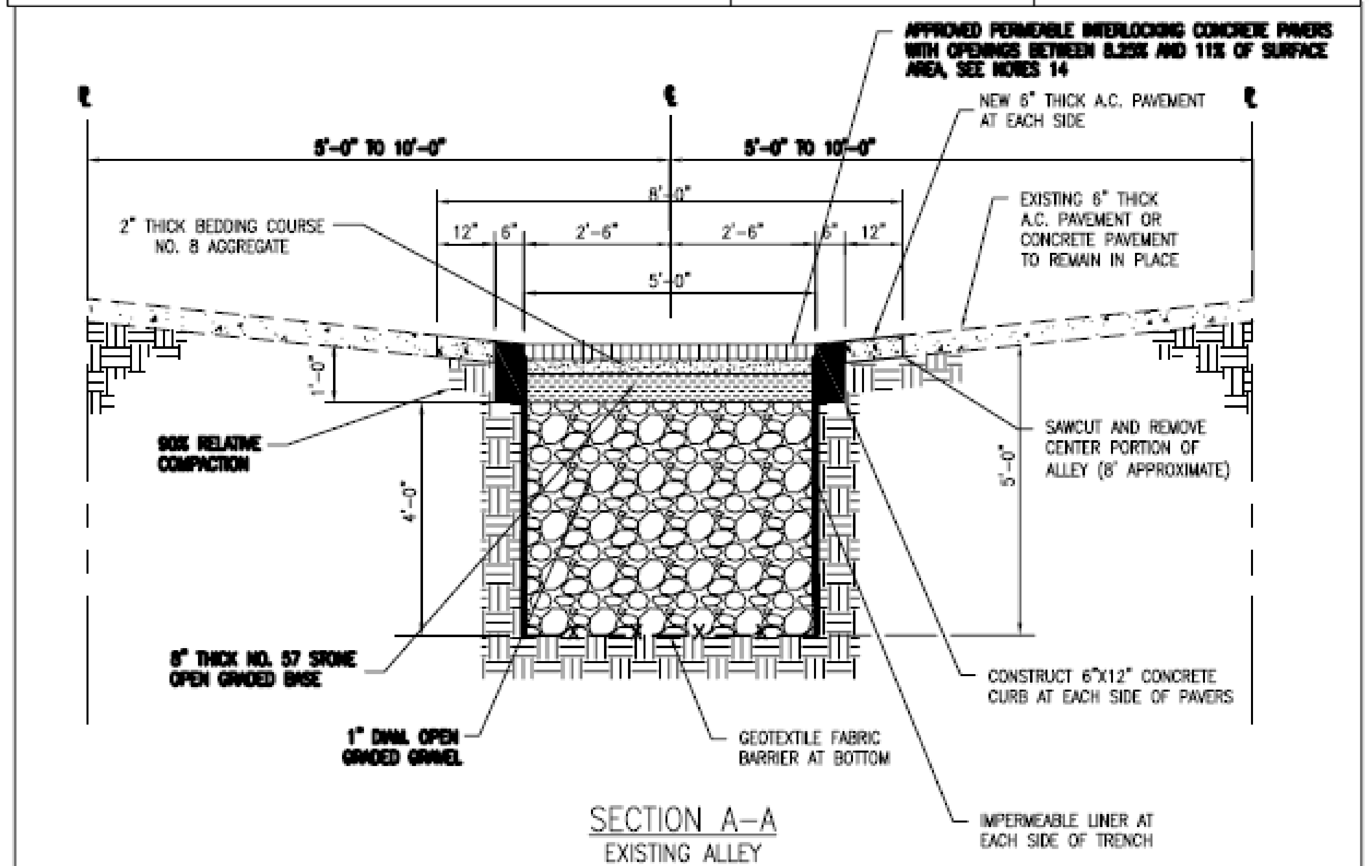
Best Management Practice Conceptual Designs for Upper Los Angeles River
CONCEPTUAL PLAN–Appendix A.4
SITE: Pumping Plant No. 647



SECTION B–B

TYPICAL SWALE SECTION

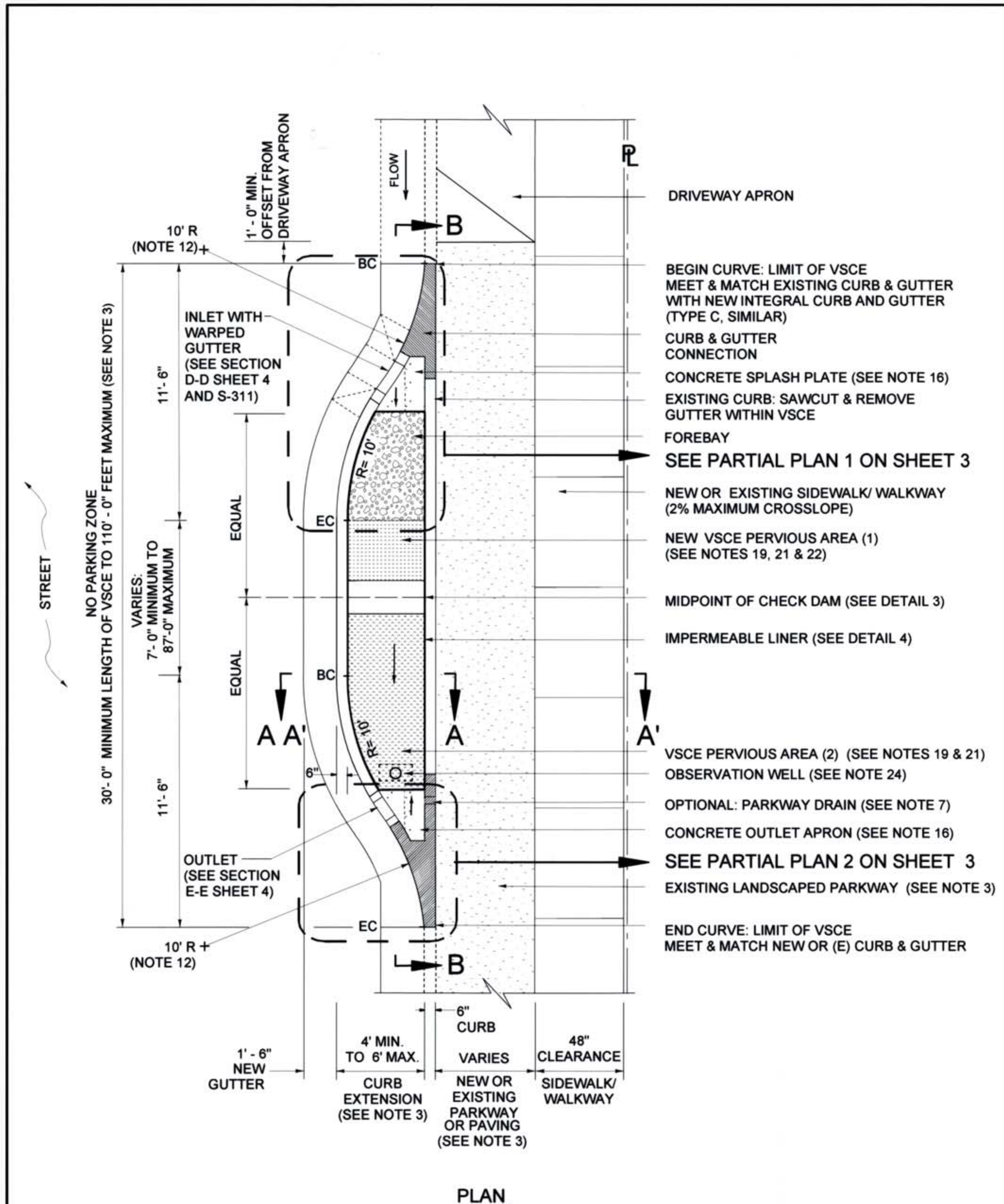
STANDARD PLAN NO. S–481–0 | SHEET 3 OF 8 SHEETS



SECTION A–A

EXISTING ALLEY

STANDARD PLAN NO. S–485–0 | SHEET 2 OF 3 SHEETS



PLAN

BUREAU OF ENGINEERING | DEPARTMENT OF PUBLIC WORKS | CITY OF LOS ANGELES

VEGETATED STORMWATER CURB EXTENSION (VSCE) | STANDARD PLAN S–484–0

PREPARED	SUBMITTED	APPROVED	SUPERSEDES	REFERENCES
DEBORAH DEETS, RLA 4839 BUREAU OF SANITATION ENRIQUE C. ZALDIVAR, P.E., DIRECTOR	JEONG PARK, S.E. 6/28/10 ENGINEER OF DESIGN BUREAU OF ENGINEERING			S–311 S–433 S–410 S–480 S–430 S–681
CHECKED PATRICK LEE, CE42448 BUREAU OF ENGINEERING	KEN REDD, P.E. 6/29/10 ACTING DEPUTY CITY ENGINEER	GARY LEE MOORE, P.E. 6-29-10 CITY ENGINEER		

REGISTERED PROFESSIONAL ENGINEER GARY LEE MOORE No. C-49446 Exp. 9/30/10 CIVIL STATE OF CALIFORNIA

SHEET 1 OF 11 SHEETS

CITY OF LOS ANGELES SANITATION DEPARTMENT OF PUBLIC WORKS

Appendix B - Hydrocalcs

Peak Flow Hydrologic Analysis

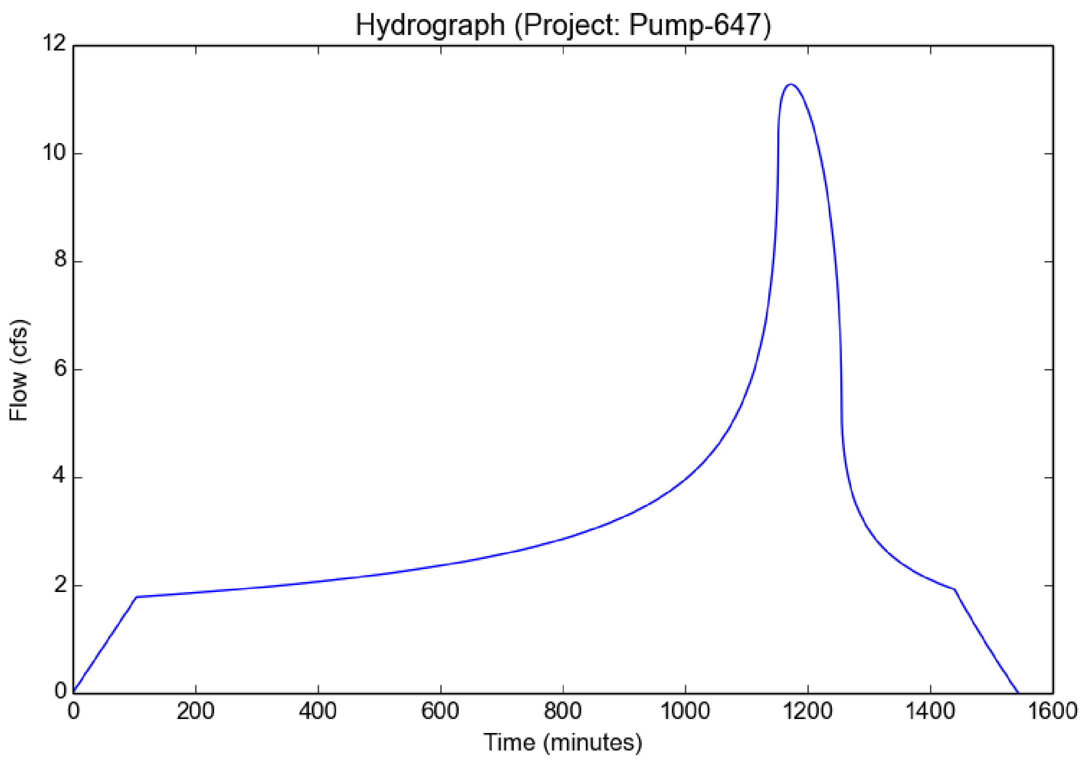
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump-647-85th.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	Pump-647
Area (ac)	127.7
Flow Path Length (ft)	3000.0
Flow Path Slope (vft/hft)	0.006
85th Percentile Rainfall Depth (in)	0.88
Percent Impervious	0.75
Soil Type	16
Design Storm Frequency	85th percentile storm
Fire Factor	0.71
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.88
Peak Intensity (in/hr)	0.1261
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.7
Time of Concentration (min)	104.0
Clear Peak Flow Rate (cfs)	11.2716
Burned Peak Flow Rate (cfs)	11.8333
24-Hr Clear Runoff Volume (ac-ft)	6.502
24-Hr Clear Runoff Volume (cu-ft)	283228.5742



Peak Flow Hydrologic Analysis

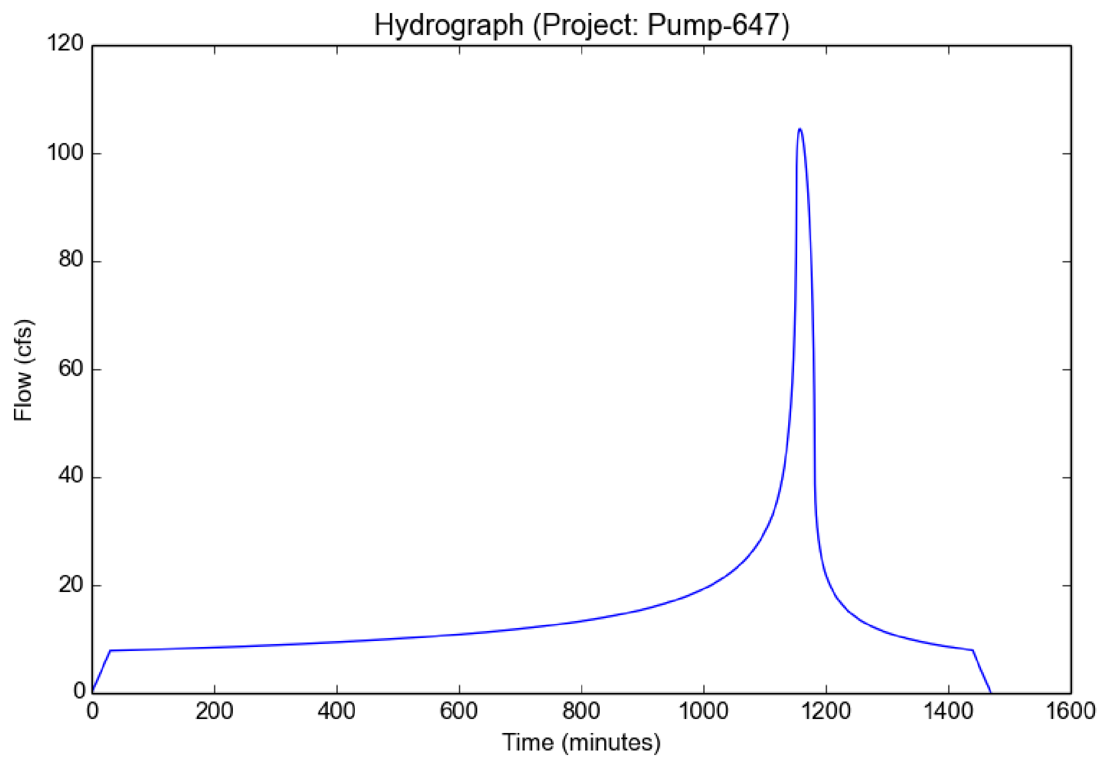
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump-647-10yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	Pump-647
Area (ac)	127.7
Flow Path Length (ft)	3000.0
Flow Path Slope (vft/hft)	0.006
50-yr Rainfall Depth (in)	5.5
Percent Impervious	0.75
Soil Type	16
Design Storm Frequency	10-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	3.927
Peak Intensity (in/hr)	1.0093
Undeveloped Runoff Coefficient (Cu)	0.5421
Developed Runoff Coefficient (Cd)	0.8105
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	104.4712
Burned Peak Flow Rate (cfs)	110.0826
24-Hr Clear Runoff Volume (ac-ft)	29.5777
24-Hr Clear Runoff Volume (cu-ft)	1288406.3284



Peak Flow Hydrologic Analysis

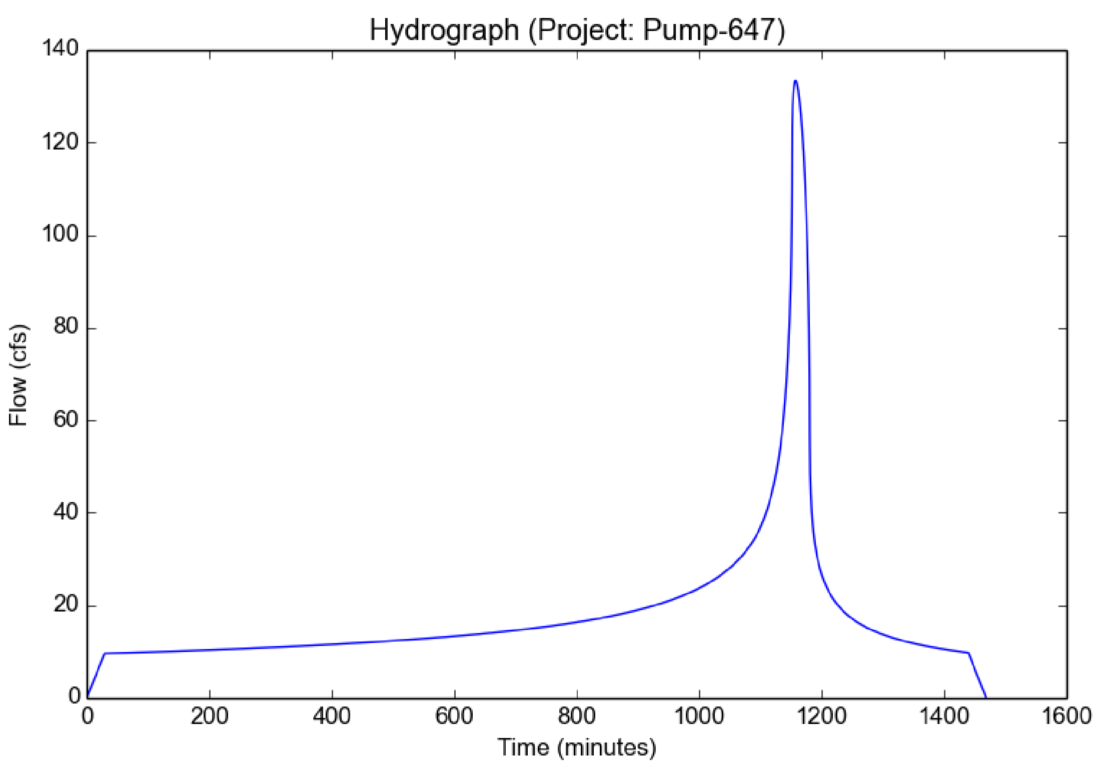
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump-647-25yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	Pump-647
Area (ac)	127.7
Flow Path Length (ft)	3000.0
Flow Path Slope (vft/hft)	0.006
50-yr Rainfall Depth (in)	5.5
Percent Impervious	0.75
Soil Type	16
Design Storm Frequency	25-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	4.829
Peak Intensity (in/hr)	1.2611
Undeveloped Runoff Coefficient (Cu)	0.6117
Developed Runoff Coefficient (Cd)	0.8279
Time of Concentration (min)	29.0
Clear Peak Flow Rate (cfs)	133.3328
Burned Peak Flow Rate (cfs)	139.9989
24-Hr Clear Runoff Volume (ac-ft)	36.5953
24-Hr Clear Runoff Volume (cu-ft)	1594090.0061



Peak Flow Hydrologic Analysis

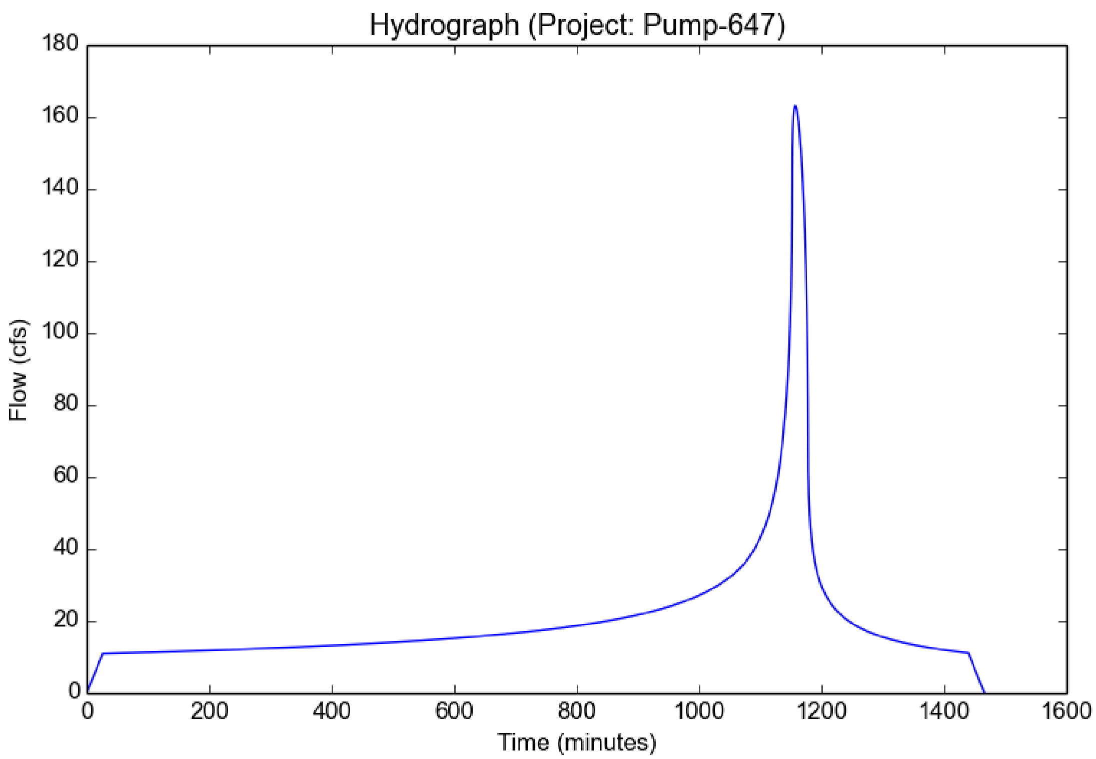
File location: W:/Projects/City of Los Angeles/2015 Conceptual Design (TOS 31)/Modeling/HydroCalc/Project - Pump-647-50yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Project
Subarea ID	Pump-647
Area (ac)	127.7
Flow Path Length (ft)	3000.0
Flow Path Slope (vft/hft)	0.006
50-yr Rainfall Depth (in)	5.5
Percent Impervious	0.75
Soil Type	16
Design Storm Frequency	50-yr
Fire Factor	0.71
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	5.5
Peak Intensity (in/hr)	1.512
Undeveloped Runoff Coefficient (Cu)	0.6797
Developed Runoff Coefficient (Cd)	0.8449
Time of Concentration (min)	26.0
Clear Peak Flow Rate (cfs)	163.1369
Burned Peak Flow Rate (cfs)	170.5978
24-Hr Clear Runoff Volume (ac-ft)	41.8838
24-Hr Clear Runoff Volume (cu-ft)	1824457.2622



Appendix C – Pump Calculations

CITY OF LOS ANGELES
Plant No. 647 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #647 (Venice) Storm Water PS BMP pun

Givens:
1. 85th Percentile flow is 11.3 CFS (5,072 gpm)
2. Assume 1300 lf of 16" pipe to BMP
3. Static Head is 20'

Assumptions:
1. The Hazen-Williams C-factors are assumed to be as follows:
   Aged Ductile Iron Pipe = 100
2. Minor losses are neglected within the pipeline and pump station
3. The pump suction grade line is based on the water levels in the Plant #647 wet well
   LWL = -3.06 HWL = 0.94
5. The pump discharge is pumping to the summit manhole.
   Elev = 15

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: h_L=10.44*L(ft)*$Q^{1.85}$(gpm)/$C^{1.85}$*$D^{4.87}$(inches)

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
16	1300	DIP	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
1	-	0	0	0
Minor losses have been neglected				**0**

System Curve Calculations

Step 2 ***Minor Losses (Continued)***

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
1	-	0	0	0
1	-	0	0	0
Minor Losses have been neglected				**0**

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift

Summit MH	15
Low Water Level	-3.06
$H_{(static-max)}$=	18.06

Minimum Static Lift

Summit MH	15
High Water Level	0.94
$H_{(static-min)}$=	14.06

CITY OF LOS ANGELES
Plant No. 647 Storm Water PS

System Curve Calculations

Step 4 ***Determine System Curve***

Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	18.1	14.1	16.1	0.00
500	0.4	0.0	18.4	14.4	16.4	0.80
1000	1.3	0.0	19.4	15.4	17.4	1.60
1500	2.8	0.0	20.8	16.8	18.8	2.39
2000	4.7	0.0	22.8	18.8	20.8	3.19
2500	7.2	0.0	25.2	21.2	23.2	3.99
3000	10.0	0.0	28.1	24.1	26.1	4.79
3500	13.3	0.0	31.4	27.4	29.4	5.59
4000	17.1	0.0	35.1	31.1	33.1	6.39
4500	21.2	0.0	39.3	35.3	37.3	7.18
5000	25.8	0.0	43.9	39.9	41.9	7.98
5072	26.5	0.0	44.6	40.6	42.6	8.10
5500	30.8	0.0	48.8	44.8	46.8	8.78
6000	36.2	0.0	54.2	50.2	52.2	9.58

CITY OF LOS ANGELES
Plant No. 647 Storm Water PS

System Curve Calculations

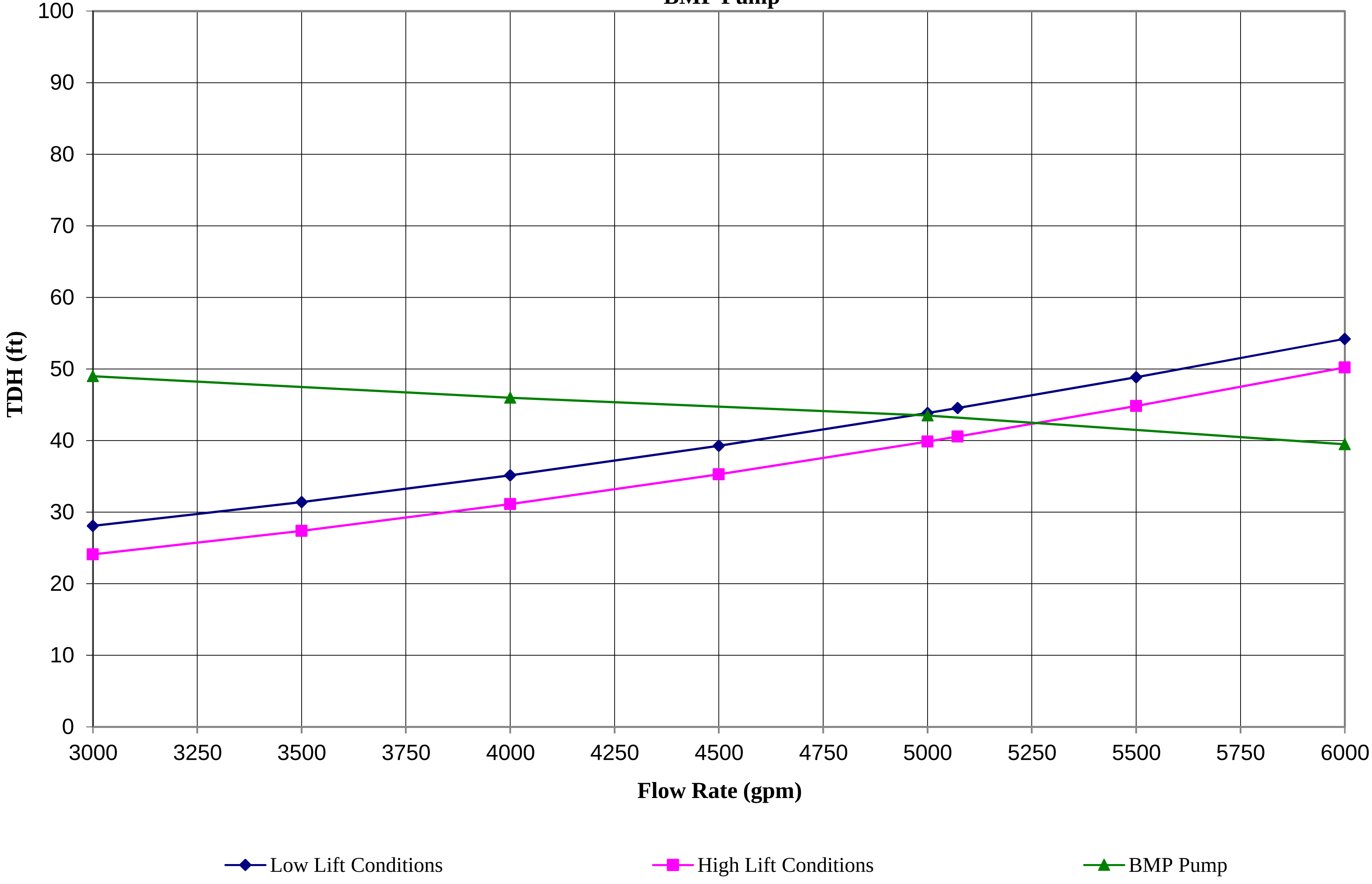
Step 5 ***New Pump Curve***

Flygt
NP 3400/736 3~1270

90 hp

Q (gpm)	TDH (ft)
1000	56
2000	53
3000	49
4000	46
5000	43.5
6000	39.5
7000	35

CITY OF LOS ANGELES
Plant No. 647 Storm Water PS
System Curve
BMP Pump



CITY OF LOS ANGELES
Plant No. 647 Storm Water PS

System Curve Calculations

Objective: Determine the system curve for the Plant #647 (Venice) Storm Water PS 50 yr stor

Givens:
1. 50yr storm flow is 163.1 CFS = 73,204 gpm
2. Approximately 2500 LF to discharge point
3. High tide is at 6.67 ft

Assumptions:
1. The Hazen-Williams C-factors are assumed to be as follows:
   Aged Concrete Pipe = 100
2. Minor losses are neglected within the pipeline and pump station
3. The pump suction grade line is based on the water levels in the Plant #647 wet well
   LWL = -3.06 HWL = 0.94
5. The pump discharge is pumping to the summit manhole.
   Elev = 6.67

Step 1 ***Calculate Pipe Friction Losses***

Hazen-Williams Equation: h_L=10.44*L(ft)*$Q^{1.85}$(gpm)/$C^{1.85}$*$D^{4.87}$(inches)

Pipe Dia (in)	Length (L.F.)	Material	C Factor (Assumed)
66	2500	Concrete	100

Step 2 ***Calculate Minor Losses***

Minor Losses Equation: $h_M=Kv^2/2g$

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
66	90 deg	0.25	3	0.75
66	Ent loss	0.8	1	0.8
Total assumed minor losses				**1.55**

System Curve Calculations

Step 2 ***Minor Losses (Continued)***

Pipe Dia (in)	Fitting	K Values	Quantity	K Total
1	-	0	0	0
1	-	0	0	0
None				**0**

Step 3 ***Determine Static Lift***

$H_{(static)}$ = Summit MH -Elev (Wet Well)

Maximum Static Lift	
Summit MH	6.67
Low Water Level	-3.06
$H_{(static-max)}$=	9.73

Minimum Static Lift	
Summit MH	6.67
High Water Level	0.94
$H_{(static-min)}$=	5.73

CITY OF LOS ANGELES
Plant No. 647 Storm Water PS

System Curve Calculations

Step 4 ***Determine System Curve***

Q (gpm)	Friction H_L (ft)	Minor H_L (ft)	Max TDH (ft)	Min TDH (ft)	Avg TDH (ft)	Velocity in FM (ft/sec)
0	0.0	0.0	9.7	5.7	7.7	0.00
2500	0.0	0.0	9.7	5.7	7.7	0.23
5000	0.0	0.0	9.8	5.8	7.8	0.47
7500	0.1	0.0	9.8	5.8	7.8	0.70
10000	0.2	0.0	9.9	5.9	7.9	0.94
12500	0.3	0.0	10.0	6.0	8.0	1.17
15000	0.4	0.0	10.2	6.2	8.2	1.41
17500	0.5	0.1	10.3	6.3	8.3	1.64
20000	0.6	0.1	10.5	6.5	8.5	1.88
22500	0.8	0.1	10.6	6.6	8.6	2.11
25000	1.0	0.1	10.8	6.8	8.8	2.35
27500	1.2	0.2	11.1	7.1	9.1	2.58
30000	1.4	0.2	11.3	7.3	9.3	2.81
32500	1.6	0.2	11.5	7.5	9.5	3.05
35000	1.8	0.3	11.8	7.8	9.8	3.28
37500	2.1	0.3	12.1	8.1	10.1	3.52
40000	2.3	0.3	12.4	8.4	10.4	3.75
42500	2.6	0.4	12.7	8.7	10.7	3.99
45000	2.9	0.4	13.1	9.1	11.1	4.22
47500	3.2	0.5	13.4	9.4	11.4	4.46
50000	3.5	0.5	13.8	9.8	11.8	4.69
52500	3.9	0.6	14.2	10.2	12.2	4.93
55000	4.2	0.6	14.6	10.6	12.6	5.16
57500	4.6	0.7	15.0	11.0	13.0	5.40
60000	5.0	0.8	15.4	11.4	13.4	5.63
62500	5.3	0.8	15.9	11.9	13.9	5.86
65000	5.7	0.9	16.4	12.4	14.4	6.10
67500	6.2	1.0	16.9	12.9	14.9	6.33
70000	6.6	1.0	17.4	13.4	15.4	6.57
72500	7.0	1.1	17.9	13.9	15.9	6.80
73204	7.2	1.1	18.0	14.0	16.0	6.87
75000	7.5	1.2	18.4	14.4	16.4	7.04
77500	8.0	1.3	19.0	15.0	17.0	7.27
80000	8.4	1.4	19.5	15.5	17.5	7.51
82500	8.9	1.4	20.1	16.1	18.1	7.74
85000	9.4	1.5	20.7	16.7	18.7	7.98
87500	10.0	1.6	21.3	17.3	19.3	8.21

CITY OF LOS ANGELES
Plant No. 647 Storm Water PS

System Curve Calculations

Step 5 ***New Pump Curve***

Flygt
Dry Pit Submersible

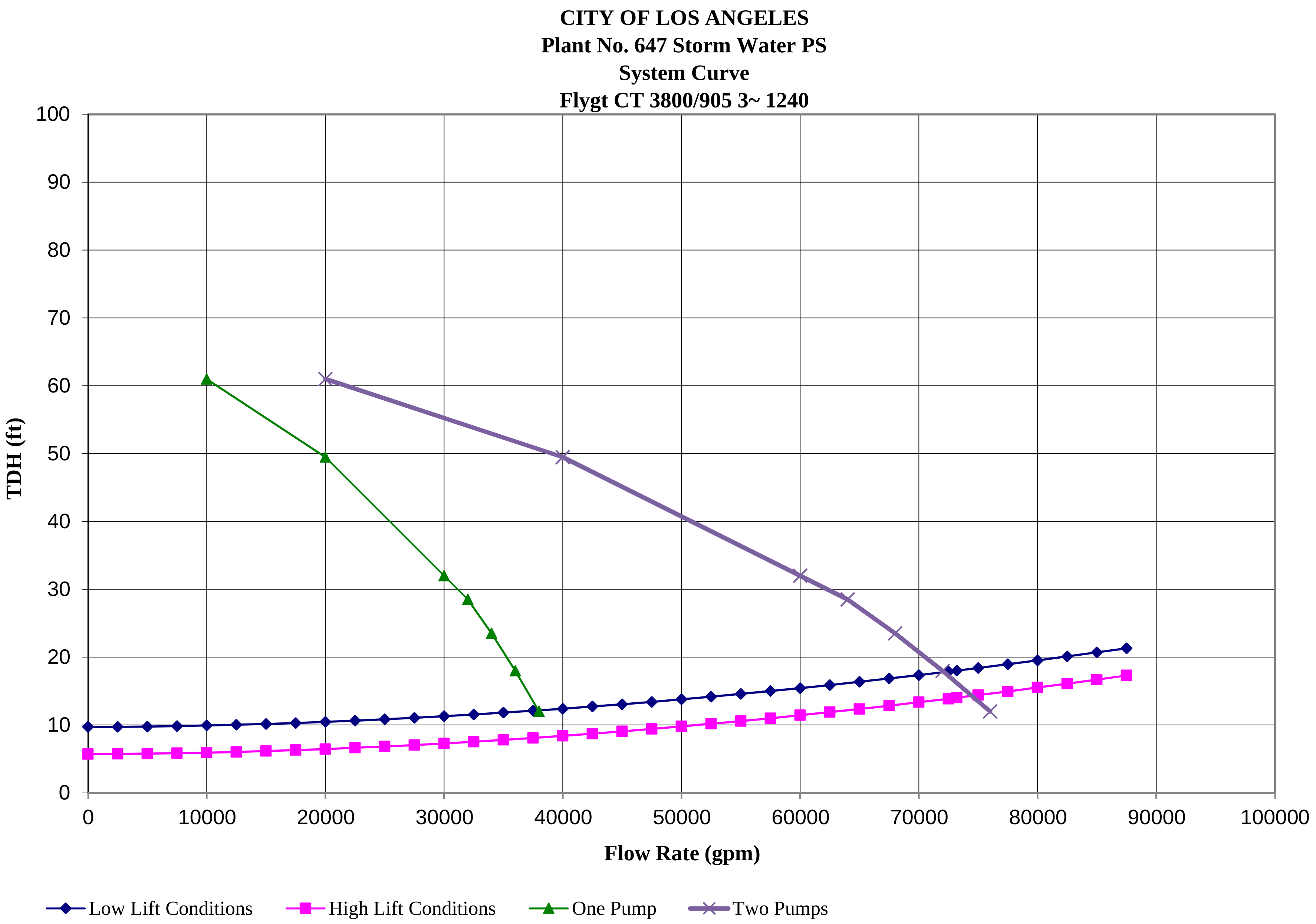
(1 Pump) CT 3800/985 3~1240

Q (gpm)	TDH (ft)
10000	61
20000	49.5

Flygt
Dry Pit Submersible

(2 Pumps) CT 3800/985 3~1240

Q (gpm)	TDH (ft)
20000	61
40000	49.5


CITY OF LOS ANGELES
Plant No. 647 Storm Water PS
System Curve
Flygt CT 3800/905 3~ 1240
TDH (ft)
0
10
20
30
40
50
60
70
80
90
100
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
Flow Rate (gpm)
Low Lift Conditions
High Lift Conditions
One Pump
Two Pumps

Product specification

Receiver		From

Quant.	Item no.	Description
		Block: 1
2		***Patented self cleaning semi-open channel impeller, ideal for pumping in*** *waste water applications. Modular based design with high adaptation grade.* *DUTY POINT* *- Fluid:Water, pure* *- Flow:5072 US g.p.m* *- Head:44.6 ft* *- Fluid temperature:39.2 °F* *- Motor : 3~460V/60Hz* *- Rated power : 90 hp* *- Speed : 590 rpm* *- Total Moment of Inertia : 65.02 lb ft²* *- Degree of protection : --* *- Motor design : 3 PH STD W*
		Subtotal:

Total price excl. VAT	VAT in %	Total price incl. VAT
0.00 USD	1900	0.00 USD

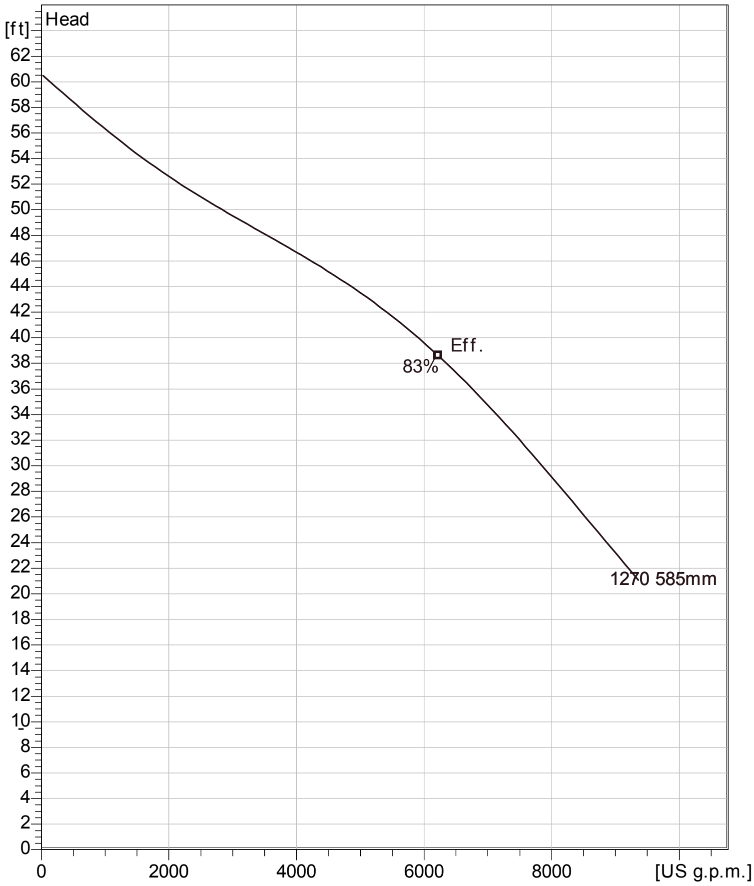
Project	Project ID	Created by	Created on	Last update
TETRA TECH	**PLANT#647**	**Ricardo Guanio**	**2015-04-21**	**2015-04-21**

xylem
Let's Solve Water

NP 3400/736 3~ 1270

Technical specification

FLYGT



Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet

General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Impeller

Impeller material	Grey cast iron
Discharge Flange Diameter	15 3/4 inch
Suction Flange Diameter	500 mm
Impeller diameter	585 mm
Number of blades	3

Motor

Motor #	N0736.000 43-44-12VD-W 90hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	12
Phases	3~
Rated power	90 hp
Rated current	135 A
Starting current	475 A
Rated speed	585 rpm
Power factor	
1/1 Load	0.68
3/4 Load	0.62
1/2 Load	0.50
Efficiency	
1/1 Load	92.2 %
3/4 Load	92.5 %
1/2 Load	91.6 %

Configuration

Project	Project ID	Created by	Created on	Last update
TETRA TECH	PLANT#647	Ricardo Guanio	2015-04-21	2015-04-21

NP 3400/736 3~ 1270

Performance curve

Pump

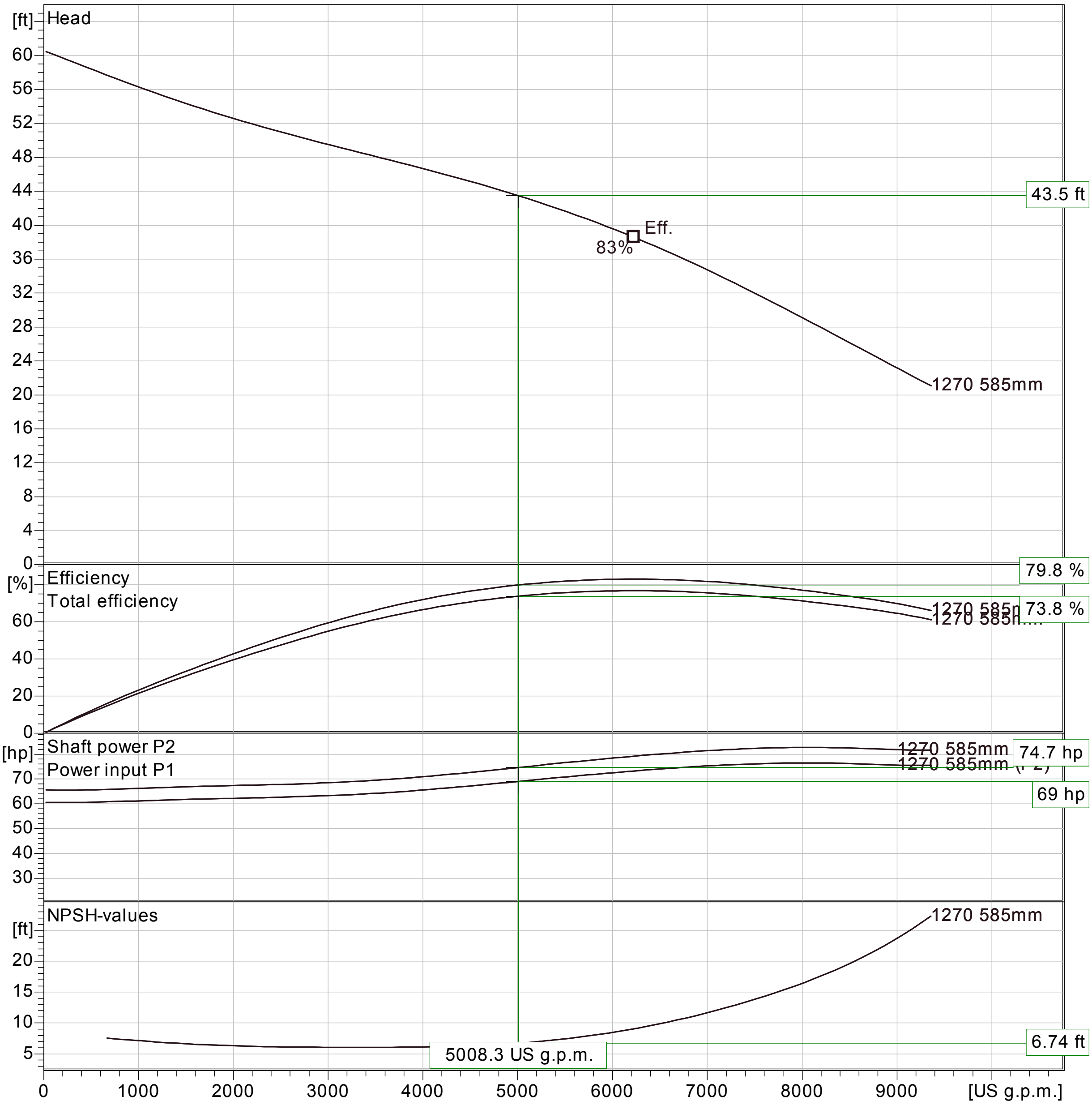
Discharge Flange Diameter	15 3/4 inch
Suction Flange Diameter	500 mm
Impeller diameter	23 1/16"
Number of blades	3

Motor

Motor #	N0736.000 43-44-12VD-W 90hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	12
Phases	3~
Rated power	90 hp
Rated current	135 A
Starting current	475 A
Rated speed	585 rpm

Power factor	
1/1 Load	0.68
3/4 Load	0.62
1/2 Load	0.50

Efficiency	
1/1 Load	92.2 %
3/4 Load	92.5 %
1/2 Load	91.6 %



Water, pure

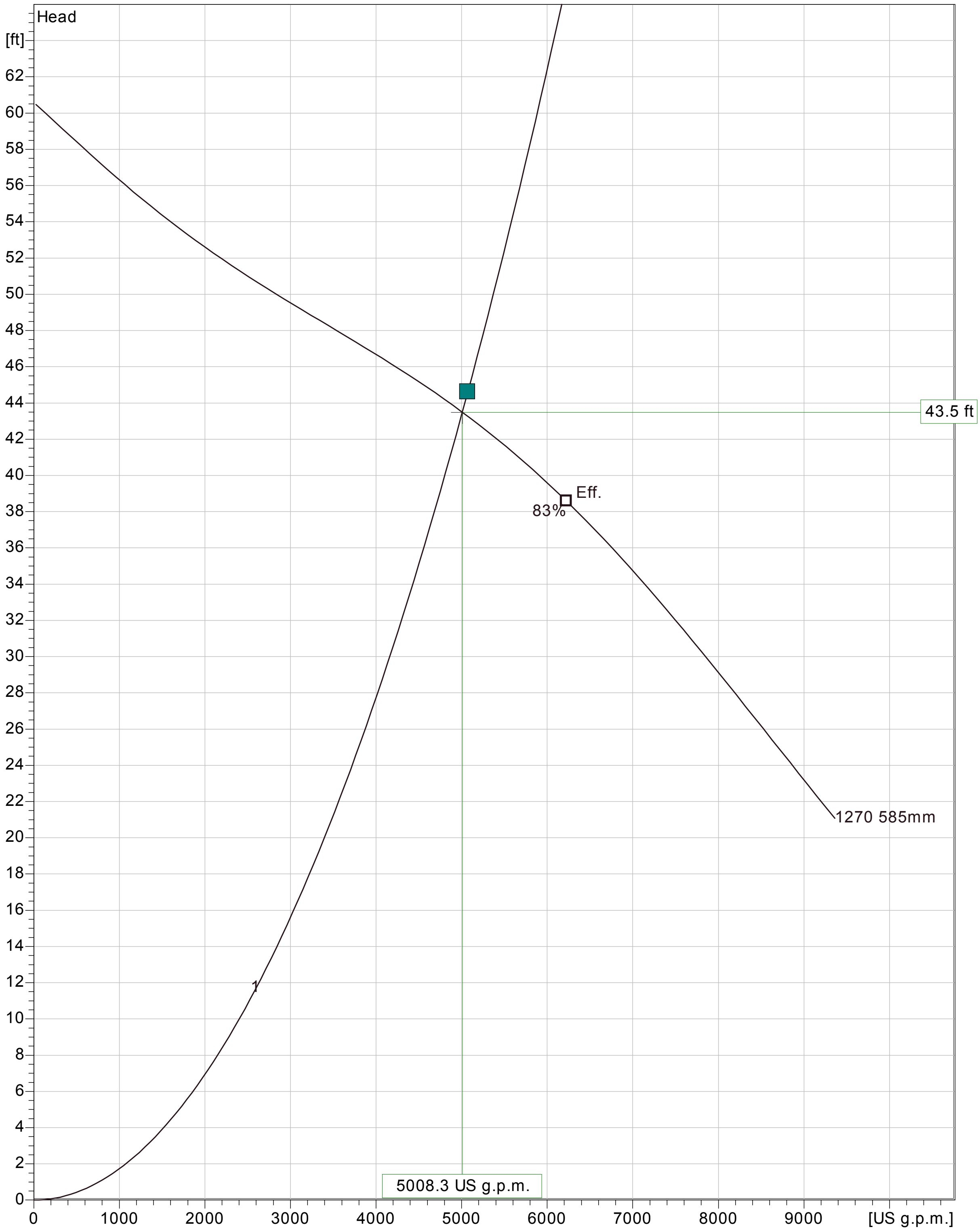
Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
TETRA TECH	**PLANT#647**	**Ricardo Guanio**	**2015-04-21**	**2015-04-21**

xylem
Let's Solve Water

NP 3400/736 3~ 1270

Duty Analysis



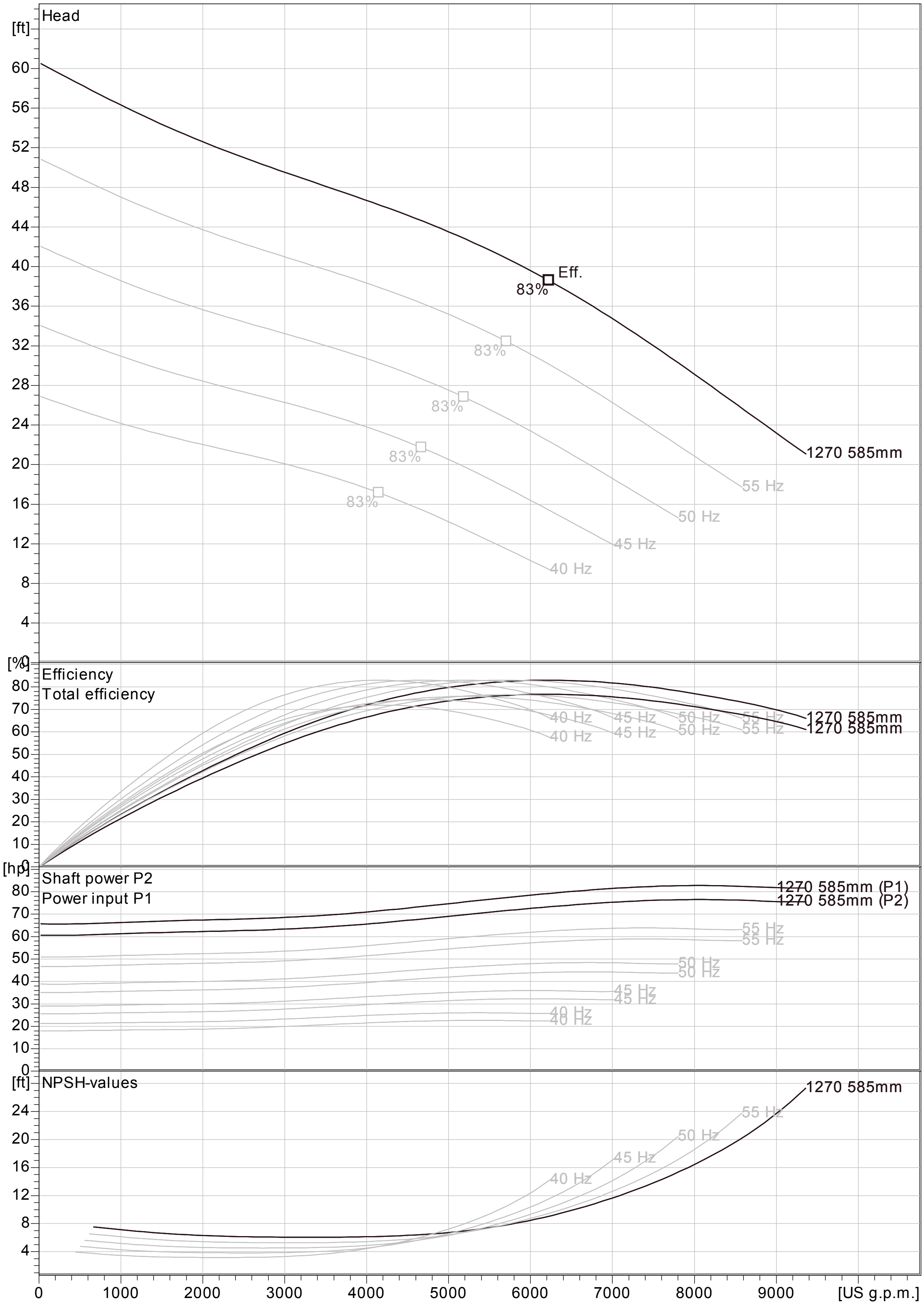
Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	5010 US g.p.m.	43.5 ft	69 hp	5010 US g.p.m.	43.5 ft	69 hp	79.8 %	185 kWh/US MG	6.74 ft

Project	Project ID	Created by	Created on	Last update
TETRA TECH	PLANT#647	Ricardo Guanio	2015-04-21	2015-04-21

NP 3400/736 3~ 1270

VFD Curve

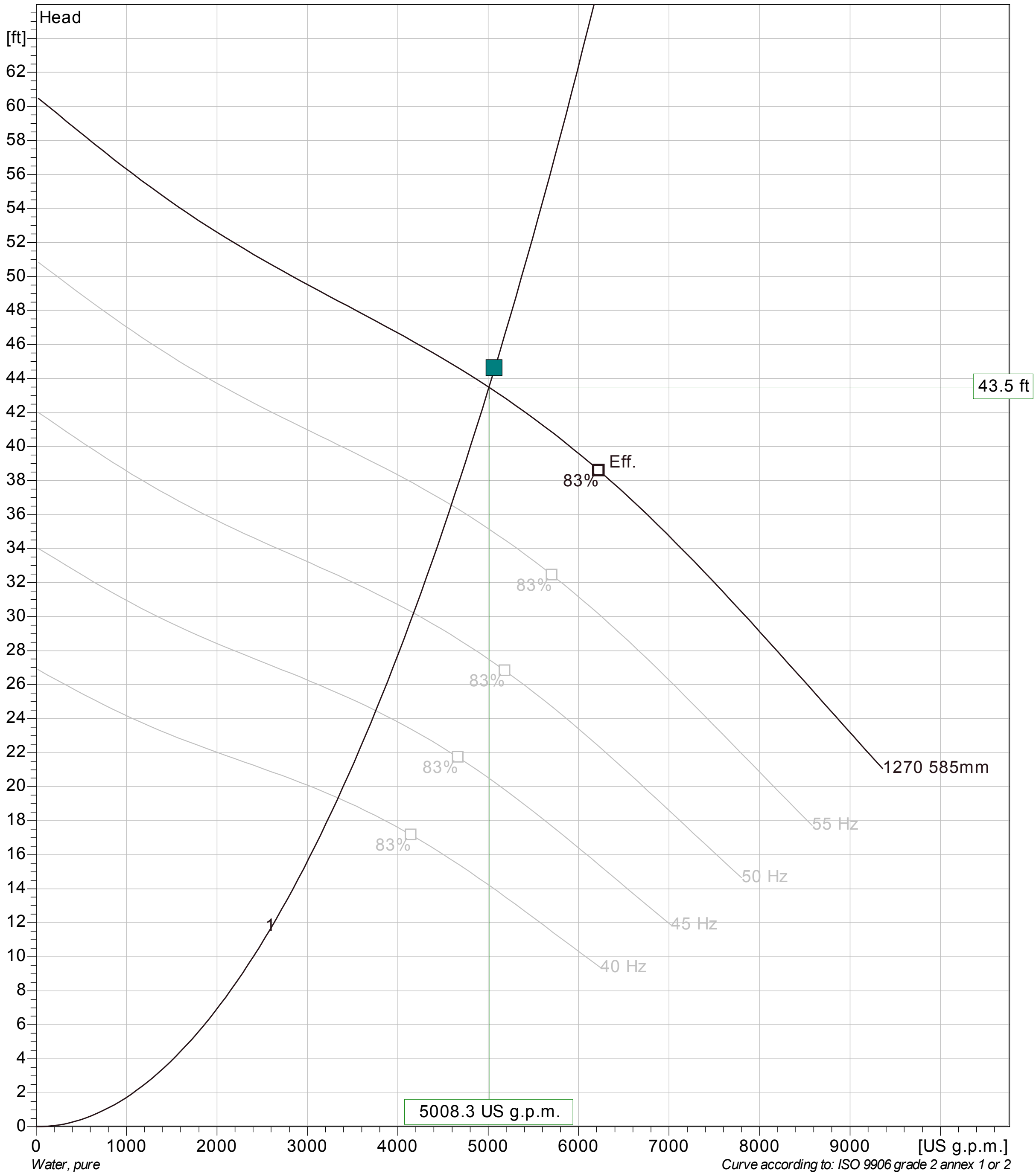


Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Project	Project ID	Created by	Created on	Last update
TETRA TECH	**PLANT#647**	**Ricardo Guanio**	**2015-04-21**	**2015-04-21**

NP 3400/736 3~ 1270

VFD Analysis



Pumps running /System	Individual pump Frequency	Flow	Head	Shaft power	Total Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	5010 US g.p.m.	43.5 ft	69 hp	5010 US g.p.m.	43.5 ft	69 hp	79.8 %	185 kWh/US MG	6.74 ft
1	55 Hz	4590 US g.p.m.	36.6 ft	53.2 hp	4590 US g.p.m.	36.6 ft	53.2 hp	79.8 %	156 kWh/US MG	5.87 ft
1	50 Hz	4170 US g.p.m.	30.2 ft	40 hp	4170 US g.p.m.	30.2 ft	40 hp	79.8 %	131 kWh/US MG	5.04 ft
1	45 Hz	3760 US g.p.m.	24.5 ft	29.1 hp	3760 US g.p.m.	24.5 ft	29.1 hp	79.8 %	108 kWh/US MG	4.25 ft
1	40 Hz	3340 US g.p.m.	19.3 ft	20.5 hp	3340 US g.p.m.	19.3 ft	20.5 hp	79.8 %	88.5 kWh/US MG	3.52 ft

Project	Project ID	Created by	Created on	Last update
TETRA TECH	PLANT#647	Ricardo Guanio	2015-04-21	2015-04-21

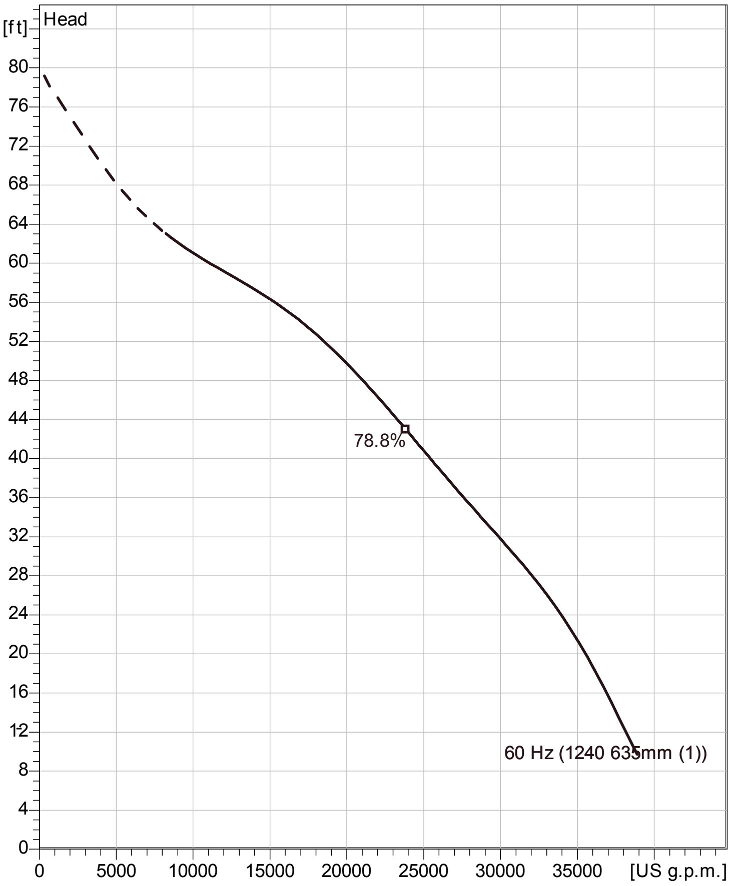
NP 3400/736 3~ 1270

Dimensional drawing

Project	Project ID	Created by	Created on	Last update
TETRA TECH	PLANT#647	Ricardo Guanio	2015-04-21	2015-04-21

CT 3800/905 3~ 1240

Technical specification



Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Note: Picture might not correspond to the current configuration.

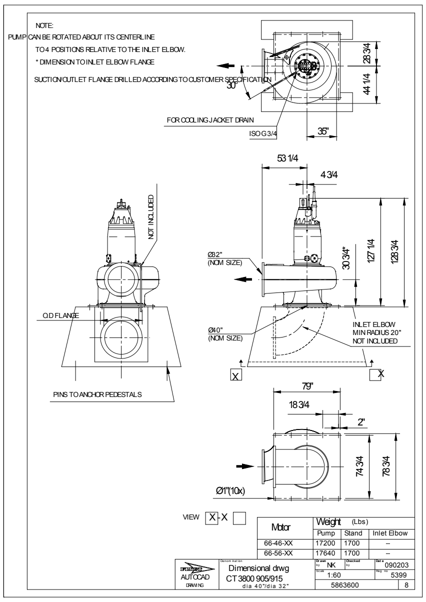
General

Shrouded single or multi-channel impeller pumps with large throughlets and single volute pump casing for liquids containing solids and fibres. Cast iron design with double sealing technology.

Impeller

Impeller material	Spherodial graphite cast iron
Discharge Flange Diameter	31 1/2 inch
Suction Flange Diameter	1000 mm
Impeller diameter	635 mm
Number of blades	4
Throughlet diameter	5 11/16 inch

Installation: T - Vertical Permanent, Dry



Motor

Motor #	C0905.000 66-46-12AA-D 350hp
Stator variant	38
Frequency	60 Hz
Rated voltage	460 V
Number of poles	12
Phases	3~
Rated power	350 hp
Rated current	450 A
Starting current	1710 A
Rated speed	590 rpm
Power factor	
1/1 Load	0.78
3/4 Load	0.75
1/2 Load	0.67
Efficiency	
1/1 Load	93.5 %
3/4 Load	94.5 %
1/2 Load	94.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2015-04-16	

CT 3800/905 3~ 1240

Performance curve

Pump

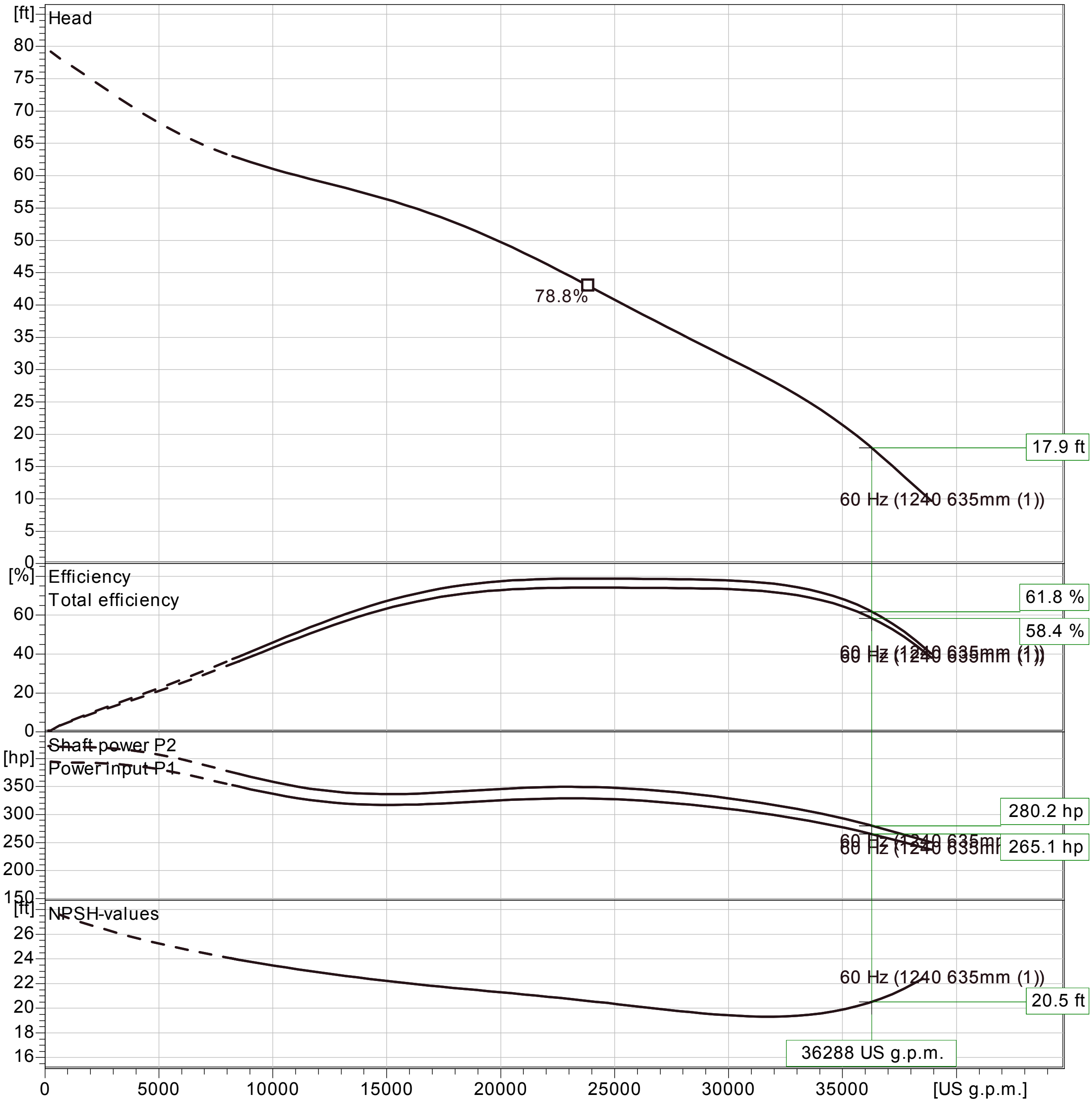
Discharge Flange Diameter	31 1/2 inch
Suction Flange Diameter	1000 mm
Impeller diameter	25"
Number of blades	4
Throughlet diameter	5 11/16 inch

Motor

Motor #	C0905.000 66-46-12AA-D 350hp
Stator variant	38
Frequency	60 Hz
Rated voltage	460 V
Number of poles	12
Phases	3~
Rated power	350 hp
Rated current	450 A
Starting current	1710 A
Rated speed	590 rpm

Power factor	
1/1 Load	0.78
3/4 Load	0.75
1/2 Load	0.67

Efficiency	
1/1 Load	93.5 %
3/4 Load	94.5 %
1/2 Load	94.5 %

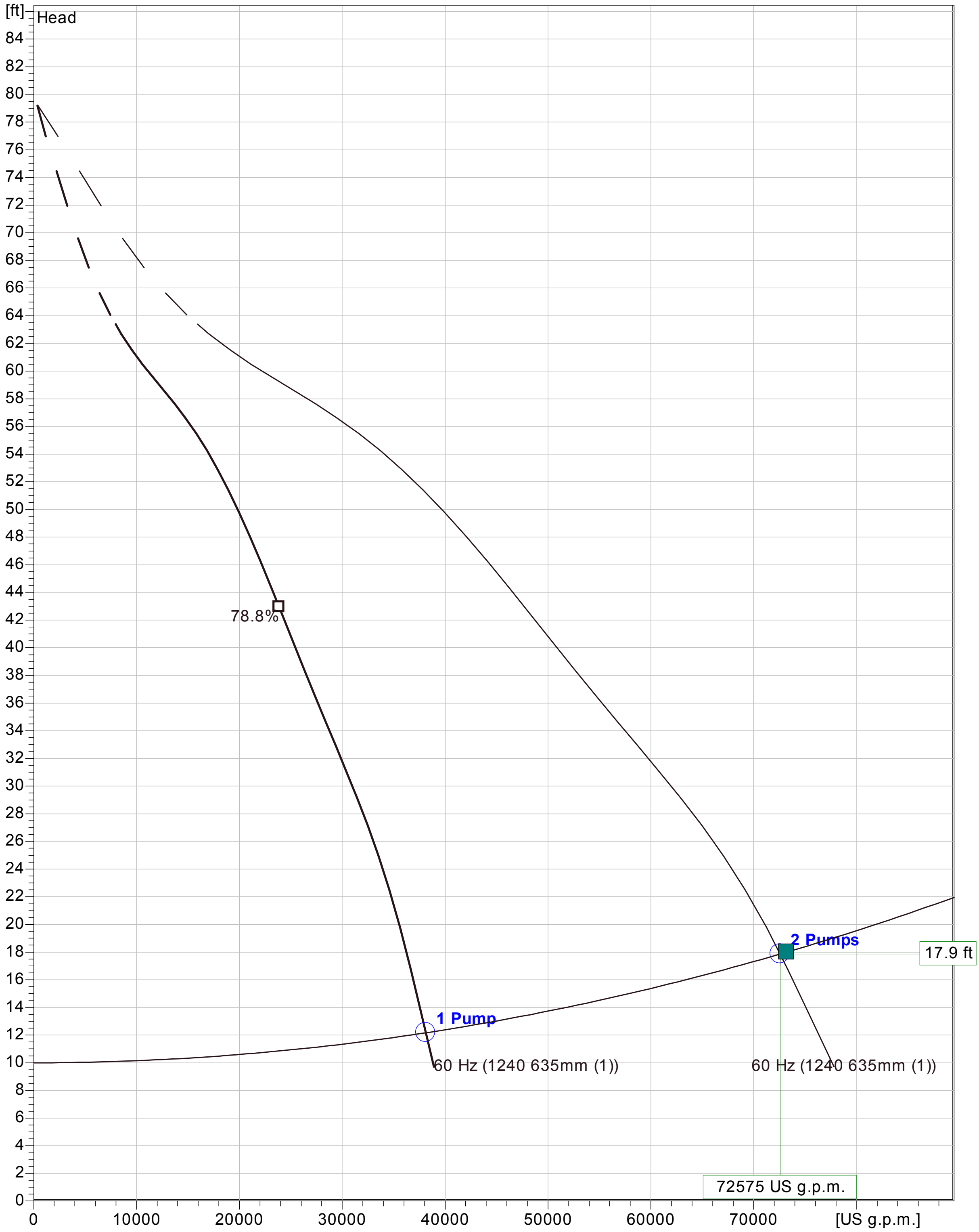


Water, pure — *Curve according to: ISO 9906 grade 2 annex 1 or 2*

Project	Project ID	Created by	Created on	Last update
			2015-04-16	

CT 3800/905 3~ 1240

Duty Analysis



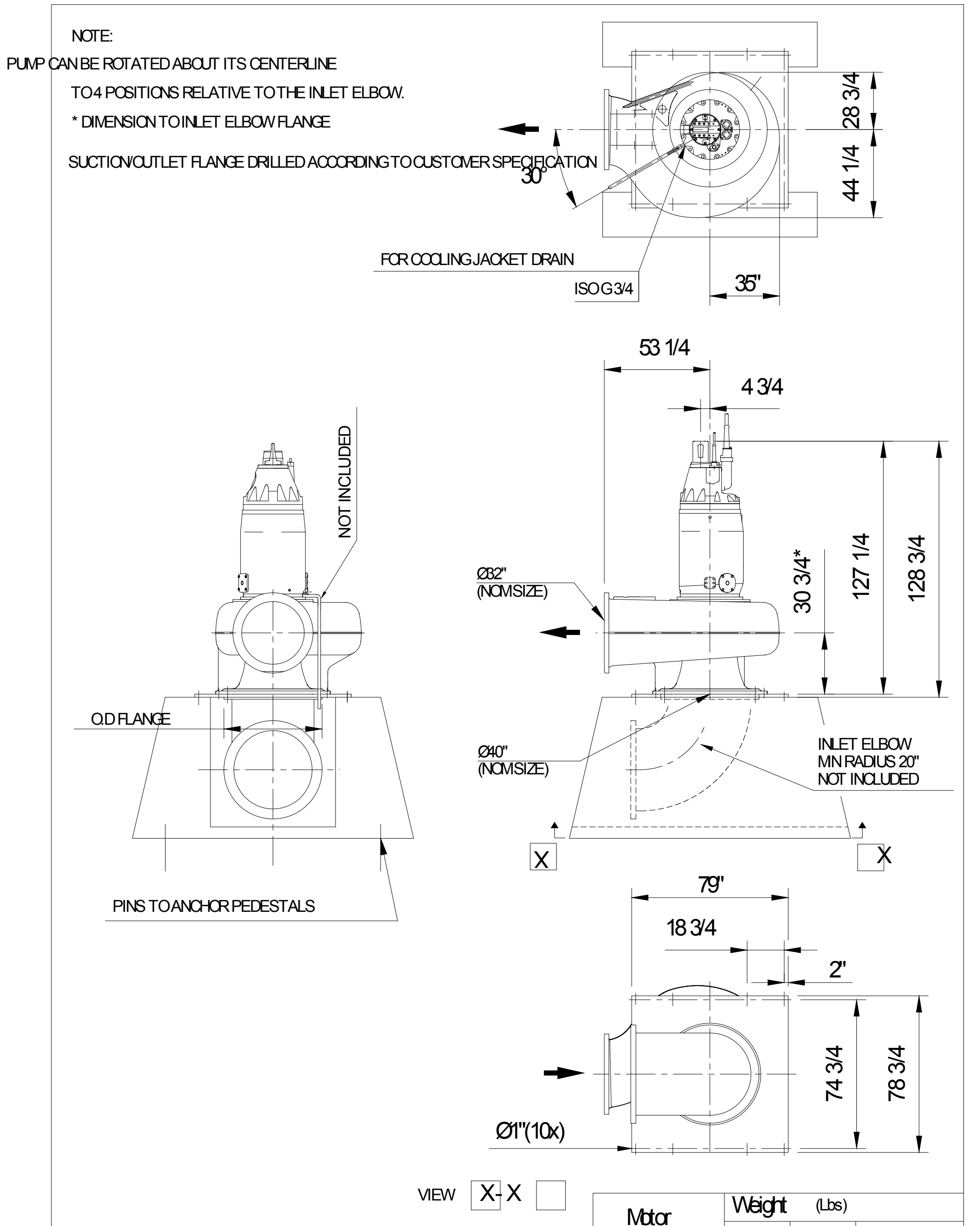
Water, pure *Curve according to: ISO 9906 grade 2 annex 1 or 2*

	Individual pump			Total					
Pumps running /System	Flow	Head	Shaft power	Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
2	36300 US g.p.m.	17.9 ft	265 hp	72600 US g.p.m.	17.9 ft	530 hp	61.8 %	96 kWh/US MG	20.5 ft
1	38100 US g.p.m.	12.2 ft	246 hp	38100 US g.p.m.	12.2 ft	246 hp	48 %	85.1 kWh/US MG	22 ft

Project	Project ID	Created by	Created on	Last update
			2015-04-16	

CT 3800/905 3~ 1240

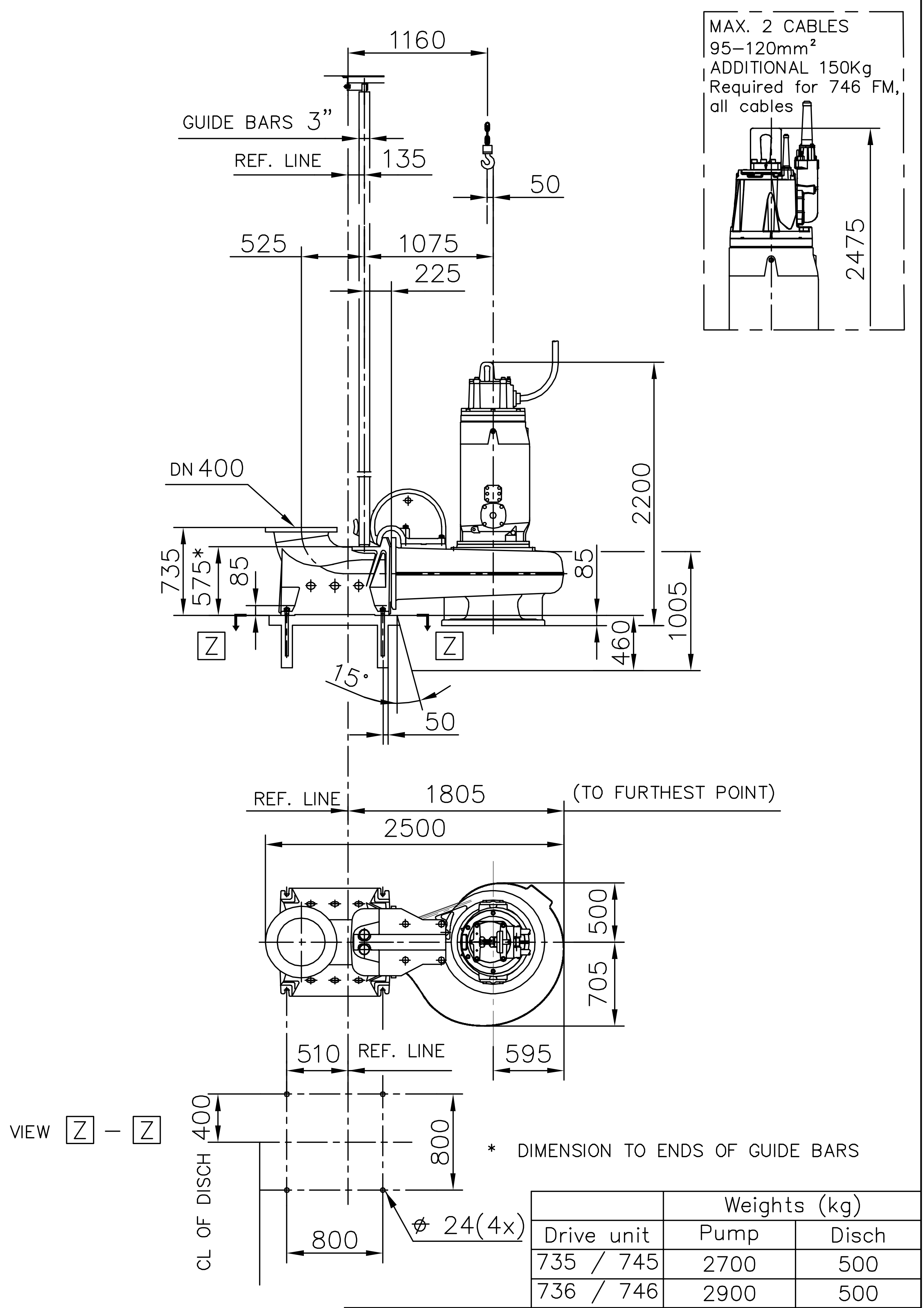
Dimensional drawing



Motor	Weight (Lbs)		
	Pump	Stand	Inlet Elbow
66-46-XX	17200	1700	–
66-56-XX	17640	1700	–

FLYGT AUTOCAD DRAWING	Denomination: Dimensional drwg CT 3800 905/915 dia 40"/dia 32"	Drawn by: NK	Checked by:	Date: 090203
		Scale: 1:60		Reg no: 5399
		5863600		8

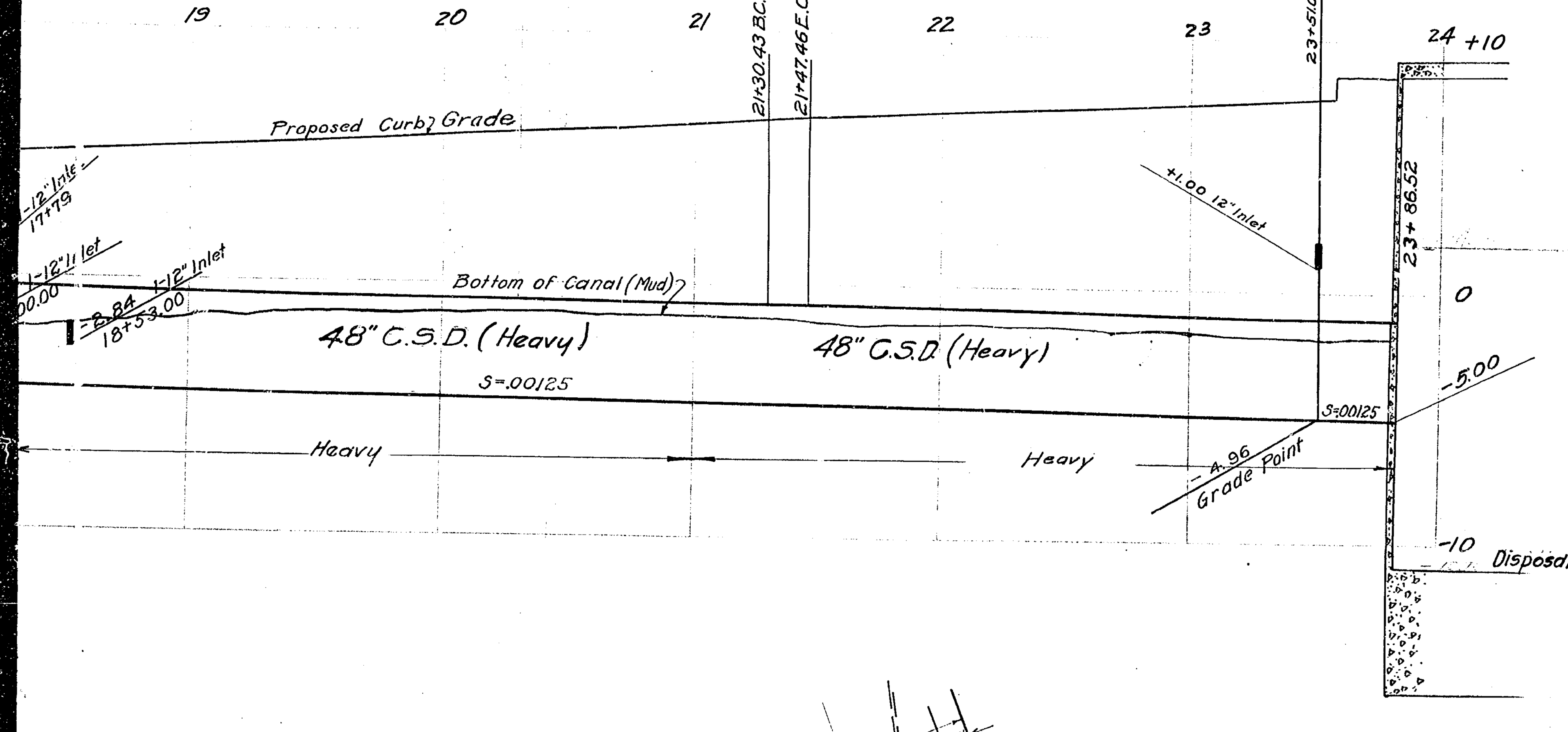
Project	Project ID	Created by	Created on	Last update
			2015-04-16	

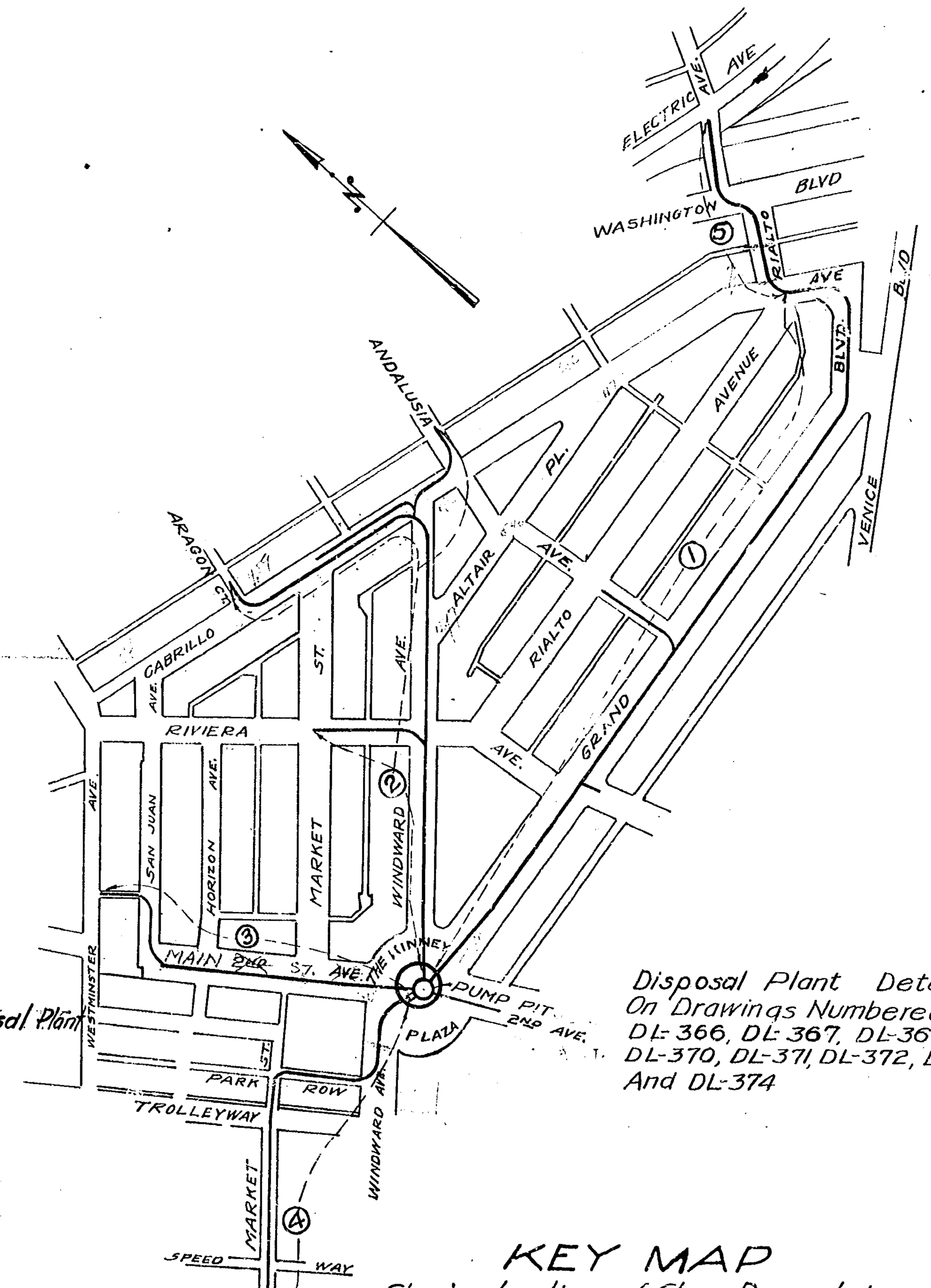


Drive unit	Weights (kg) Pump	Disch
735 / 745	2700	500
736 / 746	2900	500

FLYGT AUTOCAD DRAWING	Denomination: Dimensional drwg CP,NP 3400 735/745/736/746 DN 400	Drawn by IW	Checked by JP	Date 140115
		Scale 1:40		Reg no 5399
		6441700		6

Appendix D – BOE “D” Plans

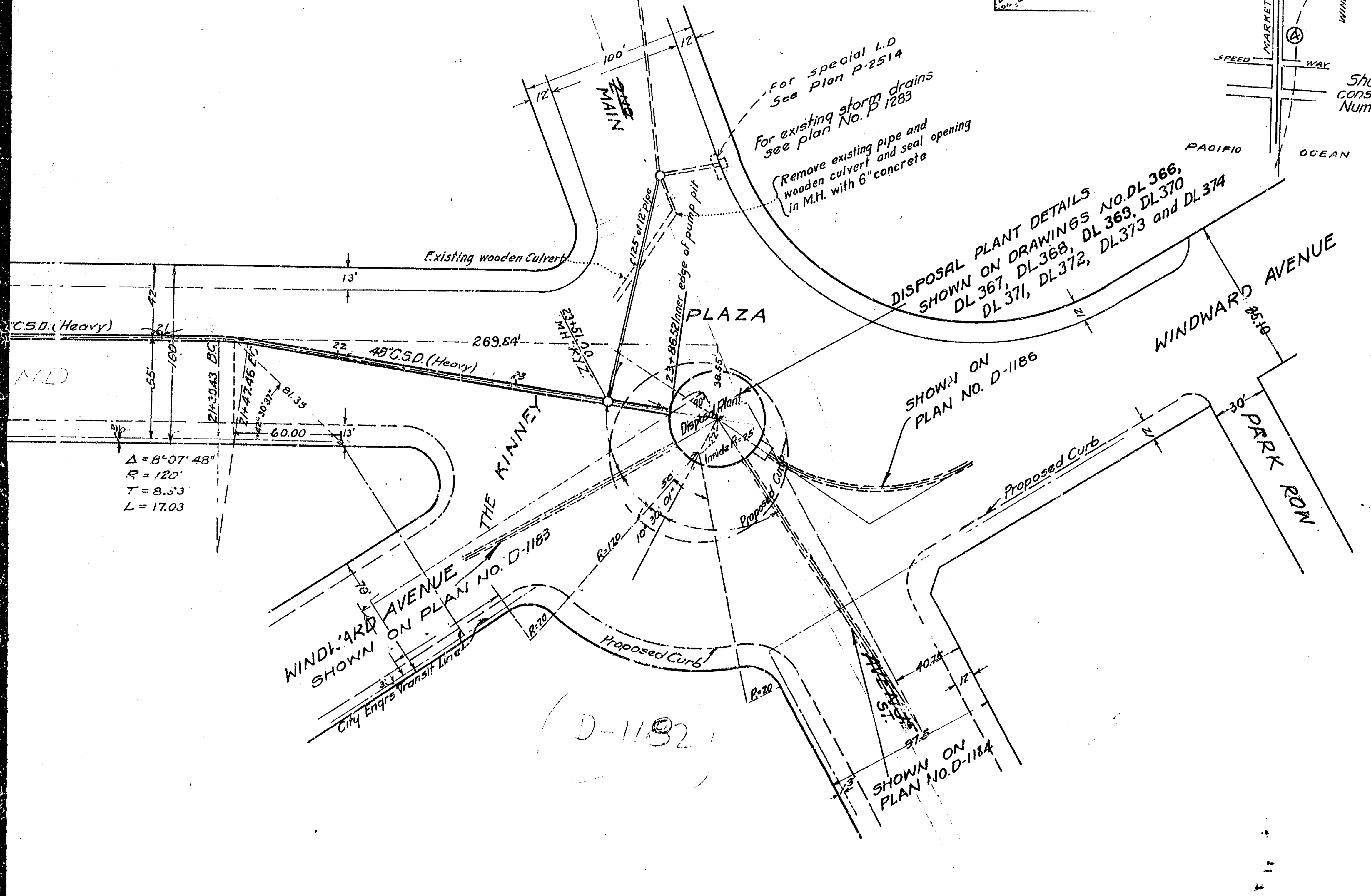




Disposal Plant Details Shown On Drawings Numbered: DL-366, DL-367, DL-368, DL-369, DL-370, DL-371, DL-372, DL-373 And DL-374

KEY MAP

Showing locations of Storm Drains to be constructed. ←○→ indicates Sheet Numbers and Show limits
Scale 300 - 1" (Approximate)



(D-1182)

NORTH CANALS STORM DRAIN SYSTEM
CITY OF LOS ANGELES
John C. Shaw, City Engineer

STORM DRAINS IN
GRAND BOULEVARD
BETWEEN RIALTO AVE AND THE KINNEY PLAZA
AND IN
THE KINNEY PLAZA
AT WINDWARD AVENUE

References - F.B. No. 11605

SUMMARY
LENGTHS REQUIRED FOR CONSTRUCTION

48" Diameter Reinforced Concrete Pipe (Medium)	119	Lin. Ft.
48" " " " " (Heavy)	557	" "
42" Diameter Reinforced Concrete Pipe (Medium)	436	" "
33" " " " " (Medium)	938	" "
30" " " " " (Medium)	330	" "
18" " Pipe	[illegible]	" "
15" " "	3.0	" "
12" " "	888	" "
MH "KYZ" (Plan No D 975)	5	
M.H. Frame & Cover Sets (Plan No 29205)	5	
Standard Junction Chamber No 1 (" " 26890)	1	
Catch Basin No. 18 (" " 27669)	6	
" " No 23 (" " 28944)	7	
18" Concrete Cap	1	
12" Concrete Cap	1	
Remodel Lighting Conduit (Plan No 29860)	1	

Sheet 1
" 2
" 3

Notice to Contractors

Work shall be done in accordance with Plan No. D-828.
All pipe not otherwise specified shall be cement pipe.
Schedule for Additional work as per Note 56, Plan No. D 828.

______ per cubic yard Class "A" Concrete.
______ per cubic yard Class "C" Concrete.
______ per cubic yard for excavation. (including back fill + haulaway)
______ per lb. for reinforcing steel in place.
______ per lineal foot for 6" House Connection Sewers.
______ per lineal foot for 6" House " " (reinforced as per Plan No 11147)
______ Piles per ft below cutoff line

Front Wall of catch basin No. 18, No. 23, and No 24, shall be constructed on the Curb line instead of outside the curb line as shown on the Standard Plans.
Where construction of stubs to receive catch basin connections is specified, such stubs shall be set in proper line to conform to location of proposed basins as shown and the end capped.
Where abandoned pipes or culverts are broken into the end of same shall be sealed with 8 inches of concrete.
Water tight connections shall be made between the wall of the pump pit and the storm drain pipes at points where such pipes enter the wet well of the pump pit. No such connection shall be made, however, until 28 days after the pouring of the pump pit walls.
All round piles used in this improvement, shall be straight and sound from end to end and be free from defects and cracks, and all piles shall be creosoted and said creosoting shall penetrate into each pile a distance of not less than one (1) inch from any point of the circumference of each pile throughout the entire length of said piles and the creosoting of each pile shall be done by the standard drying and pressure method for applying this treatment.
Attention of the Contractor is called to the fact that the storm drain to be built is largely below ground water level and the requirements are that special care shall be exercised to so construct the drains that infiltration of ground water will be the minimum, not to exceed, in any event, at the completion of the work or any portion thereof, a rate of flow at any point of measurement of 200 gallons per internal inch of diameter per mile of drain per 24 hours.
In making the crossing under the Kinney Tunnel at Park Row, the Contractor shall maintain all pipe lines within said tunnel during construction.
In the construction of the Outfall under the pleasure pier at the end of Market St. the contractor shall not interfere with the operation of any of the concessions on the pier without the consent of the owners of said concessions.
Although soil conditions along the route of the proposed drain are beleived to be as shown on the plans and as actually determined by test holes on the ground, the City of Los Angeles does not guarantee the same.
Except on Venice Blvd. and Washington Blvd. street lighting conduits and light posts have been abandoned for use and contractor may remove same where interference with new construction is encountered.
This improvement also includes work shown on. DL 366, DL 367, DL 368, DL 369, DL 370, DL 371, DL 372, DL 373, DL 374, P2512, P2513, P2514, P2515, P2516, P2517, D1174, D1003, D1183, D1184, D1186, and D1208
(The summary does not include items for which unit prices are to be bid)

RESURFACING SCHEDULE
See Plan No D1186

LIST OF STANDARD PLANS	PLAN NO.
Manhole "KYZ"	D-975
Standard Jct. Chamber #1	26890
Local Depression #3	D-893
M.H. Frame & Cover Sets	29205
Catch Basin No 18	27669
Catch Basin No 23	28944
Local Depression #4	D 894
Remodel Light Conduit	29860
Pipe Junction	29164

WINDWARD AVENUE AND 2ND AVENUE IMPROVEMENT DISTRICT AIII-63112

Designed by W.D. Potter
Checked by Truckey-Price
Submitted 8/25 1927
[signature]
Venice District Engineer
Approved 8-27- 1927
By E.A. Tuttle
Engr. Metropolitan Storm Drain Div.

Drawn by L.J. Truckey
Sanitary Sewer [illegible]
Substructure Engr. [illegible]
Approved Aug 29, 1927
JOHN C. SHAW
City Engineer
[signature]
Chief Deputy

	Signature	Date
O+W. Engr.	[signature]	[illegible]
St. Design Engr.	[signature]	9-12-27
Water Dept. Engr.	[signature]	[illegible]
St. Lighting Engr	[signature]	9/12/27
Bridge Design Engr.	M.B. per H.H.W.	8-27-27
Sanitary Swr. Design Engr.	[signature]	[illegible]

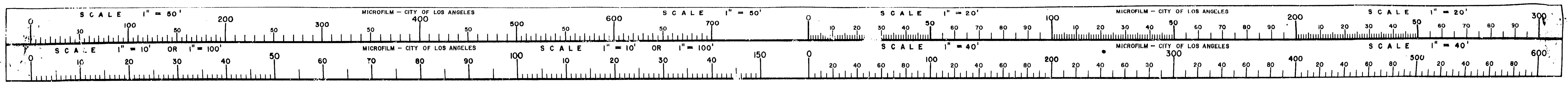
These Elevations are based on the U.S.G.S datum adopted July 1st 1925, Ordinance No 52,222.

D-1182

Sheet No 1 of 5 Sheets

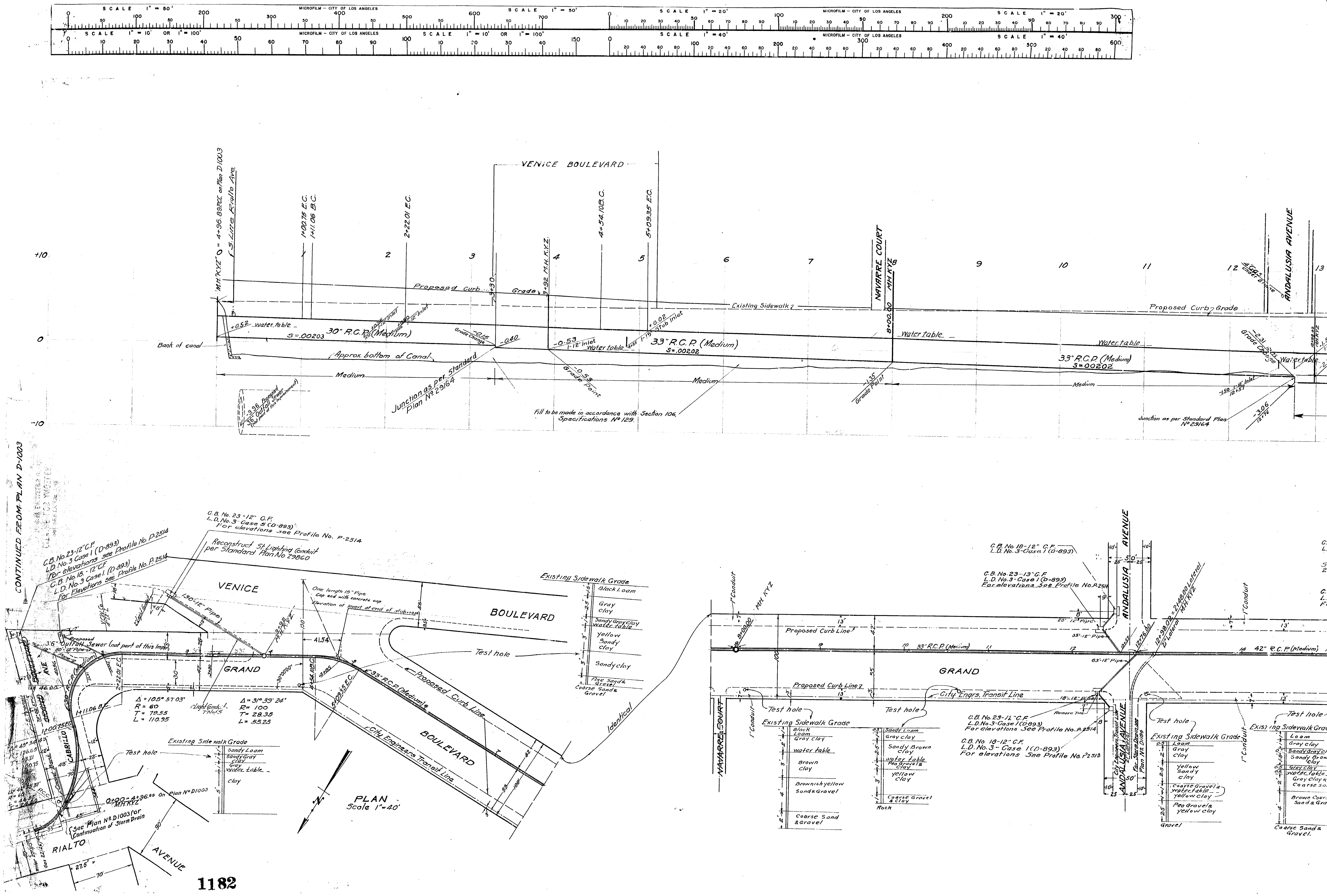
D 1182 1

CERTIFICATE
I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles and Section 34090.5 of the Government Code.
REX E. [illegible], City Clerk
Date 1-7-69
by [signature] Deputy

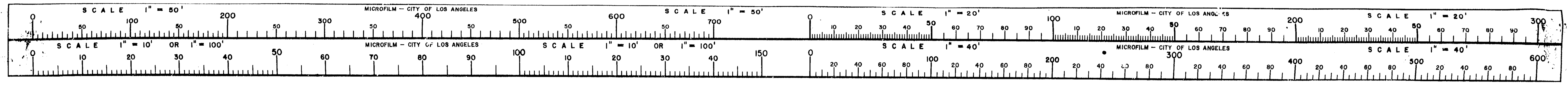


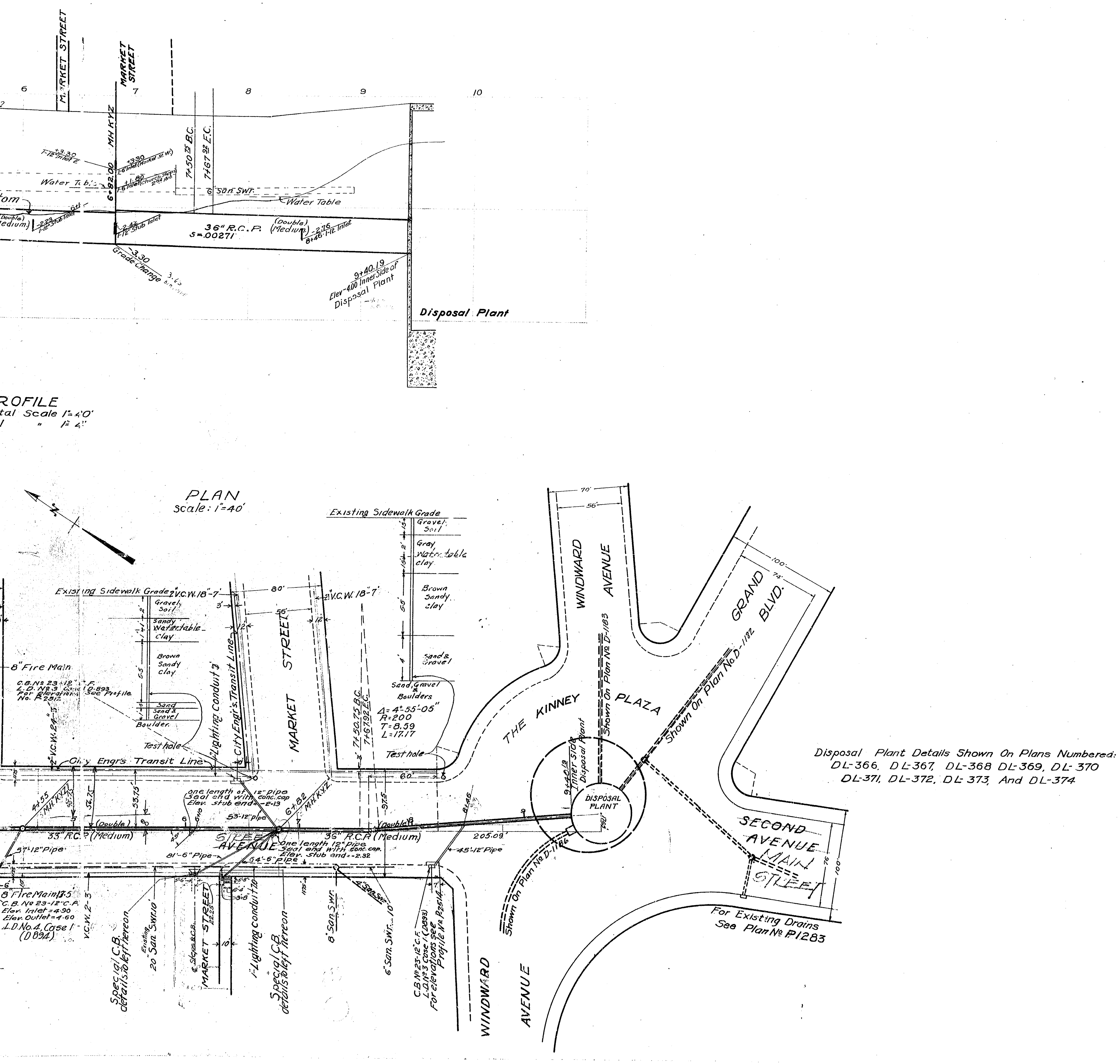
NAVARRE COURT
ANDALUSIA AVENUE
RIVIERA AVENUE
Proposed Curb Grade
Existing Sidewalk
Water table
33" R.C.P. (Medium)
S=.00202
42" R.C.P. (Medium)
S=.00138
48" C.S.D. (Medium)
48" C.S.D. (Heavy)
S=.00125
Bottom of Canal (Mud)
Grade Change
Grade Point
Junction as per Standard Plan Nº 23164
Medium
Heavy
Proposed Curb Line
GRAND
BOULEVARD
Test hole
Existing Sidewalk Grade
City Engrs. Transit Line
Existing wooden Culvert
PLAZA
WINDWARD AVENUE
THE KINNEY
SHOWN ON PLAN NO. D-1183
PLAN
Scale 1"=40'
Standard Junction Chamber No.1
C.B. No. 23-12" C.F.
L.D. No. 3 Case I (D-893)
For elevations See Profile No. P-2514
C.B. No. 18-12" C.F.
L.D. No. 4, Case I (D-894)
Δ = 8°07'48"
R = 120'
T = 8.53
L = 17.03
D-1182

D1182 2


SCALE 1" = 50'
MICROFILM - CITY OF LOS ANGELES
SCALE 1" = 10' OR 1" = 100'
SCALE 1" = 20'
SCALE 1" = 40'
VENICE BOULEVARD
NAVARRE COURT
ANDALUSIA AVENUE
Proposed Curb Grade
Existing Sidewalk
Water table
30" R.C.P. (Medium)
S = .00203
33" R.C.P. (Medium)
S = .00202
Approx bottom of Canal
Bank of canal
Junction as per Standard Plan Nº 29164
Fill to be made in accordance with Section 106, Specifications Nº 129.
Grade Point
Medium
CONTINUED FROM PLAN D-1003
VENICE
BOULEVARD
GRAND
CABRILLO
RIALTO
AVENUE
AVE
Reconstruct St. Lighting Conduit per Standard Plan No 29860
C.B. No. 23 - 12" C.F. L.D. No. 3 Case 5 (D-893) For elevations see Profile No. P-2514
36" Outfall Sewer (not part of this Imp.)
Proposed Curb Line
City Engineers Transit Line
Test hole
Existing Sidewalk Grade
Δ = 105° 57' 03" R = 60 T = 79.55 L = 110.95
Δ = 31° 39' 24" R = 100 T = 28.35 L = 55.25
See Plan Nº D1003 for Continuation of Storm Drain
PLAN
Scale 1" = 40'
Identical
42" R.C.P. (Medium)
Black Loam
Gray Clay
Sandy clay
Yellow Sandy Clay
Coarse Sand & Gravel
Brown Clay
Rock
1182

D1182 3





NORTH CANALS STORM DRAIN SYSTEM

CITY OF LOS ANGELES

John C. Shaw, City Engineer

STORM DRAINS in

1ST ALLEY WESTERLY OF RIVIERA AVENUE

BETWEEN WESTMINSTER AVENUE AND SAN JUAN AVENUE

IN

SAN JUAN AVENUE

BETWEEN 1ST ALLEY WESTERLY OF RIVIERA AVE. & SECOND AVE.

IN

SECOND AVENUE

BETWEEN SAN JUAN AVE. & KINNEY PLAZA

IN

THE KINNEY PLAZA

AT SECOND AVENUE

IN

ANDALUSIA AVENUE

BETWEEN RIALTO AVENUE AND GRAND BOULEVARD

References:- F.B. 11605, 11506 11532, 11560-11535-11602

SUMMARY

LENGTHS REQUIRED FOR CONSTRUCTION

Item	Quantity	Unit
36" Diameter Reinforced Concrete Pipe (Double Medium)	256	Lin. ft.
33" " " " "	448	" "
27" " " " (Heavy)	97	" "
27" " " " (Medium)	196	" "
21" " Pipe	242	" "
18" " "	32	" "
15" " "	80	" "
12" " "	469	" "
Catch Basin No. 18 Standard Plan No 27669	4	
Catch Basin No. 23 " " No 28944	6	
Catch Basin No. 24 " " No 29101 (2 Opening)	1	
Catch Basin No. 22A " " No D.L.22 (1 Grating)	3	
Catch Basin (Special)	2	
Catch Basin No 21A " " No D.L.22 (1 Grating)	1	
6" Pipe	145	Lin. ft.
Manhole KYZ Standard Plan No D-975	7	
" Frame and Cover Sets " " 29205	7	
12" Concrete Caps	2	

Notice to Contractors

For Notice to Contractors see Plan No D-1182

For Resurfacing Schedule see Plan No D-1186

	Signature	Date
Opening and Widening Engineer		
Street Design Engineer	See Plan	
Water Department Engineer		
Steet Lighting Engineer	D-1182	
Bridge Design Engineer		
Sanitary Sewer Design Engineer		

These elevations are based on the U.S.G.S. datum adopted, July 1st 1925, Ordinance No. 52,222.

List of Standard Plans	Plan No
C.B. No 18	27669
CB No 23	28944
CB No 24	29101
CB No 22A	DL22
MH.KYZ	D975
M.H. Frame & Cover	29205
C.B. Depressions	D893
" "	D894

WINDWARD AVE. AND SECOND AVE. IMP. DIST

A'11-62112

Designed by: Potter Drawn by: Price

Checked by: Price-Kirkgaard Sanitary Sewer: [illegible]

Substructures: [illegible]

Submitted 8/25 1927 Approved Aug 29 1927

[signature]
Venice District Engineer

John C. Shaw
City Engineer

Approved: 8-27-1927
E. A. Tuttle
Eng. Mgr. Storm Drain Div.

[signature]
Chief Deputy

Sheet No 3 of 5 Sheets

D-1184

D1184 1

CERTIFICATE

I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles and Section 34090.5 of the Government Code.

Date 7-3-69

REX E. LAYTON, City Clerk

By [signature] Deputy

D1184 2

CERTIFICATE

I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles and Section 34096.5 of the Government Code.

REX E. LAYTON, City Clerk

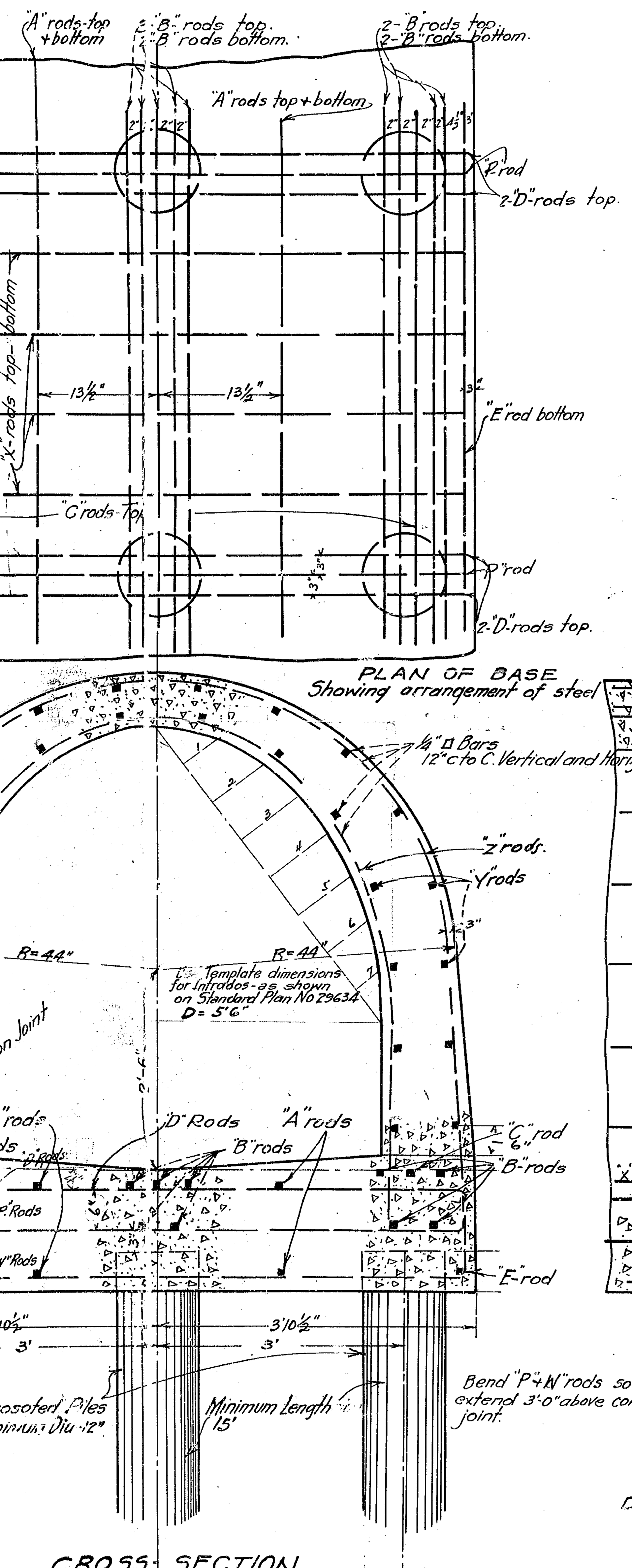
Date 1-3-69

By L.E. Janus

Deputy

DETAILS OF OUTLET STRUCTURE (SECTION "A")

Between Sta. 15+70.00 and Sta. 16+72.50
Scale 1"=1'

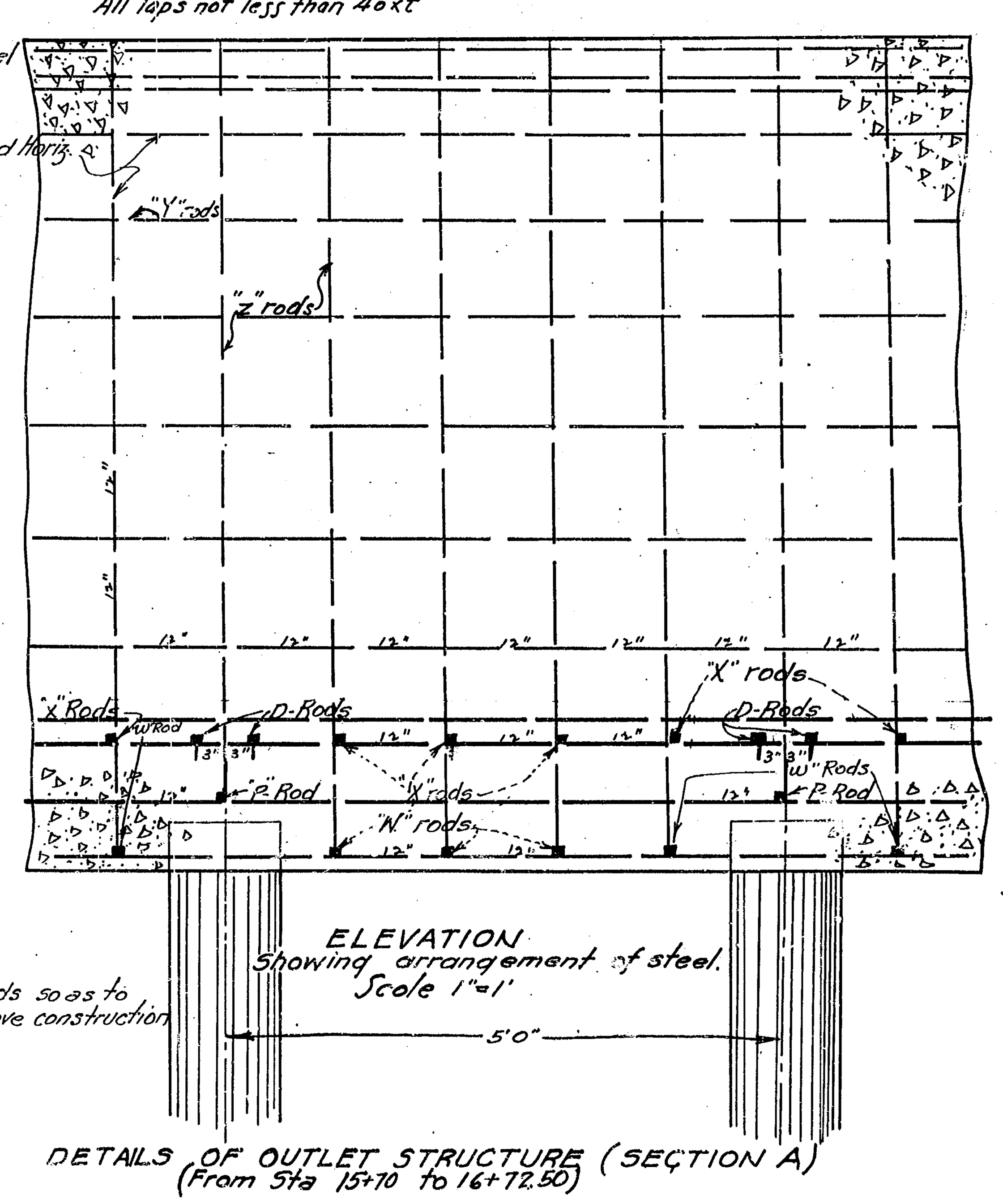


OUTLET STRUCTURE
Approved Aug. 30, 1927
Los Angeles Municipal Art Commission
by F. W. Blanchard President
J. J. Backus Secretary

TABLE OF REINFORCING STEEL

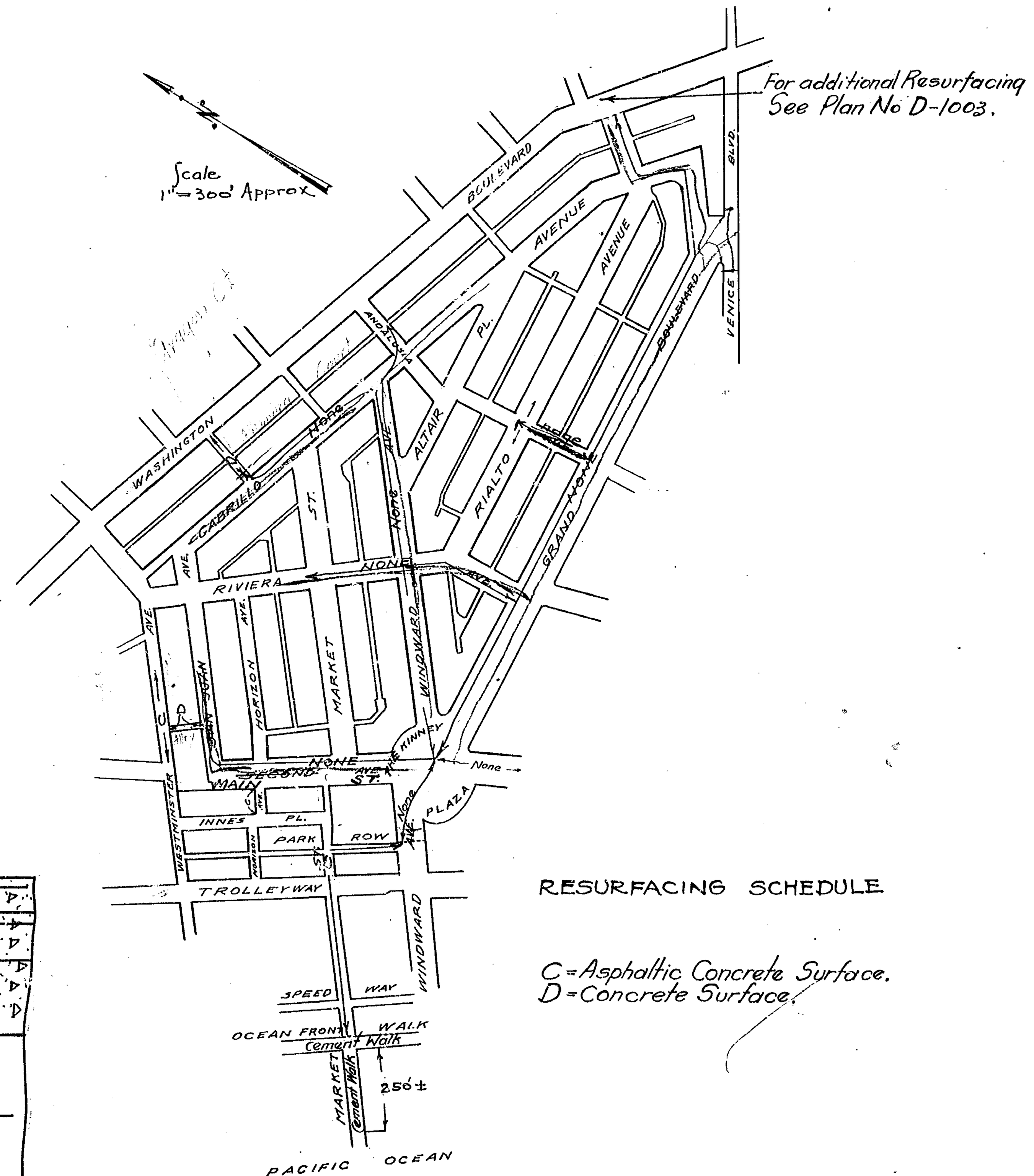
No.	Bars		Length
4-"A" rods	1/4□	straight-continuous	100'
13-"B" "	1/2□	" "	100'
2-"C" "	1/2□	" "	100'
4-"D" "	1/2□	hook both ends	7'3"
2-"P" "	1/4□	see detail	7'3"
81-"X" "	1/4□	straight continuous	7'3"
30-"Y" "	1/4□	" "	100'
101-"Z" "	1/4□	as shown	18'
81-"W" "	1/4□	see detail	7'3"
101-"Z" "	1/4□	as shown	16'
2-"M" Bars	5/8□		25'-6"

All laps not less than 40xt



ELEVATION
Showing arrangement of steel.
Scale 1"=1'

DETAILS OF OUTLET STRUCTURE (SECTION A)
(From Sta 15+70 to 16+72.50)



RESURFACING SCHEDULE

C=Asphaltic Concrete Surface.
D=Concrete Surface.

PILING SCHEDULE — 3800# Drop Hammer.

Bent No. Location	Pile No.	Original Length	Length below Cut-off	Length Under Gd.	Avg. Final Drop-Hammer	Avg Final Penetration	Date Driven
1-16+70	2	16'	15'	14.5'	6'	2"	11-9-29
" "	3	16'	15'	14.5'	6'	1"	"
" "	1	16'	15'	14.5'	6'	2"	"
2-16+65	5	16'	15'	14.5'	8'	2"	"
" "	4	20'	15'	14.5'	5'	1"	"
" "	6	20'	15'	14.5'	6'	2"	"
3-16+60	8	16'	15'	14.5'	5'	2"	11-10-29
" "	9	15'	15'	14.5'	4'	1"	"
" "	7	22'	15.3'	14.8'	6'	2"	"
4-16+55	11	20'	15'	14.5'	8'	2"	"
" "	10	21'	15.8'	15.3'	8'	2"	"
" "	12	20'	15.3'	14.8'	6'	2"	"
5-16+50	14	20'	15.1'	14.6'	10'	2"	"
" "	15	16'	15.2'	14.7	8'	2"	11-11-29
" "	13	22'	16.5'	16.'	6'	1"	"
6-16+45	17	20'	15.5'	15.'	6'	2"	"
" "	18	22'	15.5'	15.'	8'	2"	"
" "	16	21'	16'	15.5'	6'	2"	"
7-16+40	20	20'	15'	14.5'	12'	2"	"
" "	19	22.3'	15'	14.5'	12'	1"	"
" "	21	22.3'	15.5'	15.'	10'	2"	"
8-16+35	23	20.1'	15.7'	15.2'	8'	2"	"
" "	24	20'	15.1'	14.6'	10'	2"	"
" "	22	20'	15.2'	14.7'	6'	2"	"
9-16+30	26	16'	15'	14.5'	12'	2"	"
" "	27	20'	15.2'	14.7'	12'	3"	"
" "	25	22'	15'	14.5'	10'	2"	"
10-16+25	29	23'	15'	14.5'	8'	2"	"
" "	28	20'	15.5'	15.'	8'	2"	"
" "	30	20'	15'	14.5'	8'	2"	"
11-16+20	32	20'	15.1'	14.6'	12'	2"	"
" "	33	22'	15.5'	15.'	8'	2"	11-12-29
" "	31	20'	15.2'	14.7'	6'	2"	"
12-16+15	35	16'	15.7'	15.2'	8'	1"	"
" "	34	20'	15.2'	14.7'	8'	2"	"
" "	36	20'	15.5'	15.0'	6'	2"	"
13-16+10	38	16'	15'	14.5'	10'	1"	"
" "	39	22'	15.4'	14.9'	8'	1"	"
" "	37	20'	15.3'	14.8'	6'	1"	"
14-16+05	40	20'	15'	14.5'	12'	1"	"
" "	41	16'	15'	14.5'	10'	1"	"
" "	42	21'	15'	14.5'	10'	1"	"
15-16+00	44	20'	15.6'	15.1'	12'	1"	"
" "	45	20'	15'	14.5'	12'	1"	"
" "	43	20'	16.4'	15.9'	12'	1"	"
16-15+95	47	20	16.1'	15.6'	12'	2"	11-13-29
" "	48	22'	16.5'	16'	10'	1"	"
" "	46	20'	16.4'	15.9'	8'	1"	"
17-15+90	50	20'	15.5'	15'	6'	2"	"
" "	49	20'	16.3'	14.8'	8'	2"	"
" "	51	21'	15.1'	14.6'	10'	1"	"
18-15+85	53	21'	15.4'	14.9'	8'	2"	"
" "	54	20'	15'	14.[illegible]	10'	2"	"
" "	52	20'	15.7'	15.2'	6'	2"	"
19-15+80	56	20'	15.2'	14.7'	6'	1"	"
" "	57	20'	15.9'	15.4'	4'	2"	"
" "	55	21'	15.3'	14.8'	4'	2"	"
20-15+75	59	21'	15.6'	15.1'	6'	2"	"
" " "	60	22'	16.'	15.5'	8'	1"	"
" " "	58	20'	15'	14.5'	10	2"	"
21-15+70	61	19'	15.5'	15.'	8'	2"	"
" " "	62	16'	15'	14.5'	6'	2"	"
" " "	63	16'	15'	14.5'	8'	2"	"

NORTH CANALS STORM DRAIN SYSTEM

CITY OF LOS ANGELES
John C. Shaw, City Engineer

STORM DRAINS IN
THE KINNEY PLAZA
AT WINDWARD AVENUE
IN
WINDWARD AVENUE
BETWEEN KINNEY PLAZA AND PARK ROW
IN
PARK ROW
BETWEEN MARKET STREET AND WINDWARD AVENUE
IN
MARKET STREET
BETWEEN PARK ROW AND THE PACIFIC OCEAN

References. F.B. 11605, 10521, 11515, 11517, 11529

SUMMARY

Section "A" (Detail hereon)	102.50 Lin ft.
Section "B" (Detail hereon)	8.33 "
5'-0" Monolithic Concrete Storm Drain (Reinf. Elliptical Arch) Plan No 29634	176.67 "
5'-6" " " " (" ") " " "	1130.00 "
12" Diameter Pipe	36.00 "
12" Dia. San. Swr. Pipe	15.00 "
Manhole "X" (Plan No 29164)	4
Special San. Swr. Manhole "A" (Detail hereon)	1
Catch Basin No 23 (Plan No 28944)	2
Manhole Frame and Cover Sets (Plan No 29205)	4
Section C (Detail hereon)	200. Lin ft.
Section C (" ")	55.00 "

— NOTICE TO CONTRACTORS —
For Notice to Contractors see Plan No. D-1182

Resurfacing Schedule
See Sketch to left hereon.

These Elevations are based on the U.S.G.S. datum adopted July 1, 1925, Ord 52,222.

LIST OF STANDARD PLANS

Manhole "X" --- 29164
Manhole Frames + Covers --- 29205
Catch Basin No 23 --- 28944
Monolithic Concrete Storm Drain --- 29634

WINDWARD AVE. AND ~~SECOND AVE~~ MAIN ST. IMP. DIST.

Designed by: Baker-Tuckey / Williams
Checked by: Price
Drawn by: Tuckey-Hogan
Sanitary Sewer 6-1-27
Substructure
Submitted 8/25 1927
Approved Aug 29, 1927
[signature] Venice District Engineer
John C. Shaw, City Engineer
Approved 8-27 1927
E. A. Tuttle, Engr. Metropolitan Storm Drain Div.
R.W.K. [signature] Chief Deputy

D-1186
Sheet No 4 of 5 Sheets

D1186 1


SCALE 1" = 50'
SCALE 1" = 10' OR 1" = 100'
SCALE 1" = 20'
SCALE 1" = 40'
MICROFILM - CITY OF LOS ANGELES
DETAILS; TUNNEL CROSSING. Sta. 3+71.88 to 3+80.21
SECTIONAL ELEVATION
On ¢ of Tunnel. Scale 3/4"=1'
SECTIONAL ELEVATION
On ¢ of Storm Drain. Scale 3/4"=1'
Kinney Co. Concrete Tunnel.
All pipes to be maintained in operation during Construction of Storm Drain.
Remove Tunnel Floor Slab and construct Storm Drain as shown hereon
Hydraulic Section as per Standard Plan Nº 29634.
Standard Plan Nº 29634.
2-Existing 24" Vit. Clay Pipes — To be removed where interfering with construction and sealed with 8" of concrete
Construction Joint
"A" Bars 2-3/4"ø 6" cc. 6'-11" long (hooked both ends)
"B" Bars 2-3/8"ø 6" cc. Vert. 5'-6" long. (under Tunnel Walls)
"C" Bars 5-1/4"ø horizontal. 8'-1" long.
"E" Bars 2-3/8"ø (under Tunnel Walls) Vert. leg 3'-0" long Horiz. leg 2'-3" " with hook.
"D" Bars 2-1/2"ø 6" cc. 2'-0" long (under tunnel Walls)
NOTE:- All bends + hooks. Bars, 1/2"ø and under 2" dia. Bars over 1/2"ø, 3" dia.
—SECTION "B"—
Kinney Co. Concrete Tunnel
10" Water Pipes
Remove Tunnel Floor Slab
12" Sanitary Sewer See Detail
Standard Storm Drain Standard Plan Nº 29634
Sta. 3+71.68
Sta. 3+80.01
Sta. 3+81.84
DETAIL:- Elevation showing Discharge of 5'-6" Section at Station 16+72.50 Scale 3/4"=1'
"M" Bars Constructed with vertical face
Elev. -0.90
Sta. 16+72.50
Note: All transverse and Vertical Steel to be 3" Clear of face of cement except where otherwise shown.
Construct Section A identical to Monolithic Concrete Sewer (Reinforced Elliptical Arch) Standard Plan No 29634 except as modified hereon. (D= 5'6")
DETAILS OF OUTLET STR
(SECTION "A")
Between Sta. 15+70.00 and
Scale 1"=1'
PLAN OF BASE
Showing arrangement of steel
CROSS SECTION
Creosoted Piles Minimum Dia-12"
Minimum Length 15'
Bend "P"+"W" rods so as to extend 3'-0" above construction joint.
PACIFIC OCEAN
Standard 3/4 steps 13" c/c
Ventilator Stack
Section of Manhole Shaft
Section at ¢ Manhole
DETAILS OF VENTILATOR M.H. at Station 15+45 Scale - 1/2"=1' Constructed Sept. 1930 by Maintenance Forces. Order No. 3820 - 8/23/30
"D" Rod-1/2"
"P" Rod 1/2"
"W" Rod 1/2"
Scale 1"=2'
PLAN Scale 1"=20'
Highest Tide 4.61
PACIFIC OCEAN
Existing Amusement Structure
STREET
City Engrs Transit Line
Existing Piles
ELLIPTICAL ARCH
REINFORCED
Section "A" (Detail to right hereon)
Note: Contractor Shall maintain existing fire main and appurtenances during construction.
Note: Change in alignment during construction as per Supplementary Plan.
Δ= 25°17'18" R= 60' T= 13.46 L= 26.48
Δ=32°14'20" R=60' T=17.34' L=33.76'
PILING AS DRIVEN (See table to right hereon)
D1186 2
CERTIFICATE
I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles and Section 34090.5 of the Government Code.
REX E. LAYTON, City Clerk
Deputy

D1186 3

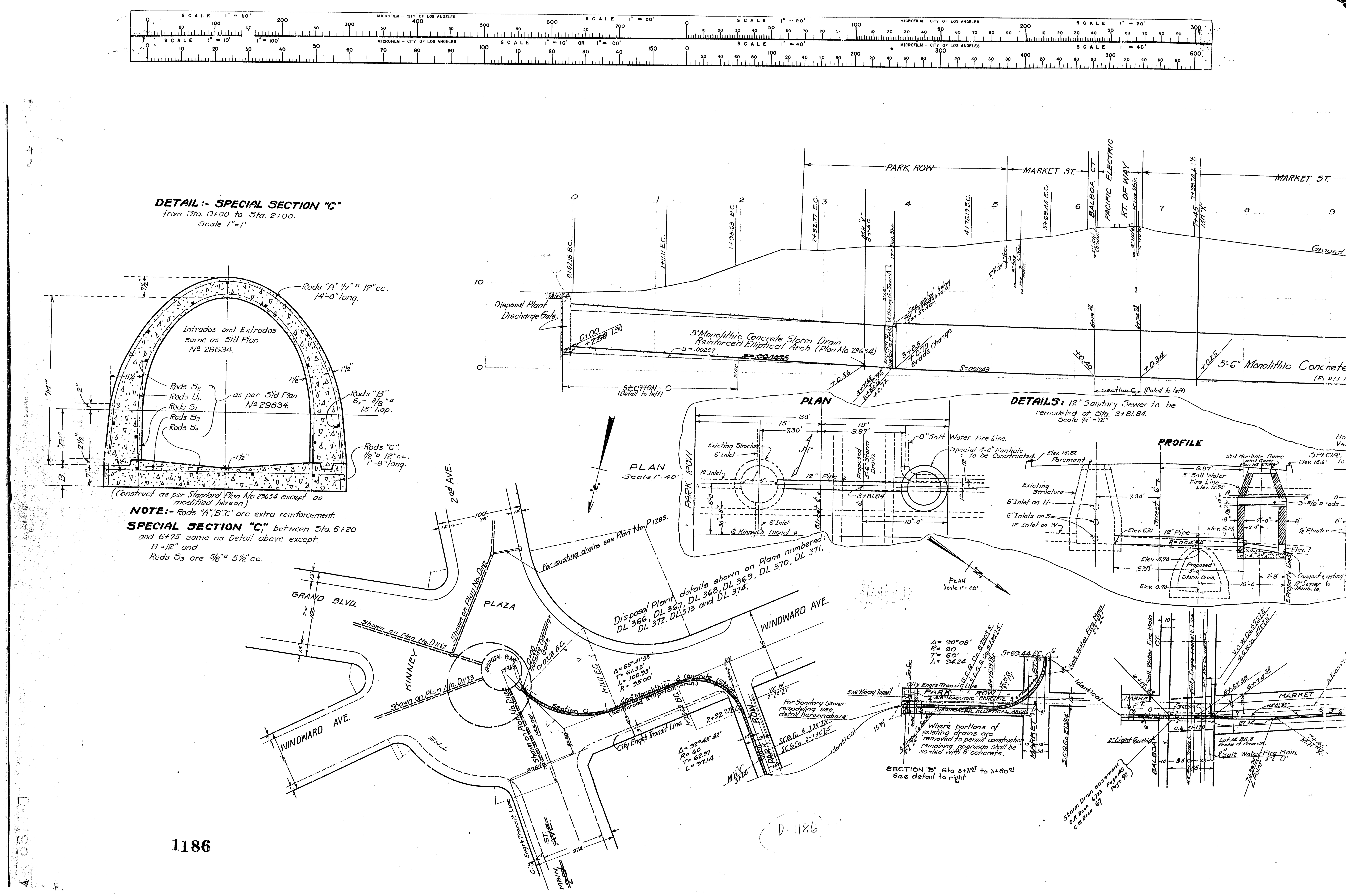
CERTIFICATE

I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles and Section 34090.5 of the Government Code.

REX E. LAYTON, City Clerk

By _______ Deputy

Date 1-3-69



1186

D-1186

D1186 4

CERTIFICATE

I hereby certify that this is a true and accurate copy of the official city record described there, made in accordance with Section 434 of the Charter of the City of Los Angeles and Section 34090.5 of the Government Code.

REX E. LAYTON, City Clerk

Date 1-2-69

By L. E. James, Deputy

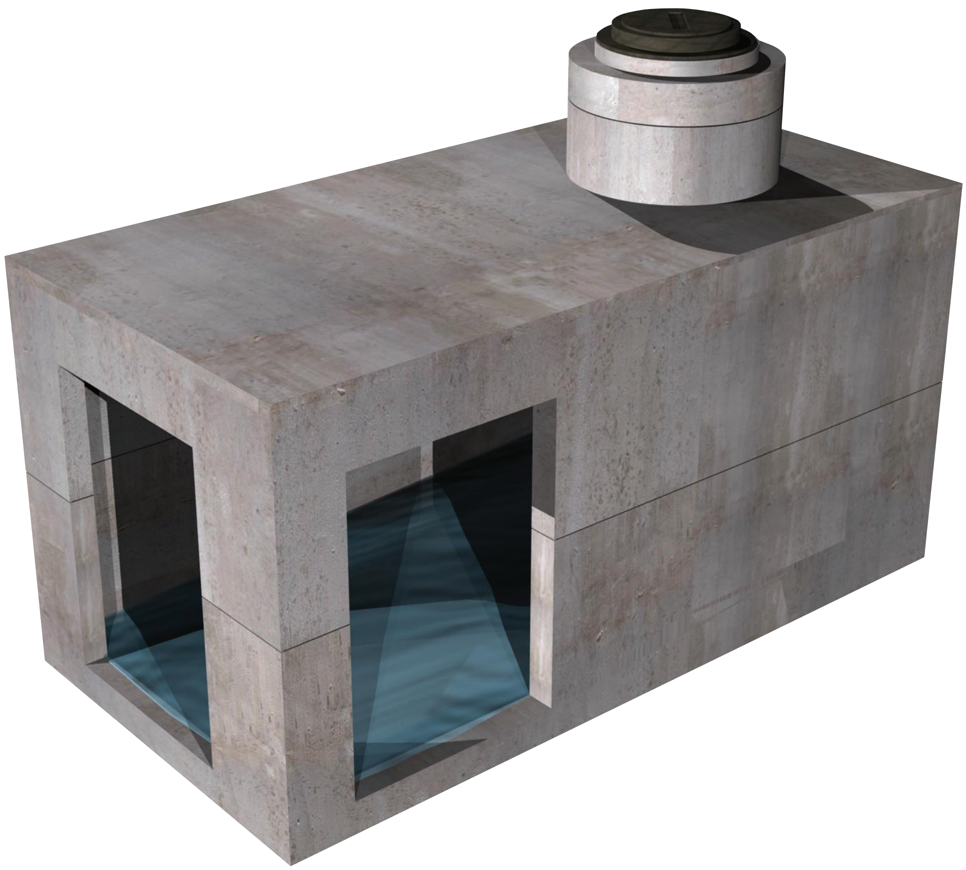
Appendix E – Product Information

STORM CAPTURE

Detention / Infiltration

TOTAL STORMWATER MANAGEMENT SYSTEM

From Oldcastle Stormwater Solutions Comes Storm Capture, A Modular Stormwater Management System for Infiltration, Detention, Retention, and Treatment.



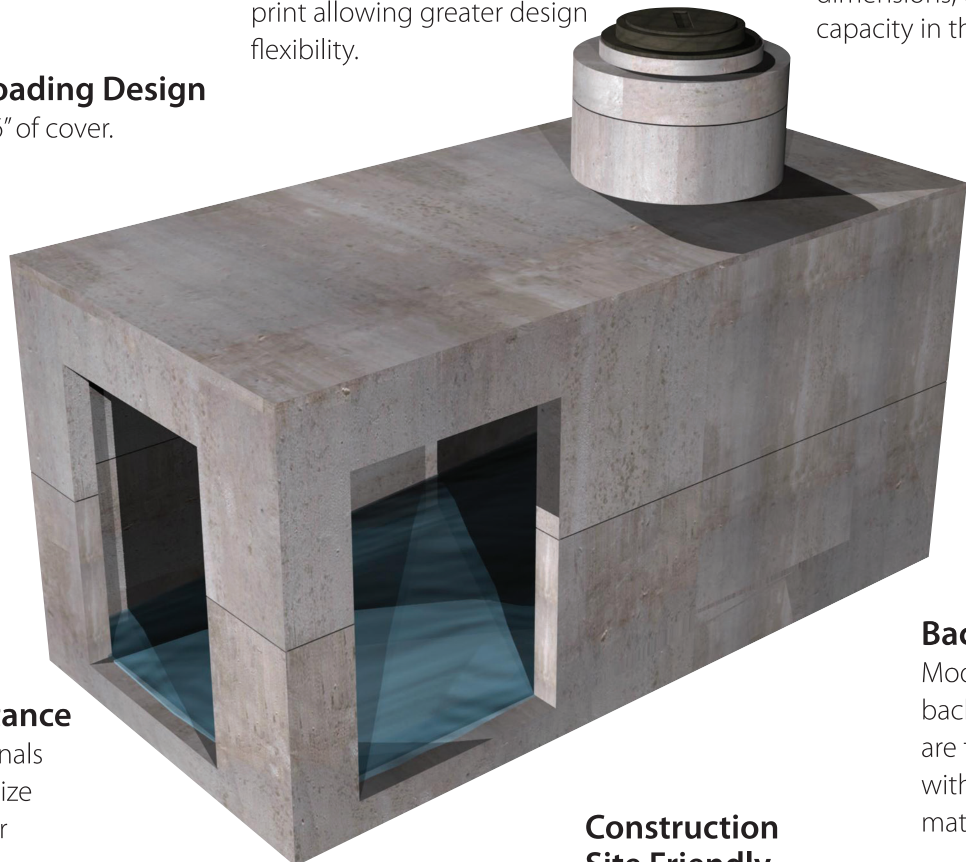
Oldcastle
Stormwater Solutions™

Storm Capture Module

Description
7' x 15' with a 14' maximum/ adjustable height inside dimensions, the largest capacity in the industry.

Large Storage Capacity
results in smaller system foot-print allowing greater design flexibility.

Traffic Loading Design
with only 6" of cover.



Easy to Install
modules for fast installation.

Flexible Heights
Available in heights from 2' to 14' to best-fit site needs.

Backfill
Modules do not rely on backfill for storage, and are typically backfilled with existing site materials.

Design Assistance
Let our professionals help you customize an application for your needs.

Construction Site Friendly
Contractor does not have to give up any of the site once the Storm Capture system is installed.

Treatment Train
Available with treatment train capability, pretreatment, post treatment, or both.

Same day staging and installation of StormCapture project.

StormCapture Project using Linkslab design.

StormCapture modules are designed for HS20 traffic loading.

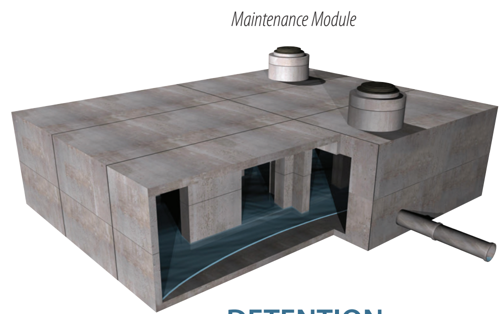
StormCapture infiltration system.

Storm Capture Benefits

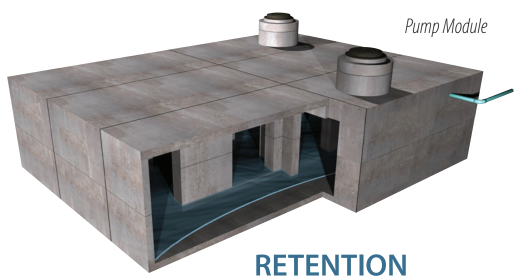
- **Fast service** - Quick and easy project help by our national engineering team with layouts and specifications to meet each project's requirements.
- **Cost savings** - Highly competitive installed and life-cycle costs.
- **Manufactured** to the rigid standards of the Oldcastle quality control program at Oldcastle facilities around the country.
- **Codes** - Designed to the latest codes for HS-20-44 (full truck load plus impact).
- **Sustainability** - The system is maintainable for long-term sustainability.
- **LID** - Ideal for Low Impact Development (LID).
- **LEED** - Manufactured locally with recycled material for potential LEED credits. *LEED 2009 for New Construction & Major Renovation, US Green Building Council: Sustainable Sites (5.1, 5.2, 6.1, 6.2), Materials & Resources (4.1, 4.2, 5.1, 5.2), Water Efficiency (1.1, 1,2, 3.1, 3.2)*

Applications

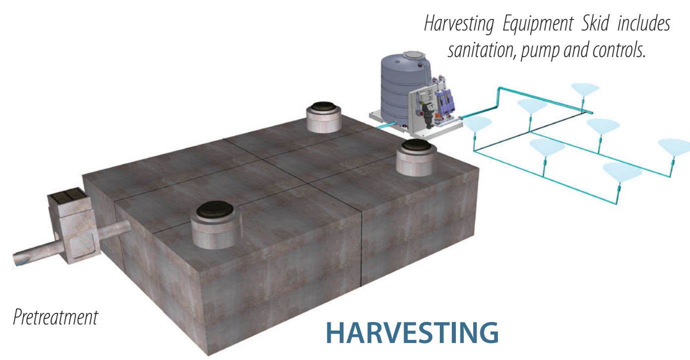
Storm Capture has many solutions for detention, retention, treatment, and harvesting that involve a combination of many parts designed to solve your stormwater management needs. Let us show you how we can design and customize a solution for you.



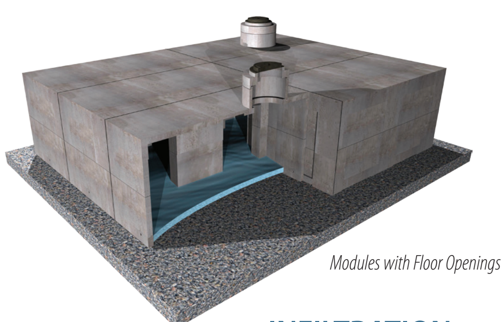
DETENTION



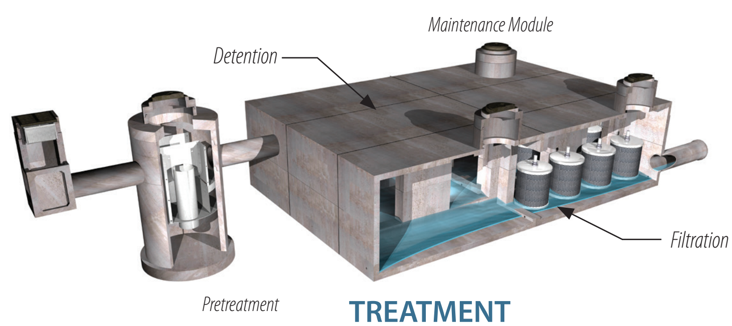
RETENTION



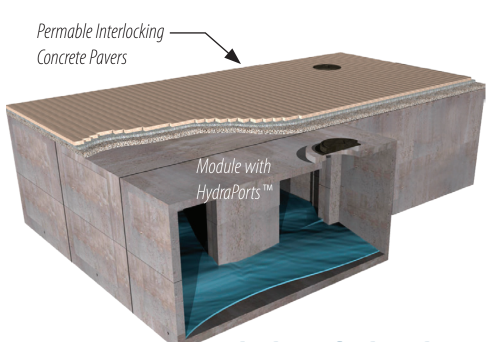
HARVESTING



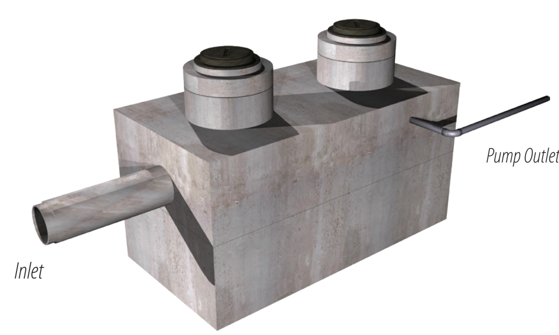
INFILTRATION



TREATMENT



PERMECAPTURE

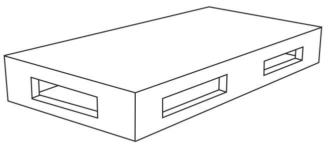


CISTERNS

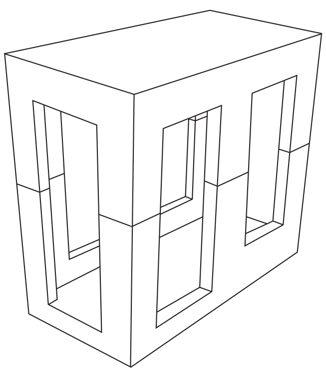



INSTALLED IN ONE DAY

Module Sizes



SC1 – one piece modules can be used for applications from 2' to 7' tall. These are appropriate for cisterns, infiltration, detention, and retention systems. SC1 modules are typically installed on a minimal compacted gravel base, dependent on specific project requirements.

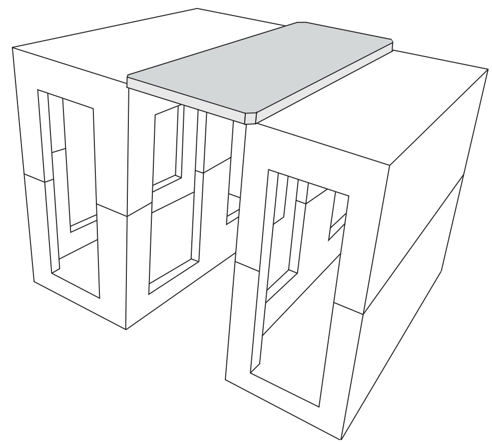


SC2 – two piece modules can be used for applications from 7' all the way up to 14' tall for maximum storage capacity in the smallest footprint. These are appropriate for cisterns, infiltration, detention, and retention systems. SC2 modules are typically installed on a compacted native subgrade.

Module Capacity

Size (ft.)	Capacity (ft^3.)	Size (ft.)	Capacity (ft^3.)
7x15x2	226	7x15x9	1027
7x15x3	343	7x15x10	1144
7x15x4	460	7x15x11	1257
7x15x5	577	7x15x12	1374
7x15x6	690	7x15x13*	1491
7x15x7	807	7x15x14*	1608
7x15x8	910		

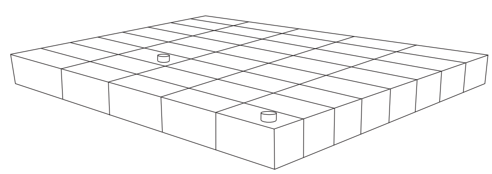
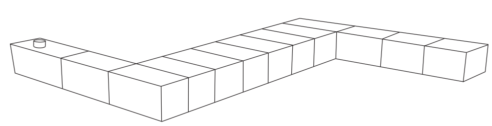
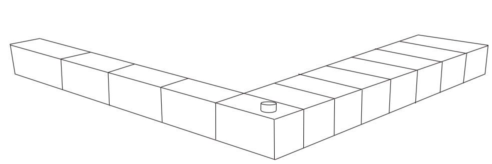
* Special design considerations required and limited availability
All dimensions are inside dimensions



Link Slab – for large storage assemblies, the unique link slab design allows significant reduction in the quantity of modules and associated costs, while providing the maximum in storage capacity.

Endless Configurations

Contact us today to start designing your system!

Humes
Water Solutions

Strength. Performance. Passion.

StormTrap® system Installation guide

SingleTrap™ model

Contents

The StormTrap® system

The StormTrap® system is a purpose-built stormwater detention and infiltration solution which provides a fully trafficable, below ground on-site detention system (OSD).

The system takes a unique design approach by connecting individual precast concrete modules into a single layer configuration that meets each project's requirements. This delivers a simple and flexible design solution without compromising above ground land use.

The growing popularity of the StormTrap® system is not only driven by its unique design and performance benefits, but by the significant installation economies it can provide. The modular design of the system means large detention volumes are delivered with the installation of each module. And because installers are able to use traditional construction processes, the installation can be completed in minimal time. Generally, it is expected that an individual StormTrap® module can be set in position in less than 10 minutes.

The StormTrap® system is available in two configurations to provide conventional detention, high early discharge or infiltration to ground water. The SingleTrap™ system and DoubleTrap™ system provide design solutions to meet volume requirements. This guide refers to the installation of the SingleTrap™ system.

The SingleTrap™ system is either founded on a strip footing to create a large infiltrative surface area, or founded on a conventional concrete slab for use as either a traditional detention basin or a basin with high early discharge.

The installation of the StormTrap® system is very simple:

1. Establish a suitable foundation.
2. Place modules row-by-row.
3. Apply StormWrap™ mastic tape across the top of the module joins.
4. Backfill.

There are a number of time-lapse videos available from humeswatersolutions.com.au which demonstrate the construction sequence and methodologies undertaken during the installation of a StormTrap® system. The library of videos includes a variety of project sizes and configurations.

As the system is made from precast concrete it is extremely strong and trafficable to AS 5100 traffic loadings (light duty designs are also available). Once the system has been installed there is no requirement for any further structural work in the trafficable pavement. The system will not deflect during construction loading, which allows rapid backfilling, and it won't suffer creep, as can be experienced with some lightweight systems.

Design and installation standards

The StormTrap® system is designed and installed in accordance with the requirements of the following Australian standards:

- AS 3600-2001 – Concrete Structures Code
- AS 5100-2004 – Bridge Design Code
- AS 5100.2-2004 – Bridge Design – Design Loads
- AS 1597.2-1996 – Precast Reinforced Concrete Box Culverts - Large Culverts
- AS/NZS 1170.1-2002 – Structural Design Actions – Part 1: Permanent, Imposed and other Actions.

Specifications

Module details

There are a number of different StormTrap® modules available and their use and placement will depend on design requirements and site layout (refer to Figure 1).

While the length and width of the modules remains constant, the height, and subsequently the mass, will vary according to the leg height for the system. The leg height varies from 600 mm to 1,500 mm, and is adjustable at 25 mm increments within this range.

Some modules will contain openings to allow for stormwater pipes or culverts and maintenance access points. Inlets and outlets may be placed at varying inverts and positions around the perimeter of the structure.

Depending on the overall size, each StormTrap® system will generally be designed with either 600 mm or 1,050 mm diameter openings for access through the roof at either end of the system. However, access openings may be in any location to fit in with specific site requirements. Designs can be modified to accommodate 900 mm x 900 mm grates.

Masses and dimensions

SingleTrap™ modules have a maximum internal leg height of 1,500 mm. The maximum mass of each module is shown in Table 1.

Table 1 – Masses and dimensions (1,500 mm height)

Module type	Mass (kg)	Length x width (mm)
I	6,730	4,000 x 2,350
II	4,320	2,000 x 2,350
III	7,660	4,000 x 2,350
IV	4,810	2,000 x 2,350
V	4,810	2,000 x 2,350
VI	8,590	4,000 x 2,350
VII	5,280	2,000 x 2,350
Light duty I	4,400	4,000 x 2,350

Figure 1 – A sample layout of a SingleTrap™ system

V	III	III	IV
II	I	I	II
II	I	I	II
IV	III	III	V

Standard type I

Standard type II

Standard type III

Standard type IV

Standard type V

Standard type VI

Standard type VII

Light duty type I

Handling and installation

Safety

Safety is a priority for Humes. It is important for all parties to observe safety requirements and regulations during transportation, handling, storage and installation, including wearing appropriate personal safety protection equipment.

It is the responsibility of the main contractor or installation contractor to produce a Safe work method statement; we recommend that this statement complies with both the National Code of Practice for Precast Tilt-up and Concrete Elements in Building Construction, and local and state codes (where they exist). Personnel should follow any safety advice provided by the main contractor/installation contractor.

The precast concrete component should only be lifted using the appropriate lifting clutches which are fitted into the designated lift points via the cast-in anchors. All lifting equipment must be certified to lift the specific mass and approved for lifting heavy components. The mass of the StormTrap® modules will vary depending on its geometry; weights will be clearly marked on the precast units and in the relevant project drawings.

All lifting and placement must proceed with caution and strictly in accordance with all relevant occupational health and safety standards. Bumping or impact of modules can cause damage and should be avoided.

The advice in this publication is of a general nature only. Where any doubt exists as to the safety of a particular lift or installation procedure, seek the guidance of a professional engineer or contact Humes for advice.

Pre-delivery

To ensure the safe and efficient installation of the StormTrap® system it is important to undertake sufficient planning prior to its arrival on site.

Equipment requirements

The following list of equipment is required for a safe and efficient installation:

- tape measure
- a can of marking spray
- chalk line/masonry string
- pinch/crowbar
- stanley knife
- two ladders
- broom
- level
- four chains
- four five-tonne Swiftlift® clutches
- Swiftlift® clutches for manhole covers or risers
- swivel for chains
- 20 mm spacers or gap gauge (available from Humes)
- safety harness for working at height
- StormMastic™ sealant
- StormWrap™ mastic tape.

Left:
Gap gauge

Site preparation

Before the StormTrap® system is installed, the concrete foundation must be poured (refer to the approval drawings supplied by Humes). The foundation details will depend on whether the system is required to provide stormwater detention or infiltration (refer to Figure 2 and Table 2 for an example).

Once the foundation is cured mark the outside edges of the system on the slab (as per the layout dimensions of the approval drawings).

Figure 2 – Example of a foundation plan

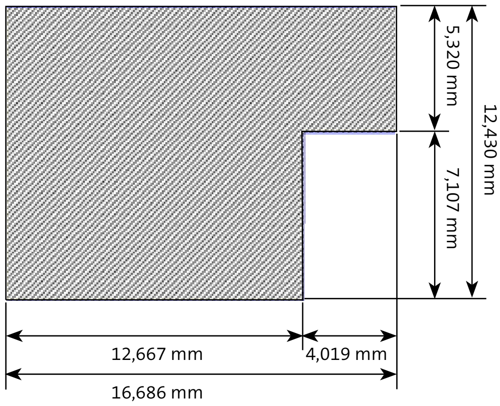
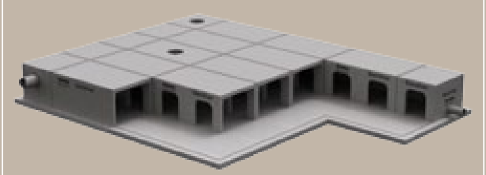
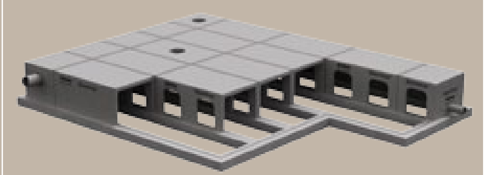
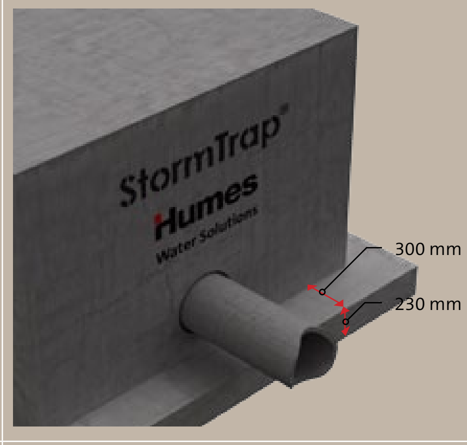
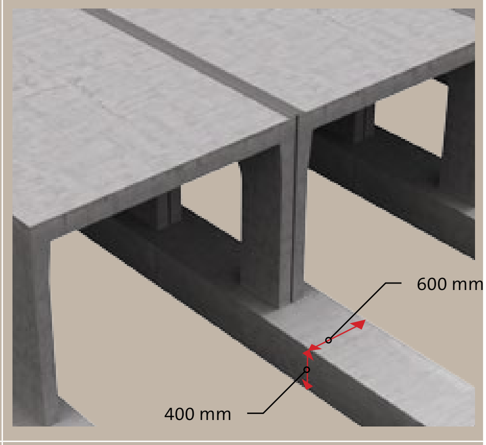


Table 2 – Foundation details

System type	Detention	Infiltration
		
Foundation	Continuous concrete slab	Strip footing
Dimensions	Slab is 230 mm thick* and extends 300 mm past outer edge of the system. 	Slab 'strips' are 400 mm thick and 600 mm wide running underneath the line of StormTrap® feet. 
Recommended cure period	7 days	7 days

Note:
*Slab design is based on in-situ material having a bearing capacity of 150 KPa; this may differ according to engineer's specifications.

Delivery

Prior to deliveries commencing, a pre-installation site meeting will occur with the contractor to finalise shipping plans including the sequencing of deliveries and the order of unloading and installing each of the modules.

The shipping plan will help to alleviate the double-handling of modules; save time and effort, make more efficient use of the crane, and reduce site congestion. The shipping plan will be provided to both the specifying engineer and contractor for sign off prior to commencing the delivery of modules to site (refer to Figure 3).

The StormTrap® modules will be delivered to site either on a semi-trailer or B-double depending on site access and the number of modules to be delivered. Each truck will typically contain 3-6 modules depending on the particular module type and mass. The first truck will typically take about 45 minutes to unload, the second truck about 30-45 minutes, and then each subsequent truck about 20-30 minutes.

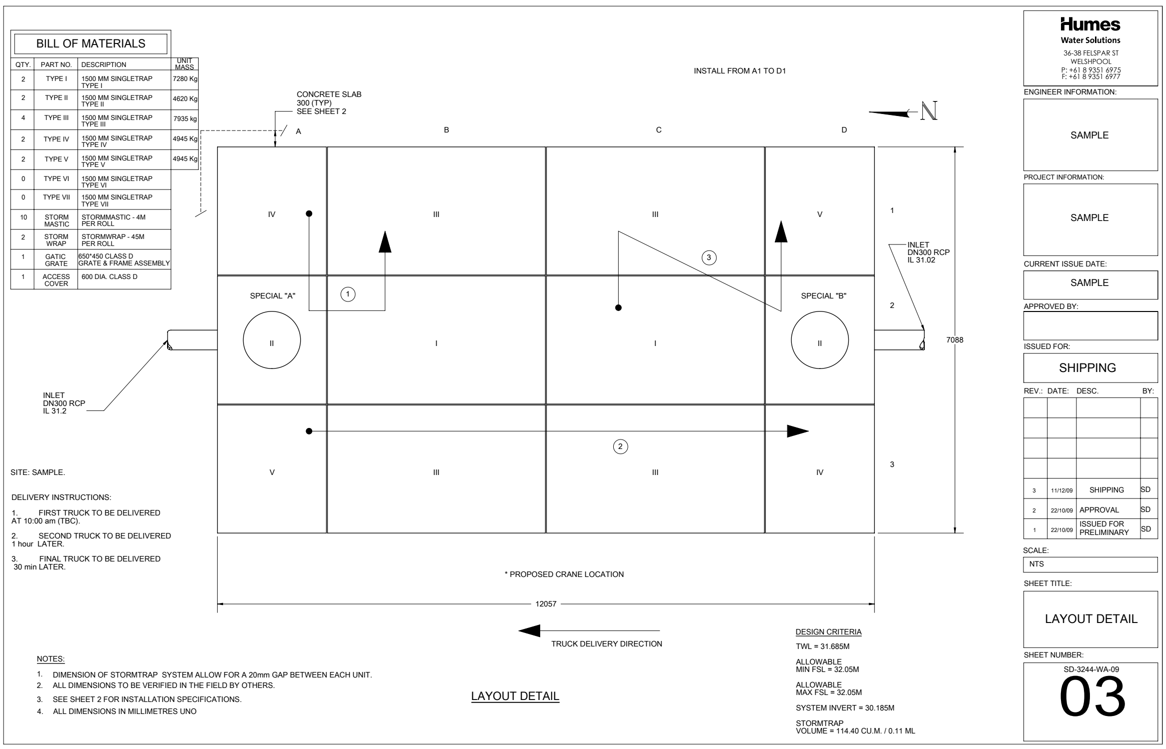
Lifting

All the precast units are supplied with cast-in lifting anchors to enable safe handling. To prevent stress and possible concrete cracking, all units must be handled using the cast-in lifting anchors and associated lifting clutches (lifting clutches can be obtained from the crane contractor or Humes). Installers should use tagged lifting equipment only. It is the installation contractor's responsibility to ensure the lifting clutches are available on site. The lifting points of anchors are clearly shown on the Humes drawings.

Wherever possible, all modular components should be lifted from the delivery truck and set directly onto the prepared substructure. Each module will take approximately 5-10 minutes to unload and set into position.

If for some reason temporary storage of the modules is required on site, they should be placed carefully on level, even ground, free of rocks and uniformly supported across the entire leg surface by using timbers. Modules should not be stacked on top of each other.

Figure 3 – Example of a shipping plan



Top:
Step one

Middle:
Step two

Bottom:
Step three

Module installation

A representative of Humes Water Solutions will be present on site at the commencement of the installation (as required) to provide support to the contractor and observe deliveries and installation.

The StormTrap® system is typically installed as follows:

1. Sweep the concrete slab/footings clean of dirt and debris.

2. Lay a bead of StormMastic™ sealant on the slab approximately 60 mm inside the perimeter line marking.

3. Secure the first module with four Swiftlift® anchors. Take care not to strike the modules together when you are unloading and lowering them. Be aware of pinch hazard at all times and don't walk or work under suspended loads.

4. When lowering the first module into position, pause 50 mm above the concrete slab, then gradually lower it into position once it is aligned with the perimeter markings. Ensure the unit is square and the bottom of the module is on the foundation before you remove the lifters.

Top:
Step four

Middle:
Step five

Bottom:
Step six

5. Align the next module with the edge markings and position it adjacent to, but no more than 20 mm from the first block (check with a gap gauge). Use a pinch or crowbar to assist with the finer adjustment of the modules.

6. Continue to install the modules row-by-row, in the order shown on the shipping plan.

Top:
Step seven

Bottom:
Step eight

7. Once two rows of modules have been laid and checked, apply StormWrap™ tape across the joins.

8. When four rows of modules have been laid, checked and sealed, backfilling can then occur (refer per note F. on page 2 of the approval drawings).

Note: During the installation check the overall dimensions of the system to make sure creep is not occurring. Adjust the laying gap when necessary to recover any discrepancies.

Contact information

National sales 1300 361 601
humeswatersolutions.com.au
info@humeswatersolutions.com.au

Head Office

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The ACPT Products Program identifies, refines, and delivers for implementation available technologies from all sources that can enhance the design, construction, repair, and rehabilitation of concrete highway pavements. The ACPT Marketing Plan enables technology transfer, deployment, and delivery activities to ensure that agencies, academia, and industry partners can derive maximum benefit from promising ACPT products in the quest for long-lasting concrete pavements that provide a safe, smooth, and quiet ride.

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U.S. Department of Transportation
Federal Highway Administration

TechBrief
DECEMBER 2012 | FHWA-HIF-13-006

Pervious Concrete

This TechBrief presents an overview of pervious concrete and its use in pavement applications. General information on the composition of pervious concrete is provided, along with a summary of its benefits, limitations, and typical properties and characteristics. Important considerations in mix proportioning, hydrological design, structural design, construction, and maintenance are also described.

Introduction

Pervious concrete, sometimes referred to as no-fines, gap-graded, permeable, or enhanced porosity concrete, is an innovative approach to controlling, managing, and treating stormwater runoff. When used in pavement applications, pervious concrete can effectively capture and store stormwater runoff, thereby allowing the runoff to percolate into the ground and recharge groundwater supplies.

Pervious concrete contains little or no fine aggregate (sand) and carefully controlled amounts of water and cementitious materials. The paste coats and binds the aggregate particles together to create a system of highly permeable, interconnected voids that promote the rapid drainage of water (Tennis et al. 2004; ACI 2010). Typically, between 15 and 25 percent voids are achieved in the hardened concrete, and flow rates for water through the pervious concrete are generally in the range of 2 to 18 gal/min/ft^2 (81 to 730 L/min/m^2), or 192 to 1,724 inch/hr (488 to 4,379 cm/hr) (ACI 2010). Figure 1 shows a typical cross section of a pervious concrete pavement.

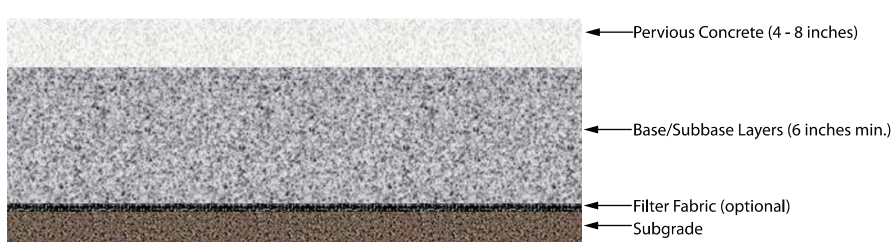

FIGURE 1. Typical pervious concrete pavement cross section (adapted from EPA 2010).

Benefits and Limitations

Table 1 summarizes some of the major benefits and limitations associated with pervious concrete. As described above, perhaps the most significant benefit provided by pervious concrete is in its use as a stormwater management tool. Stormwater runoff in developed areas (often the result of or exacerbated by the presence of conventional impervious pavement) has the potential to pollute surface and groundwater supplies, as well as contribute to flooding and erosion (Leming et al. 2007).

Pervious concrete can be used to reduce stormwater runoff, reduce contaminants in waterways, and renew groundwater supplies. With high levels of permeability, pervious concrete can effectively capture the "first flush" of rainfall (that part of the runoff with a higher contaminant concentration) and allow it to percolate into the ground where it is filtered and "treated" through soil chemistry and biology (Tennis et al. 2004; ACI 2010).

Other major benefits provided by pervious concrete include reduction in heat island effects (water percolating through the pavement can exert a cooling effect through evaporation, and convective airflow can also contribute to cooling (Cambridge 2005)), reductions in standing water on pavements (and associated hydroplaning and splash/spray potential), and reduced tire–pavement noise emissions (due to its open structure that helps absorb noise at the tire–pavement interface) (ACI 2010). In addition, pervious concrete can contribute toward credits in the LEED® (Leadership in Energy and Environmental Design) rating system for sustainable building construction (Ashley 2008).

Along with its many benefits, there are some limitations associated with the use of pervious concrete. First and foremost, pervious concrete has typically been used on lower trafficked roadways, although there are a number of installations on higher volume facilities, and research is being conducted on the structural behavior of pervious concrete slabs (see, for example, Suleiman et al. 2011; Vancura et al. 2011). In addition, pervious concrete exhibits material characteristics (primarily lower paste contents and higher void contents) and produces hardened properties (notably density and strength) that are significantly different from conventional concrete; as a result, the current established methods of quality control/quality assurance (e.g., slump, strength, air content) are in many

TABLE 1. Summary of Pervious Concrete Benefits and Limitations (Tennis et al. 2004; ACI 2010)

Benefits/Advantages	Limitations/Disadvantages
• Effective management of stormwater runoff, which may reduce the need for curbs and the number and sizes of storm sewers. • Reduced contamination in waterways. • Recharging of groundwater supplies. • More efficient land use by eliminating need for retention ponds and swales. • Reduced heat island effect (due to evaporative cooling effect of water and convective airflow). • Elimination of surface ponding of water and hydroplaning potential. • Reduced noise emissions caused by tire–pavement interaction. • Earned LEED® credits.	• Limited use in heavy vehicle traffic areas. • Specialized construction practices. • Extended curing time. • Sensitivity to water content and control in fresh concrete. • Lack of standardized test methods. • Special attention and care in design of some soil types such as expansive soils and frost-susceptible ones. • Special attention possibly required with high groundwater.

cases not applicable (ACI 2010). Moreover, a number of special practices, described later, are required for the construction of pervious concrete pavements. And, while there have been concerns about the use of pervious concrete in areas of the country subjected to severe freeze–thaw cycles, available field performance data from a number of projects indicate no signs of freeze–thaw damage (Delatte et al. 2007; ACI 2010).

Applications

Pervious concrete has been used in pavement applications ranging from driveways and parking lots to residential streets, alleys, and other low-volume roads (Tennis et al. 2004). Within these applications, pervious concrete has been used as the surface course, as a drainable base course (often in conjunction with edge drains to provide subsurface drainage), or as a drainable shoulder (to help provide lateral drainage to a pavement and prevent pumping). The focus in recent years has been on its use as a surface course as a means of providing stormwater management.

Typical Properties and Characteristics

As noted previously, many of the properties of pervious concrete are different from those of conventional concrete. These properties are primarily a function of the porosity (air void content) of the pervious concrete, which in turn depends on the cementitious content, the water-to-cementitious materials (w/cm) content, the compaction level, and the aggregate gradation and quality (ACI 2010). Table 2 summarizes some of the typical material properties associated with pervious concrete. These properties and characteristics must be considered during the structural design and pavement construction.

The cost of pervious concrete may be 15 to 25 percent higher than conventional concrete, but cost can vary significantly depending on the region, the type of application, the size of the project, and the inclusion of admixtures.

Mixture Proportioning

Like conventional concrete, pervious concrete is a mixture of cementitious materials, water, coarse aggregate, and possibly admixtures, but it contains little or no fines; however, note that a small amount of fine aggregate, typically 5 to 7 percent, is required for freeze–thaw durability (Schaefer et al. 2006; Kevern et al. 2008). Table 3 shows the typical range of materials proportions that have been used in pervious concrete. Commentary on the components of a pervious concrete is provided below (Tennis et al. 2004; Delatte et al. 2007; ACI 2010):

Cementitious materials. As with conventional concrete mixtures, conventional portland cements or blended cements are used as the primary binder in pervious concrete, although supplementary cementitious materials may also be used.

TABLE 2. Typical Pervious Concrete Properties (Tennis et al. 2004; Obla 2007)

Property	Common Value / Range
Plastic Concrete	
Slump	N/A
Unit weight	70% of conventional concrete
Working time	1 hour
Hardened Concrete	
In-place density	100 to 125 lb/ft^3
Compressive strength	500 to 4,000 lbf/in^2 (typ. 2,500 lbf/in^2)
Flexural strength	150 to 550 lbf/in^2
Permeability	2 to 18 gal/ft^2/min (384 to 3,456 ft/day)

1 in = 25.4 mm; 1 lb/ft^3 = 16 kg/m^3; 1 lbf/in^2 = 6.89 kPa; 1 gal/ft^2/min = 40.8 L/m^2/min

Coarse aggregate. Coarse aggregate is kept to a narrow gradation, with the most common gradings of coarse aggregate used in pervious concrete meeting the requirements of ASTM C33/C33M—aggregate sizes of 7, 8, 67, and 89. Coarse aggregate size 89 (top size 0.375 inch (9.5 mm)) has been used extensively for parking lot and pedestrian applications. Rounded and crushed aggregates, both normal and lightweight, have been used to make pervious concrete.

Water. The control of water is important in the development of pervious concrete mixtures, and the selection of an appropriate w/cm value is important for obtaining desired strength and void structure in the concrete. A high w/cm can result in the cement paste flowing off of aggregate and filling the void structure, whereas a low w/cm can result in mixing and placement difficulties and reduced durability. Commonly, w/cm values between 0.27 and 0.34 are used.

Admixtures. As with conventional concrete, chemical admixtures can be used in pervious concrete to obtain or enhance specific properties of the mixture. In particular, set retarders and hydration stabilizers are commonly used to help control the rapid setting associated with many pervious concrete mixtures. Air-entraining admixtures are required in freeze–thaw environments although no current method exists to quantify the amount of entrained air in the fresh paste. Air entrainment can be determined on hardened samples according to ASTM C457.

TABLE 3. Typical Pervious Concrete Materials Proportions (ACI 2010)

Mix Constituent or Design Parameter	Range
Coarse aggregate	2,000 to 2,500 lb/yd³
Cementitious materials	450 to 700 lb/yd³
Water-to-cementitious ratio	0.27 to 0.34
Aggregate-to-cementitious ratio (by mass)	4 to 4.5:1

1 lb/yd³ = 0.59 kg/m³

Mix proportioning for pervious concrete is based on striking a balance between voids, strength, paste content, and workability (ACI 2010). As such, the development of trial batches is essential to determining effective mix proportions using locally available materials. Detailed information on mix proportioning is available from ACI (2010).

Some limited work has been done investigating the freeze–thaw characteristics of pervious concrete and mix design for cold weather climates (NRMCA 2004; Schaefer et al. 2006). The freeze–thaw resistance of pervious concrete appears to be dependent on the saturation level of the voids; consequently a drainable base layer with a minimum thickness of 6 inches (150 mm) is recommended to help keep the pervious concrete layer from becoming saturated. Furthermore, as previously noted, the freeze–thaw resistance of pervious concrete has been shown to improve when sand is included in the pervious concrete mixture (Schaefer et al. 2006; Kevern et al. 2008).

Design of Pervious Pavements

Two primary considerations enter into the determination of the thickness of pervious concrete pavements: 1) hydrologic design to meet environmental requirements and 2) structural design to withstand the anticipated traffic loading applications (Leming et al. 2007; ACI 2010). These design considerations are briefly described below.

Hydrologic Design

In evaluating the hydrologic design capabilities of a pervious pavement, the approach is to determine whether the characteristics of the pervious concrete pavement system are sufficient to infiltrate, store, and release the expected inflow of water (which

includes direct rainfall and may also include excess runoff from adjacent impervious surfaces). As such, information required in a hydrologic analysis includes the precipitation intensity levels, the thickness and permeability characteristics of the pervious concrete pavement, cross slopes and geometrics, and permeability properties and characteristics of the underlying base, subbase, and subgrade materials.

Many hydrological design methods exist that can be used when designing pervious concrete pavement systems, including the Natural Resources Conservation Service Curve Number Method and the Rational Method (Leming et al. 2007). In essence, the hydrologic design of pervious concrete pavements should consider two possible conditions to ensure that excess surface runoff does not occur (Leming et al. 2007):

1. Low permeability of the pervious concrete material that is inadequate to capture the "first flush" of a rainfall event.

2. Inadequate retention provided in the pervious concrete structure (slab and subbase).

Often, the thickness of a pervious concrete pavement is first determined based on structural requirements and then analyzed to determine its suitability to meet the hydrologic needs of the project site. If the thickness is found to be insufficient, adjustments can be made to the thickness of the pervious pavement or the underlying base course. Details on hydrologic design are beyond the scope of this document but are available in the literature (Leming et al. 2007; Wanielista et al. 2007; Rodden et al. 2011).

Structural Pavement Design

Pervious concrete pavements can be designed using virtually any standard concrete pavement procedure (e.g., American Association of State Highway and Transportation Officials, Portland Cement Association, StreetPave) (Delatte 2007). The American Concrete Pavement Association has recently developed a comprehensive program, PerviousPave, that can be used to develop both structural and hydrological designs for pervious pavements (Rodden et al. 2011). Regardless of the procedure used, there are critical factors to consider in the design of pervious concrete pavements (ACI 2010):

Subgrade and subbase. In the design of pervious pavements, foundation support is typically characterized by a composite modulus of subgrade reaction, which should account for the effects of both the subgrade and the subbase. An open-graded subbase is commonly used beneath pervious concrete pavements not only to provide an avenue for vertical drainage of water to the subgrade, but also to provide storage capabilities. Special subgrade conditions (such as frost susceptibility or expansive soils) may require direct treatment.

Concrete flexural strength. The flexural strength of concrete is an important input in concrete pavement structural design. However, testing to determine the flexural strength of pervious concrete may be subject to high variability; therefore, it is common to measure compressive strengths and to use empirical relationships to estimate flexural strengths for use in design (Tennis et al. 2004).

Traffic loading applications. The anticipated traffic to be carried by a pervious pavement is commonly characterized in terms of equivalent 18,000-lb (80 kN) single-axle load repetitions, which many procedures compute directly based on assumed truck-traffic distributions. Most pervious concrete pavements are used in low-truck-traffic applications.

Currently there are no thickness standards for pervious concrete pavements, but many pervious pavements for parking lots are constructed 6 inches (150 mm) thick, whereas pervious pavements for low-volume streets have been

constructed between 6 and 12 inches (150 and 300 mm) thick (ACI 2010).

Construction Considerations

Because of its unique material characteristics, pervious concrete has a number of special construction requirements. Key aspects of pervious concrete construction include the following (Tennis et al. 2004; ACI 2010):

Placement and consolidation. Most pervious concrete is placed using fixed-form construction. For smaller projects, a hand-held straightedge or vibrating screed may be acceptable for placement, whereas for larger projects an A-frame, low-frequency, vibrating screed may be used. A few projects have used laser screeds and concrete slipform equipment. Consolidation is generally accomplished by rolling the concrete with a steel roller. Overall, the low water content and porous nature of pervious concrete require that delivery and placement be completed as quickly as possible.

Finishing. Pervious concrete pavements are not finished in the same manner as conventional pavements. In essence, the final surface finish is achieved as part of the consolidation process, which leaves an open surface. Normal concrete finishing procedures, such as with bull floats and trowels, should not be performed.

Jointing. Jointing is commonly done on pervious concrete to control random crack development. These joints are commonly formed (using a specially designed compacting roller-jointer) to a depth between one-fourth and one-third of the slab thickness.

Curing and protection. After the concrete has been jointed, it is important that the concrete be effectively cured; this is commonly achieved through the placement of thick (typically 6 mil (0.15mm)) plastic sheeting over all exposed surfaces. The plastic sheeting should be applied no later than 20 minutes following discharge of the concrete, and should remain in place for at least 7 days (longer times may be required under cold weather placement conditions or if supplementary cementitious materials are used in the mix). Liquid membrane curing compounds are not commonly used because they prevent surface moisture loss and do nothing to prevent evaporation from within the pervious concrete (Kevern et al. 2009).

Inspection and testing. The American Concrete Institute has prepared a summary of recommended inspection and testing activities that should be performed during construction of pervious concrete pavements (ACI 2010), as well as a specification for pervious concrete construction (ACI 2008). Acceptance testing for pervious concrete is typically limited to density (ASTM C1688) and thickness (ASTM C42). Test methods specific to pervious concrete are listed below:

- ASTM C1688, *Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.*
- ASTM C1701, *Standard Test Method for Infiltration Rate of In Place Pervious Concrete.*
- ASTM C1747, *Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion.*
- ASTM C1754, *Standard Test Method for Density and Void Content of Hardened Pervious Concrete.*

In recognition of the special construction requirements of pervious concrete, the National Ready Mixed Concrete Association has developed a program designed to educate, train, and certify contractors in pervious concrete placement (see http://nrmca.org/Education/Certifications/Pervious_Contractor.htm).

Maintenance

Over time, sand, dirt, vegetation, and other debris can collect in pervious concrete's voids and reduce its porosity, which can negatively affect

the functionality of the system. Thus, periodic maintenance may be needed to remove surface debris and restore infiltration capacity. Two common maintenance methods are pressure washing and power vacuuming (ACI 2010).

Performance

The performance of pervious concrete pavements may be assessed in a number of ways, including monitoring changes in the permeability/porosity of the system (which would indicate clogging of the void structure), the presence of distress (both structural and surficial), and resistance to freeze–thaw damage. Unfortunately, there are limited long-term performance data on pervious concrete, but generally performance is considered satisfactory. For example, a study in Florida indicated that pervious concrete pavements that were 10 to 15 years old were operating in a satisfactory manner without significant amounts of clogging (Wanielista et al. 2007). In another study, field inspections of 22 projects located in freeze areas were conducted, with reported good performance and no visual signs of freeze–thaw damage (although all projects were less than 4 years old at the time of inspection) (Delatte et al. 2007).

Where the performance of pervious concrete pavements has not been satisfactory, poor performance is often attributed to contractor inexperience, higher compaction of soil than specified, and improper site design (ACI 2010).

Summary and Future Needs

The use of pervious concrete has increased significantly in the last several years, perhaps largely because it is considered an environmentally friendly, sustainable product. The use of pervious concrete provides a number of benefits, most notably in the effective management of stormwater runoff. Other significant benefits include reducing contaminants in waterways, recharging groundwater supplies, reducing heat island effects, and reducing pavement–tire noise emissions.

Still, there are a number of areas that need additional developmental work to improve or enhance the capabilities of pervious concrete pavements. One area is the continued monitoring of the performance of pervious concrete so that long-term performance trends can be documented; this will also help in evaluating the suitability of pervious concrete for other applications, such as overlays. Tied in with this is the assessment of the suitability of current structural design approaches to provide competent designs, particularly regarding the fatigue behavior of pervious concrete. Finally, a third area is in the testing and evaluation of pervious concrete, as current test methods for conventional concrete are not generally applicable to pervious concrete.

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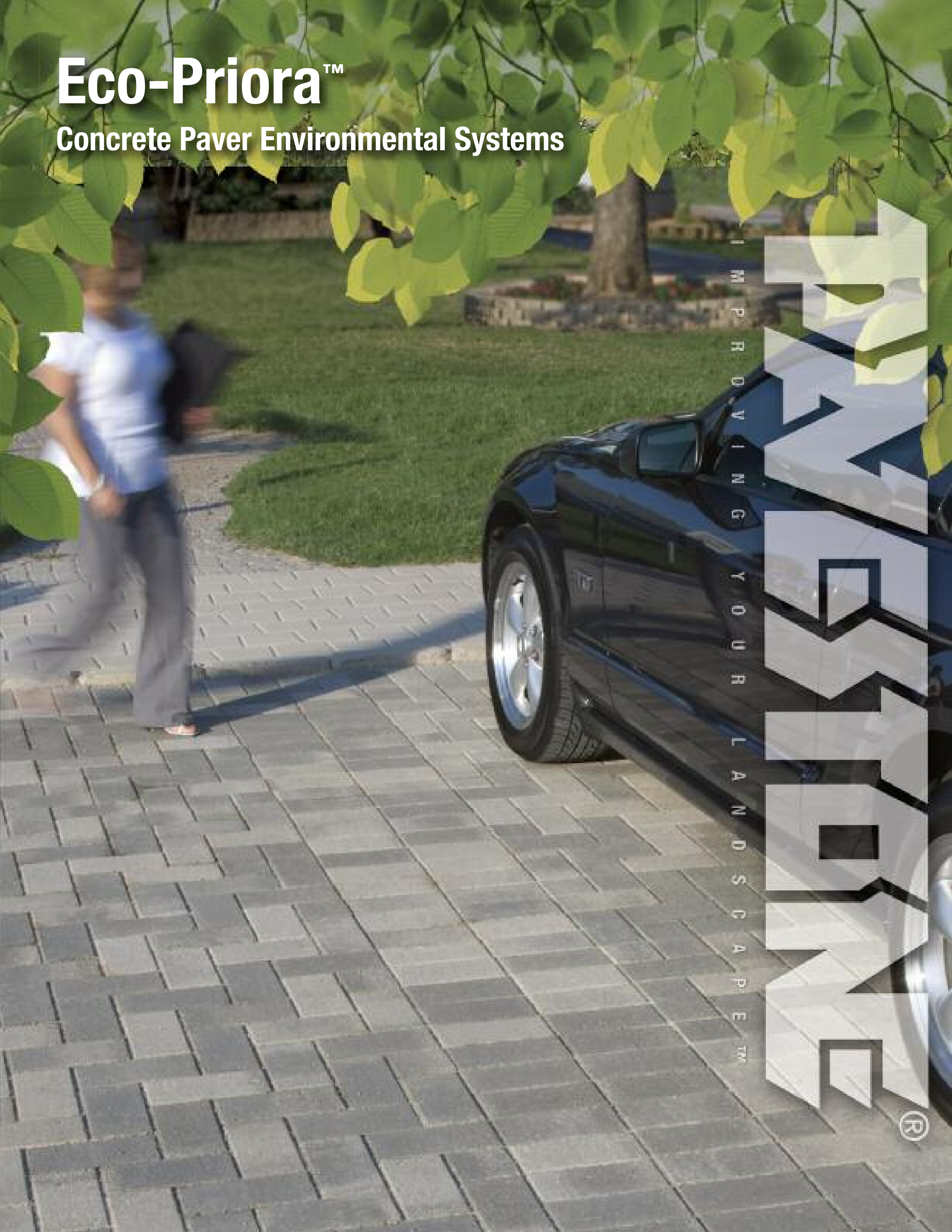
Key Words—concrete pavement construction, design, drainage, LEED® credit, maintenance, pavement design, pavement construction, permeability, pervious concrete, porous concrete, stormwater, sustainability

Eco-Priora™

Concrete Paver Environmental Systems



Eco-Priora™

Pavestone Eco-Priora™ is the sustainable solution for permeable pavements. Eco-Priora™ is produced in a 120mm x 240mm rectangular module that is 80mm in thickness with a patented interlocking joint and a micro-chamfered top edge profile. This ingenuity is singular to the Pavestone Eco-Priora™ product and insures optimum pavement performance unequaled in the permeable paver industry. The unique Eco-Priora™ joint profile allows surface water to infiltrate into the pavement and its sub-layers. With initial permeability average flow rates of over 100 inches per hour, the Eco-Priora™ product, even with a clogging factor, will still meet the majority of current storm water management plans (SWMP). The structural interlocking capability is achieved by the paving unit having interlocking joints with a minimum of two vertically aligned horizontal interlocking spacer bars on each of its sides. These spacer bars interlock throughout the depth of the block and nest adjacently with neighboring paving units. This interlocking function resists lateral and vertical displacement when the unit is exposed to load. The dynamics of pavement stress are better distributed providing a structurally superior permeable paving system.

The micro-chamfered top edge profile produces a horizontal edge to edge dimension that is nominally 7mm including installation gapping. This small joint complies dimensionally with current ADA requirements for walking surfaces with spaces no greater than 1/2 inch. This narrow jointed surface diminishes vibration for wheelchairs and shopping carts when compared to all other permeable paving products. Eco-Priora™ can assist in meeting current EPA storm water regulations and LEED certification. The Eco-Priora™ product best achieves the balance of aesthetic segmental paving and the function of permeable pavement.

APPLICATIONS

Parking Lots • Driveways • Patios • Entrance Areas • Sidewalks
Terraces Garden Pathways • Pool Decks • Pedestrian Malls • Roof Gardens • Streets

COMPOSITION AND MANUFACTURE

Eco-Priora™ is available in one size. Height = 80mm. Eco-Priora™ is made from a "no slump" concrete mix made under extreme pressure and high frequency vibrations. Eco-Priora™ has a compressive strength greater than 8000 psi, a water absorption maximum of 5% and will meet or exceed ASTM C-936. Note: Requires modifying the ASTM C 140 - Paver Annex A4 - "The test specimen shall be 60 ± 3 mm thick and, if necessary, cut to a specimen size having a Height/Thickness (width) [H/T] aspect ratio of 0.6 ± 0.1

INSTALLATION

1. Excavate unsuitable, unstable or unconsolidated subgrade material. Compact the area, which has been cleared as per the engineer's of record (EOR) requirements. Backfill and level with open graded aggregates as per the EOR's structural and hydraulic design.
2. Place bedding course of hard and angular material conforming to the grading requirements of ASTM No. 8 or No. 9 to a uniform minimum depth of 1 1/2" -2". (38mm) screeded to the grade and profile required.
3. Install Eco-Priora™ with joints approximately 1/4". (7mm).
4. Where required, cut pave stones with an approved cutting device to fit accurately, neatly and without damaged edges.
5. Tamp pave stones with a plate compactor, uniformly level, true to grade and free of movement.
6. Spread a thin layer of hard angular material conforming to the grading requirements of ASTM No. 8 or No. 9 aggregate over entire paving area.
7. Make one more pass with plate compactor to nest the aggregate and fill joints to the top.
8. Sweep and remove surplus joint material.

Complete installation & specification details are available by contacting your Pavestone Sales Representative.

Note: ✔ Permeable pavements require both civil and hydraulic engineering. All final pavements design shall be approved by a licensed engineer familiar with local site conditions, building codes and storm water management plans.

PRODUCT INFORMATION

Eco-Priora™ is available in one size. Height = 80mm

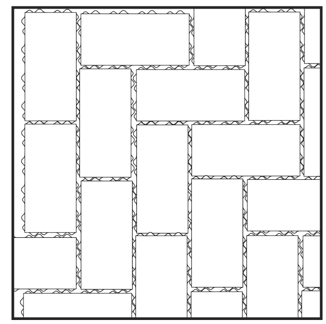
ECO-PRIORA™
(120mm x 240mm)

Eco-Priora™

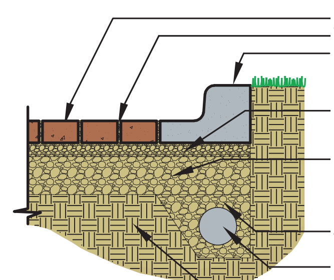
Dimensions: **4 3/4" W x 9 7/16" L x 3 1/8" H**

Wt./Stone:	11.5 lbs.
Stones/Pallet:	280
Approx. Wt./Pallet:	3,255 lbs.
Sq. Ft./Pallet:	88
Product Number:	699

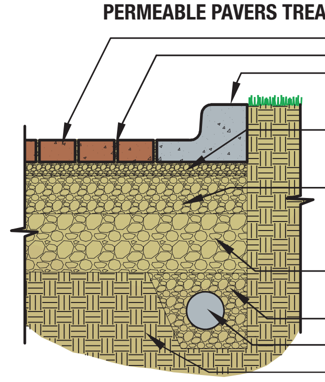
INSTALLATION PATTERN



PERMEABLE PAVERS TREATMENT



PERMEABLE PAVERS TREATMENT AND DETENTION



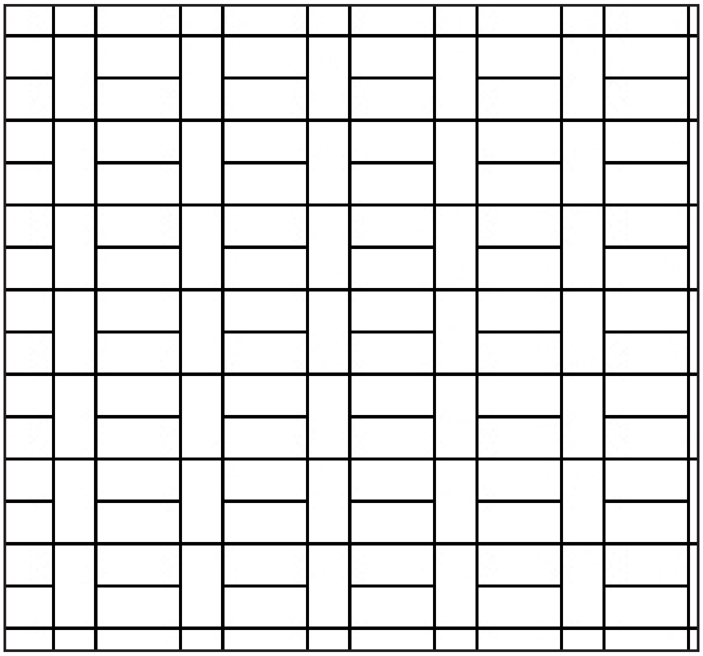
PAVESTONE®
Improving Your Landscape™
www.pavestone.com

• Atlanta, GA:	(770) 306-9691	• Houston, TX:	(281) 391-7283
• Austin/San Antonio, TX:	(512) 558-7283	• Kansas City, MO:	(816) 524-9900
• Boston, MA:	(508) 947-6001	• Las Vegas, NV:	(702) 221-2700
• Cartersville, GA	(770(607-3345	• New Orleans, LA:	(985) 882-9111
• Charlotte, NC:	(704) 588-4747	• Phoenix, AZ:	(602) 257-4588
• Cincinnati, OH:	(513) 474-3783	• St. Louis/ Cape Girardeau, MO:	(573) 332-8312
• Colorado Springs, CO:	(719) 322-0101	• Sacramento/ Winters, CA:	(530) 795-4400
• Dallas/Ft. Worth, TX:	(817) 481-5802		
• Denver, CO:	(303) 287-3700		
• Hagerstown, MD:	(240) 420-3780		

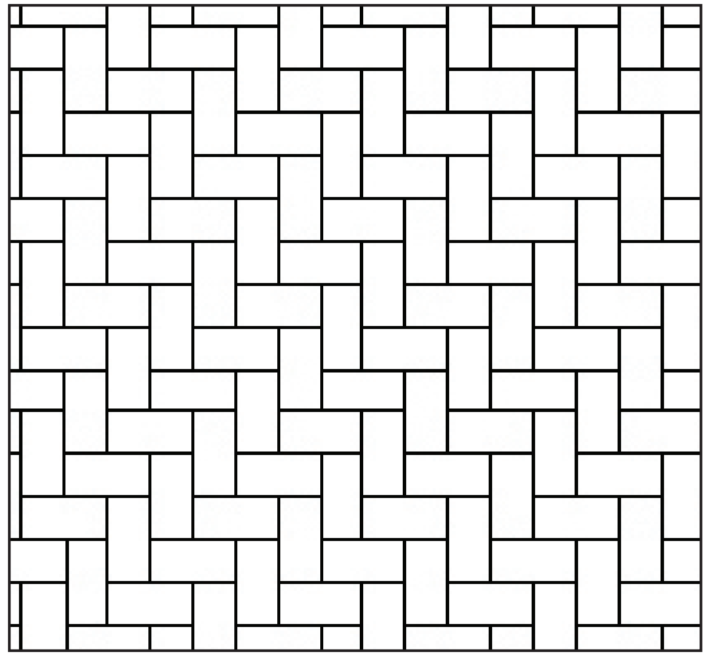
Member of ASLA and NCMA ICPI Charter Member World Wide UNI Pavers

SKU# CDC 266V4 5/10

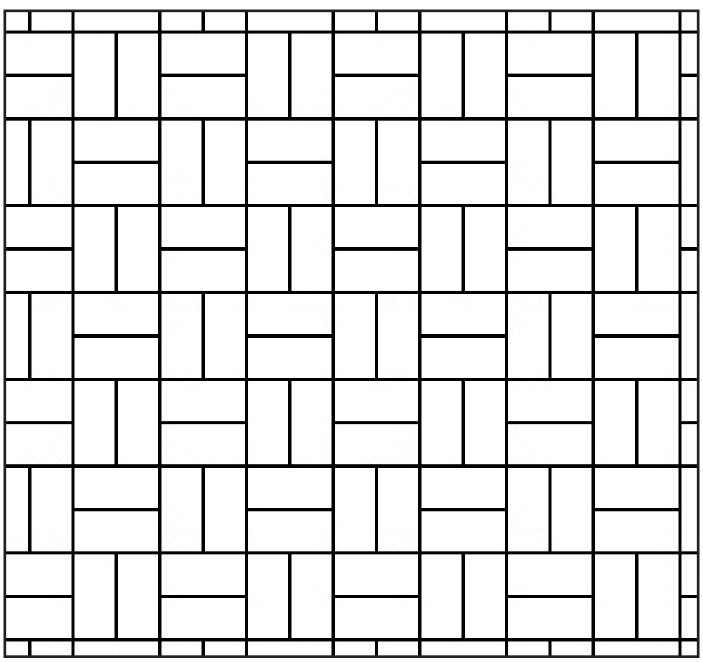
Eco-Priora™ 699 Installation Patterns



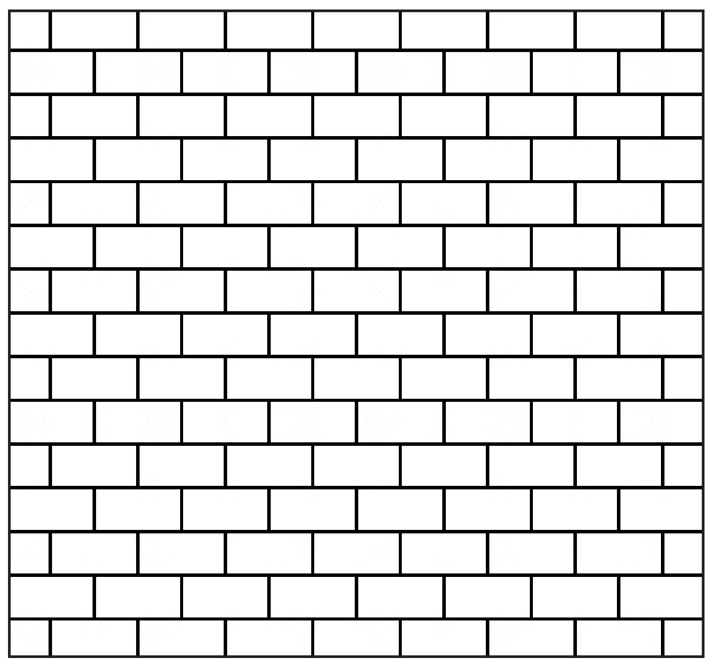
BASKETWEAVE (1)



HERRINGBONE (2)



PARQUET (5)

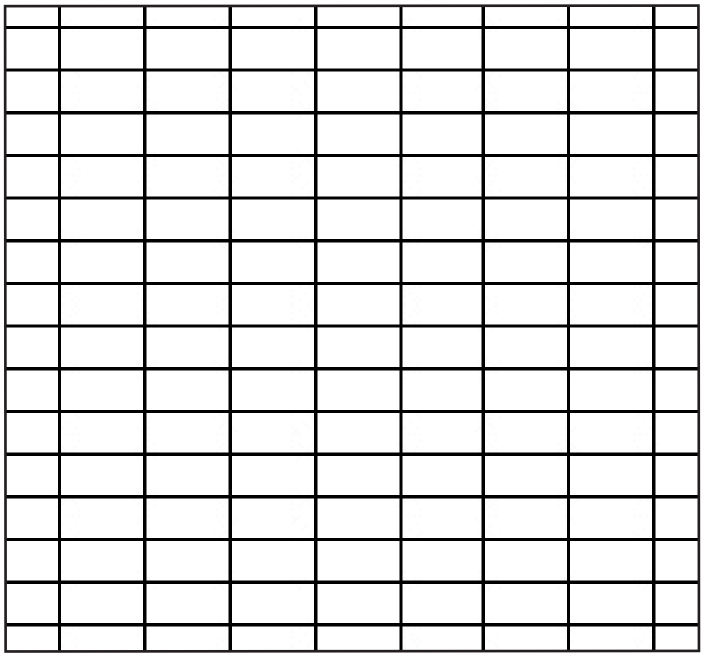


RUNNER BOND (7)

PAVESTONE®

CREATING BEAUTIFUL LANDSCAPES℠

Eco-Priora™ 699 Installation Patterns



STACK (8)

BELGARD®
COMMERCIAL
belgardcommercial.com

AquaLine™ L-stone Multi-Cobble

Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial AquaLine™ paver series, while the innovative design features of L-shape make it the perfect pavement choice for plazas, sidewalks, parking lots, alleys and small roadways. It is available in a variety of nationally offered colors, finishes and surface textures, including Texturgard™ - an ultra-durable wearing course that virtually eliminates the appearance of aging.

ADA COMPLIANT | HEAVY VEHICULAR—100MM | VEHICULAR—80MM | MECHANICAL INSTALLATION

Designed to provide an aesthetically pleasing large format permeable surface that is pedestrian friendly and functional for vehicular traffic. AquaLine combines structural joints and infiltrating voids to optimize system performance. Easier to install due to the additional interlock provided by the L-shape. It is the result of years of research on existing permeable paver products.

Benefits of AquaLine™ L-stone Multi-Cobble

STRENGTH
Manufactured to exceed the minimum standards specified in ASTM C936. Test results from an independent third party are available upon request.

ECOLOGICAL SOLUTIONS
Engineered to infiltrate up to 140 inches per hour which greatly exceeds even the heaviest storms. Where water quality improvements are required, select aggregates can be used in the voids to optimize contaminant removal.

ECONOMICAL
Permeable Pavement Systems serve as both the driving surface and stormwater management system, eliminating the need for traditional infrastructure, allowing more property to be used for revenue generation. Pavers have also been proven to last in excess of 50 years, greatly benefitting life cycle costs.

LOW MAINTENANCE
Maintenance is similar to what is commonly required for other pavement surfaces. If voids become plugged, aggregate and debris can be vacuum extracted and new aggregate material inserted, restoring the original infiltration rate.

AFFORDABILITY
Packaged for mechanical installation, resulting in a cost effective installed price.

COMFORT
ADA compliant walking surface that is high-heel and pedestrian friendly. Causes low-vibration for strollers, bikes, shopping carts and wheelchairs.

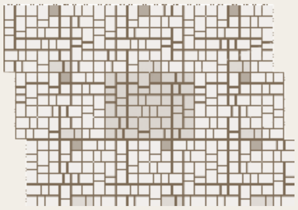
LEED POINTS
Can contribute to credits for stormwater quality and quantity, recycled materials, heat island effect, and innovation in design, among others.

AquaLine™ L-stone Multi-Cobble

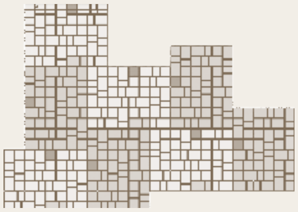
Size: 12” x 12” x 3 1/8” (or 12” x 12” x 4”)
Colors: 9 national colors, local custom colors available upon request
Finishes: Smooth, Shot Blast, Ground Face
Processes: Colorgard, Texturgard
Chamfer: 2mm
Spacers: Dual positive-interlocking integrated bars
Joint/Void: Maximum 8 mm non-structural voids
Appearance: Random 3 size cobble

BELGARD AQUALINE™ L-SHAPE	
Dimensions	12” x 12” x 80mm
sold by	sf
sf/plt	96
lbs/plt	3380
layers/plt	8
lf/plt	96*
units/plt	128
sf/layer	12
sf/unit	0.75
lf/unit	0.75
lbs/unit	26.4

*Linear feet measured when used as 12” soldier course installed in pairs (see front photo).



Stitched Pattern



Non-Stitched Pattern

BELGARD COMMERCIAL

Sierra an Oldcastle Company
10714 Poplar Avenue
Fontana, CA 92337
PH: 909.355.6422
Toll Free: 866.749.3838

For more info visit: www.belgardcommercial.com

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BELGARD®
COMMERCIAL

Eco Dublin™ Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial brand, and our Environmental Collection of permeable pavers is no exception. Belgard permeable pavers combine the best of Belgard with innovative stormwater management for a superior product line that provides sustainable solutions and aesthetically appealing designs.

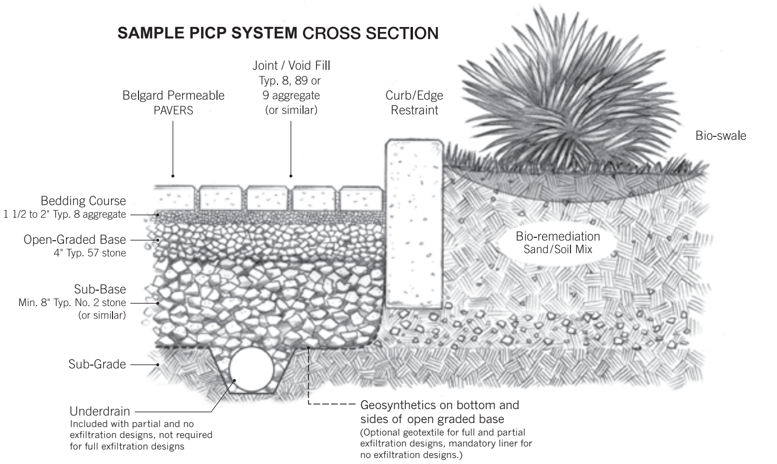
ADA COMPLIANT LT. VEHICULAR—80MM MECHANICAL INSTALLATION

Eco Dublin™

Smart-looking style meets smart science. The classic look of cut stone and contemporary materials technology combine in Eco Dublin™, the latest addition to Belgard's Environmental Series of permeable pavers.

Benefits of Belgard® Permeable Paving Stone Systems

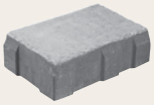
- On the US Environmental Protection Agency's (EPA) menu for structural Low Impact Development (LID) BMPs
- Can contribute toward several LEED NC-2009 points
- Reduces stormwater runoff by up to 100%
- Can be used to achieve total maximum daily load (TMDL) limits for a range of pollutants
- Certified SRI colors reduce heat island effect
- Can reduce or eliminate the need for traditional drainage and detention requirements, saving space and money
- Can be designed to accommodate all native soil types
- 50-year design life based on proven field performance



The availability of specific aggregate will often vary from region to region. In cases where it becomes necessary to substitute a similar size, your project engineer should always be consulted.

3 7/16″ x 6 7/8″ x 3 1/8″
(87.78mm x 174.57mm x 80mm)

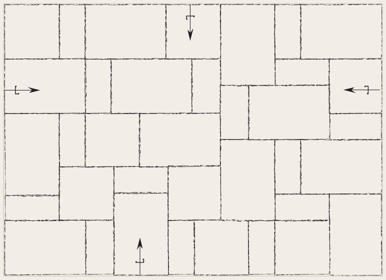
6 7/8″ x 6 7/8″ x 3 1/8″
(174.57mm x 174.57mm x 80mm)



Large Rectangle
6 7/8″ x 10 1/4″ x 3 1/8″
(174.57mm x 261.35mm x 80mm)

Shapes

(All three shapes come in each bundle.)



Mechanical Installation Laying Pattern

Sierra an Oldcastle Company
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BELGARD®
COMMERCIAL

Aqua Roc™
Environmental Collection

Beauty, functionality and quality are hallmarks of the Belgard® Commercial brand, and our Environmental Collection of permeable pavers is no exception. Belgard permeable pavers combine the best of Belgard with innovative stormwater management for a superior product line that provides sustainable solutions and aesthetically appealing designs.

ADA COMPLIANT | VEHICULAR—80MM | LT. VEHICULAR—80MM | MECHANICAL INSTALLATION

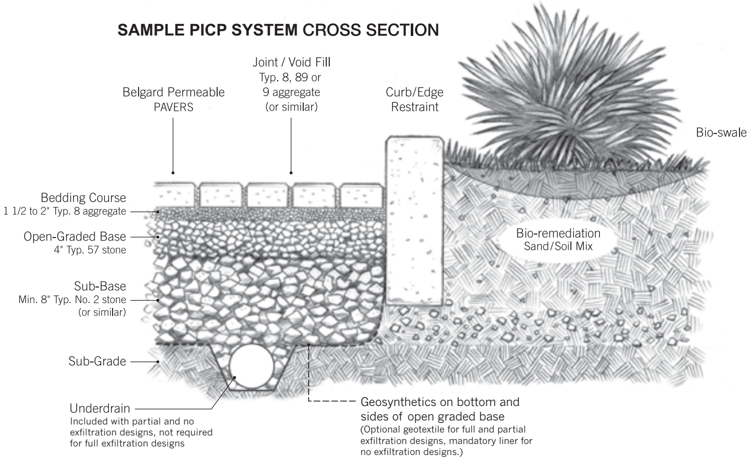
Aqua Roc™

Aqua Roc is a versatile paver featuring not only the environmentally-friendly benefits of a permeable paver, but also high visual appeal, low maintenance, and proven durability. Aqua Roc's versatile pattern range allows for flexible design options, making it an excellent choice for vehicular use.

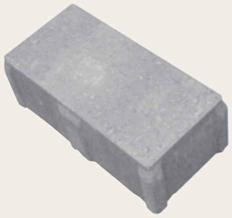
Benefits of Belgard® Permeable Paving Stone Systems

- On the US Environmental Protection Agency's (EPA) menu for structural Low Impact Development (LID) BMPs
- Can contribute toward several LEED NC-2009 points
- Reduces stormwater runoff by up to 100%
- Can be used to achieve total maximum daily load (TMDL) limits for a range of pollutants
- Certified SRI colors reduce heat island effect
- Can reduce or eliminate the need for traditional drainage and detention requirements, saving space and money
- Can be designed to accommodate all native soil types
- 50-year design life based on proven field performance

SAMPLE PICP SYSTEM CROSS SECTION

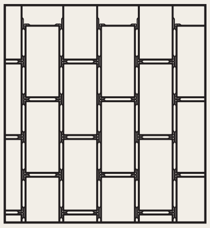


The availability of specific aggregate will often vary from region to region. In cases where it becomes necessary to substitute a similar size, your project engineer should always be consulted.

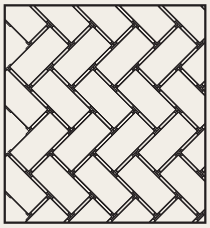


Shape

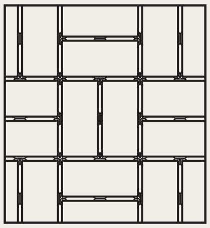
4 1/2" x 9" x 3 1/8"
(114.3mm x 228.6mm x 80mm)



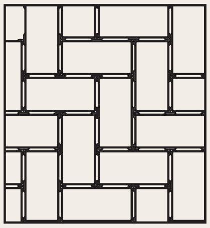
Running Bond



Herringbone 45 Degree



Basket Weave



Herringbone 90 Degree

Laying Patterns

NATIONAL CONCRETE MASONRY ASSOCIATION

ICPI INTERLOCKING CONCRETE PAVEMENT INSTITUTE

BELGARD® COMMERCIAL

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Interlocking Concrete Pavement Institute Certified Installer	City	State
California Outdoor Living	Anaheim	CA
Marina Landscape, Inc.	Anaheim	CA
VERSAI Design and Development, Pavers Division	Beverly Hills	CA
Pacific Coast Pavers	Brea	CA
Peterson Brothers Construction	Brea	CA
AJ's Landscaping	Brentwood	CA
Paver Decor Masonry, Inc.	Calimesa	CA
System Pavers - San Diego	Carlsbad	CA
OLVERA MASONRY INC.	Carpinteria	CA
Landmark Site Contractors	Corona	CA
Stepping Stone Landscape	Coronado	CA
Castlelite Block, LLC	Dixon	CA
Paver Plus, Inc.	Downey	CA
Paving Stone of San Diego, Inc.	El Cajon	CA
Coyote Construction - Pavers	Escondido	CA
Claddagh Paving	Fallbrook	CA
Aloha Pavers, Inc.	Huntington Beach	CA
I.M. Masonry Construction, Inc.	Lancaster	CA
Precision Contractors, Inc.	Lancaster	CA
Earth Shelter Developers	Lodi	CA
Go Pavers	Los Angeles	CA
Stowe Contracting, Inc.	Marina	CA
Stowe General Construction	Modesto	CA
Sierra Madre Landscape	Monrovia	CA
Systems Paving - Dallas	Newport Beach	CA
System Pavers - Novato	Novato	CA
Haney Landscape Inc.	Ojai	CA
System Pavers - Inland Impire	Ontario	CA
Alan Smith Pools	Orange	CA
Farley Interlocking Paving	Palm Desert	CA
Sunshine Landscape	Palm Desert	CA
DMA Construction	Paso Robles	CA
Edsons Pavers, Inc.	Perris	CA
Viking Pavers Inc.	Point Richmond	CA
System Pavers - Sacramento	Rancho Cordova	CA
McEntire Landscaping, Inc.	Redding	CA
INSTALL IT DIRECT	San Diego	CA
Landscapes West	San Diego	CA
Pavers 4 Less	San Diego	CA
Bauman Landscape and Construction	San Francisco	CA
Black Diamond Paver Stone and Landscape, Inc	San Jose	CA
European Paving Designs, Inc.	San Jose	CA
JCMS Landscaping	Santee	CA
Prime Gardens, Inc.	Sherman Oaks	CA
Alford's English Gardens INC	Signal Hill	CA
JFK Pavestone, Inc.	Simi Valley	CA

Tahoe Outdoor Living DBA Tahoe Paving Stones	South Lake Tahoe	CA
Pacific Pavingstone, Inc.	Sun Valley	CA
Weiland & Associates, Inc.	Swall Meadows	CA
System Pavers - Northern California	Union City	CA
System Pavers - Northern California	Union City	CA
Scarlett's Landscape, Inc.	Ventura	CA
System Pavers - Ventura	Ventura	CA
Southwest Specialties of California, Inc.	Walnut	CA
Southwest Specialties of California, Inc.	Walnut	CA

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
Anthonie		Smith		T.B. Penick	San Diego	CA	92128	Pervious Concrete Craftsman	6/3/2016
Bill		Beeson		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Craftsman	2/5/2019
Danny		Stewart		T.B. Penick	San Diego	CA	92128	Pervious Concrete Craftsman	6/3/2016
David		Liguori		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Craftsman	11/14/2019
Dennis	M.	Collins		Enviro-Crete, Inc.	Orangevale	CA	95662	Pervious Concrete Craftsman	10/1/2017
Guy		Collignon		Enviro-Crete, Inc.	Orangevale	CA	95662	Pervious Concrete Craftsman	6/13/2016
Steven	J.	Carrera		S 7 J Carrera Construction, Inc.	Watsonville	CA	95076	Pervious Concrete Craftsman	2/24/2016
Wayne		Jenness		T.B. Penick	San Diego	CA	92120	Pervious Concrete Craftsman	6/3/2016

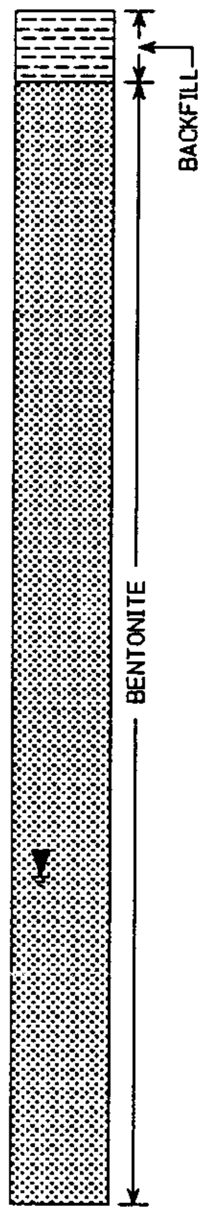
First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
Alejandro		Ruiz Villalobos		Robert A. Bothman	Salinas	CA		Pervious Concrete Installer	10/26/2017
Alexander		Renteria		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Arturo		Rosas		Beeson Masonry	Lake Hughes	CA	93532	Pervious Concrete Installer	8/6/2019
Daniel		Rodriguez Avalos		Robert A. Bothman, Inc.	Salinas	CA		Pervious Concrete Installer	10/26/2017
Edward		Ramirez		GPF Concrete	Perris	CA	92574	Pervious Concrete Installer	1/16/2017
Hector		Vela Villagrana		Robert A. Bothman Inc.	Antioch	CA	94509	Pervious Concrete Installer	10/26/2017
Humberto		Tovalin		T.B. Penick	San Diego	CA	92128	Pervious Concrete Installer	6/3/2016
Isaias		Ruiz		Melo Concrete Construction	Gilroy	CA		Pervious Concrete Installer	10/26/2017
Jaime		Sanitillan		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Jaime		Villegas		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
James		Lamping		T.B. Penick	San Diego	CA	92128	Pervious Concrete Installer	6/3/2016
Joey		Lankford		Beeson Masonry	Lake Hughes	CA	93532	Pervious Concrete Installer	8/6/2019
Jose		Ceron		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Installer	11/8/2015
Juan		Munoz		Galvan's Place and Finish	Perris	CA	92574	Pervious Concrete Installer	1/16/2017
Luis		Castellanos		Robet A. Bothman Inc.	San Jose	CA		Pervious Concrete Installer	10/26/2017
Mario		Ortiz		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Michael		Orosz		Beeson Pervious Concrete	Lake Hughes	CA	93532	Pervious Concrete Installer	2/5/2019
Mike		Beczak		T.B. Penick	San Diego	CA	92128	Pervious Concrete	6/3/2016

First Name	Intial	Last Name	Suffix	Company	City	State	ZIP	Cert Type	Expiration Date
								Installer	
Piedad		Menchara Solorio		Robert A. Bothman Inc.	Salinas	CA	93905	Pervious Concrete Installer	10/26/2017
Ricardo	R.	Galvan		Galvan's Place and Finish	Perris	CA	92571	Pervious Concrete Installer	1/16/2017
Robert		Estrada		Bay Area Pervious Concrete	San Carlos	CA	95040	Pervious Concrete Installer	5/4/2017
Ron		Parietti			Pilot Hill	CA	95664	Pervious Concrete Installer	6/30/2015
Salvador		Rosas		Robert A. Bothman Inc.	San Jose	CA	95116	Pervious Concrete Installer	10/26/2017
Sergio		Grageda		Bay Area Pervious Concrete	San Carlos	CA	94070	Pervious Concrete Installer	11/8/2015
Victor		Santana		Robert A. Bothman Inc.	Salinas	CA	93906	Pervious Concrete Installer	10/26/2017

Appendix F – Soil Report

917550B12A

LOG OF BORING B-12A

BORING / WELL CONSTRUCTION	DEPTH (FEET)	BLOW COUNT	USCS DESIGNATION	SOIL DESCRIPTION	SAMPLE ID	PID / FID
	0			ASPHALT PAVEMENT 4 INCHES THICK.		
	0.3–1.5		SP	SAND, FINE TO MEDIUM GRAINED, TRACE CLAY BINDER, SOME SMALL PEBBLES, SLIGHTLY MOIST, LOOSE TO MEDIUM DENSE, DARK BROWN, NO PRODUCT ODOR.		
	1.5–12		SP	SAND, FINE TO MEDIUM GRAINED, SLIGHTLY MOIST, LOOSE TO MEDIUM DENSE, LIGHT BROWN, NO PRODUCT ODOR		
	5	10, 12, 16			B12-5	0
	10	10, 12, 20			B12-10	0
	12–16.5		SP	SAND, FINE TO MEDIUM GRAINED, WET, DENSE, GRAYISH BROWN, NO PRODUCT ODOR.		
	15	30, 50, 30			B12-15	0
	17					

ANALYSES (mg/Kg) ppm — FIELD: PID / FID; LABORATORY: 8020 BTEX, 8015e, 8015m, 418.1, LEAD

SURFACE ELEVATION: UNKNOWN
TOTAL DRILL DEPTH: 15 ft.
FINAL SAMPLE DEPTH: 1.5 ft.
TOTAL DEPTH: 16.5 ft.
TYPE OF SAMPLER: 3" O.D. MODIFIED PORTER SAMPLER

DATE DRILLED: 12-5-91
LOGGED BY: DEBBIE WILSON
SUPERVISED BY: RICK PILAT
DIAMETER OF BORING: 6 in.
WATER ENCOUNTERED AT: 12 ft.

ALT
ACTIVE LEAK TESTING, INC.
1300 SOUTH BEACON STREET SUITE #120
SAN PEDRO, CA 90731

CLIENT: DAMSON OIL CORP.
1 MARKET STREET
VENICE, CA.

Page 1 of 1 in log
Page 3 of 8 in project

BORING NO. B4
AREA 2 Storage Buildings

9175500B4

SAMPLE NUMBER	PENETRATION BLOW COUNT	SAMPLE	UNIFIED SOIL CLASS	LITHOLOGY	DESCRIPTION	WELL DETAIL-BACKFILL	FEET
							0
B4-2		■	SP		SAND and GRAVEL		
B4-5		■	SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor. Terminated Boring at 5 Feet, Electrical Conduits Encountered.		5
							10
							15
							20
							25

SUPERVISED BY: John Nicolich
LOGGED BY: Dan Louks
DATE STARTED: TIME:
DATE FINISHED: TIME:
DATE DRAWN: 7/8/91

SAMPLE SPOON LENGTH/SLEEVE DIA.:
WATER ENCOUNTERED AT: N/A
TOTAL DEPTH: 5 FEET
GROUND SURFACE ELEVATION:
DIAMETER OF BORING: 4 INCHES
DRILL RIG: Hand Auger

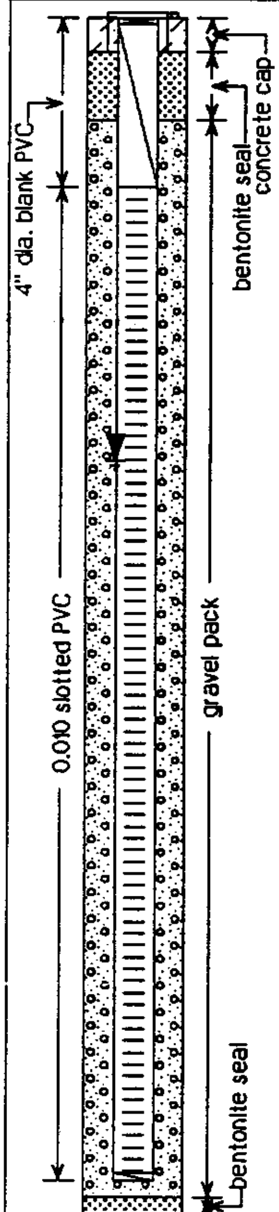
DASH/12-90

DIAGNOSTIC ENGINEERING INC.
50 E. Foothill Boulevard, Arcadia, Ca. 91006

NAME: Damson Oil Corporation
SITE: 40 West Horizon Avenue
CITY, STATE: Venice, California
PROJECT NO.: 1A2908AA001

917550B14A

LOG OF BORING B-14A



Depth (feet)	Blow Count	USCS Designation	Soil Description	Sample ID	PID / FID (Field)	8020 BTEX	8015g	8015m	418.1	8240
0–4		SW	SAND, FINE TO COARSE GRAINED, OCCASIONAL SMALL PEBBLES, SLIGHTLY MOIST, LOOSE TO MEDIUM DENSE, DARK BROWN, NO PRODUCT ODOR.							
4–8	5 8 15	SW	SAND, FINE TO COARSE GRAINED, OCCASIONAL SMALL PEBBLES, SLIGHTLY MOIST, MEDIUM DENSE, BROWN, NO PRODUCT ODOR.	B14-5	0	ND ND ND ND			ND	
8–13	10 16 25	SW	SAND, FINE TO COARSE GRAINED, OCCASIONAL SMALL PEBBLES, SLIGHTLY MOIST, MEDIUM DENSE, LIGHT BROWN, NO PRODUCT ODOR.	B14-10	0	ND NC ND ND			200	
13–17	25 25 30	SW	SAND, FINE TO COARSE GRAINED, OCCASIONAL SMALL PEBBLES, WET, DENSE, LIGHT BROWN, NO PRODUCT ODOR.	B14-15	28	ND ND ND ND			ND	ND
17–29		SW	SAND, FINE TO COARSE GRAINED, WET, DENSE, DARK GRAY, SLIGHT PRODUCT ODOR. UNABLE TO RETAIN SAMPLES BELOW 16.5 FEET.	B14-20	7					
				B14-25	0					
29–35		SW	SAND, FINE TO COARSE GRAINED, WITH NUMEROUS SMALL PEBBLES, WET, DENSE, DARK GRAY, SLIGHT PRODUCT ODOR. GRAB SAMPLE OBTAINED AT APPROXIMATELY 35 FEET.	B14-30	0					
				B14-35	0	ND			200	

ANALYSES (mg/Kg) ppm — FIELD: PID / FID; LABORATORY: 8020 BTEX, 8015g, 8015m, 418.1, 8240

SURFACE ELEVATION: UNKNOWN
TOTAL DRILL DEPTH: 35 ft.
FINAL SAMPLE DEPTH: 35 ft.
TOTAL DEPTH: 35 ft.
TYPE OF SAMPLER: 3" O.D. MODIFIED PORTER SAMPLER

DATE DRILLED: 12-5-91
LOGGED BY: DEBBIE WILSON
SUPERVISED BY: RICK PILAT
DIAMETER OF BORING: 8 in.
WATER ENCOUNTERED AT: 13 ft.

ALT
ACTIVE LEAK TESTING, INC.
1300 SOUTH BEACON STREET SUITE #120
SAN PEDRO, CA 90731

CLIENT: DAMSON OIL CORP.
1 MARKET STREET
VENICE, CA.

BORING NO. B5

AREA 1 Pump Building

Part 1 of 1

9175500B5

SAMPLE NUMBER	PENETRATION BLOW COUNT	SAMPLE	UNIFIED SOIL CLASS	LITHOLOGY	DESCRIPTION	WELL DETAIL-BACKFILL	FEET
							0
					14" Concrete Slab		
B5-2			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		
B5-5			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		5
B5-10			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No odor		10
							15
							20
							25

SUPERVISED BY: John Nicolich
LOGGED BY: Dan Louks
DATE STARTED: TIME:
DATE FINISHED: TIME:
DATE DRAWN: 7/8/91

SAMPLE SPOON LENGTH/SLEEVE DIA.:
WATER ENCOUNTERED AT: N/A
TOTAL DEPTH: 10 FEET
GROUND SURFACE ELEVATION:
DIAMETER OF BORING: 4 INCHES
DRILL RIG: Hand Auger

DASH/12-90

DIAGNOSTIC ENGINEERING INC.
50 E. Foothill Boulevard, Arcadia, Ca. 91006

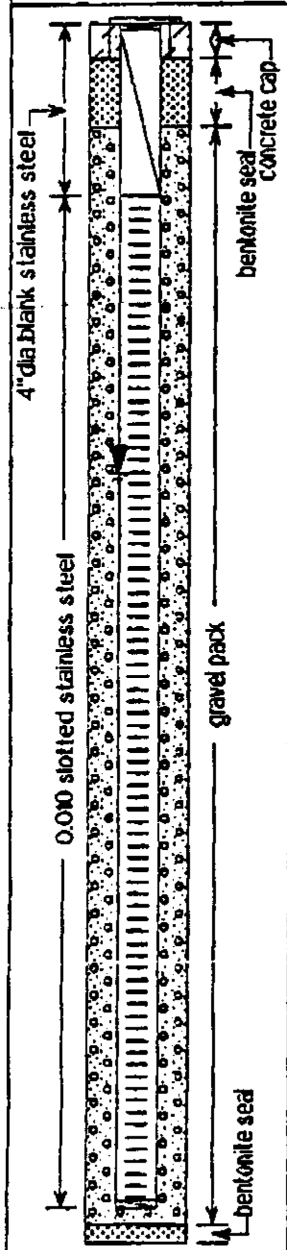
NAME: Damson Oil Corporation
SITE: 40 West Horizon Avenue
CITY, STATE: Venice, California
PROJECT NO.: 1A2908AA001

FEB- 4-92 TUE 9:01

P. 02

917550B17A

LOG OF BORING B-17A



Depth (feet)	Interval	Blow Count	USCS Symbols	USCS Designation	Soil Description	Sample ID	Field: PID / FID	Lab: 8020 BTEX	Lab: 8015g	Lab: 8015m	Lab: 418.1	Lab: 8240
0–3				SP	SAND, FINE TO MEDIUM GRAINED, TRACE CLAY BINDER, SOME SMALL PEBBLES, SLIGHTLY MOIST, MEDIUM DENSE, BROWN, NO PRODUCT ODOR.							
3–13				SP	SAND, FINE TO MEDIUM GRAINED, SLIGHTLY MOIST, MEDIUM DENSE, LIGHT BROWN, NO PRODUCT ODOR.							
5–6.5	■	7 / 11 / 11				B17-5	0	ND ND ND ND			ND	
10–11.5	■	10 / 10 / 20				B17-10	0	ND ND ND ND			ND	
13–16				SP	SAND, FINE TO MEDIUM GRAINED, WET, MEDIUM DENSE, LIGHT BROWN, STRONG PRODUCT ODOR.							
15–16	■	30 / 50				B17-15	0	ND ND			100	

SURFACE ELEVATION: UNKNOWN
TOTAL DRILL DEPTH: 35 ft.
FINAL SAMPLE DEPTH: 35 ft.
TOTAL DEPTH: 35 ft.
TYPE OF SAMPLER: 3" O.D. MODIFIED PORTER SAMPLER

DATE DRILLED: 12-5-91
LOGGED BY: DEBBIE WILSON
SUPERVISED BY: RICK PILAT
DIAMETER OF BORING: 8 in.
WATER ENCOUNTERED AT: ≟ 13 ft.

ALT

ACTIVE LEAK TESTING, INC.
1300 SOUTH BEACON STREET SUITE #120
SAN PEDRO, CA 90731

CLIENT: DAMSON OIL CORP.
1 MARKET STREET
VENICE, CA.

917550B18 A

LOG OF BORING B-18A

BORING / WELL CONSTRUCTION	DEPTH (FEET)	USCS DESIGNATION	SOIL DESCRIPTION
BACKFILL (0–1 ft)	0–1.5	GW	GRAVEL, COARSE TO VERY COARSE WITH SOME SILTY FINE TO COARSE SAND, SOME COBBLES AND DEBRIS, LOOSE, DRY, GRAY, NO PRODUCT ODOR.
BENTONITE (1–10 ft)	1.5–2.5	CL	CLAY, SANDY, FINE TO COARSE GRAINED WITH SOME SILT AND FINE GRAVEL, STIFF, MOIST, BROWN, NO PRODUCT ODOR.
	2.5–10	SP	SAND, MEDIUM GRAINED WITH SOME FINE AND COARSE SAND, MEDIUM DENSE, MOIST, GRAY-BROWN TO TAN, NO PRODUCT ODOR.

Sampling intervals: 2–2.5 ft, 5–5.5 ft, 9.5–10 ft. Blow count: none recorded.

ANALYSES (mg/Kg) ppm

Depth (ft)	SAMPLE ID	FIELD: PID / FID	LAB: 8020 BTEX	LAB: 8015g	LAB: 8015m	LAB: 418.1	LAB: 8240
2	B18-2	0	ND			ND	
2.5			ND				
3			ND				
3.5			ND				
5	B18-5	0	ND			ND	
5.5			ND				
6			ND				
6.5			ND				
10	B18-10	0	ND			ND	

SURFACE ELEVATION: UNKNOWN
TOTAL DRILL DEPTH: 10 ft.
FINAL SAMPLE DEPTH: 10 ft.
TOTAL DEPTH: 10 ft.
TYPE OF SAMPLER: 3" HAND AUGER

DATE DRILLED: 12-5-91
LOGGED BY: LARRY NEUVIRTH
SUPERVISED BY: LARRY NEUVIRTH
DIAMETER OF BORING: 3 in.
WATER ENCOUNTERED AT: ▼ NOT ENCOUNTERED

ALT
ACTIVE LEAK TESTING, INC.
1300 SOUTH BEACON STREET SUITE #120
SAN PEDRO, CA 90731

CLIENT: DAMSON OIL
1 MARKET STREET
VENICE, CA.

SAMPLE NUMBER	PENETRATION BLOW COUNT	SAMPLE	UNIFIED SOIL CLASS	LITHOLOGY	BORING NO. B8 AREA 6 Water Injection Pump — Part 1 of 1 — 917550OB8 — DESCRIPTION	WELL DETAIL-BACKFILL	FEET
							0
B8-2			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		
B8-5			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		5
B8-10			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		10
							15
							20
							25

SUPERVISED BY: John Nicolich
LOGGED BY: Dan Louks
DATE STARTED: TIME:
DATE FINISHED: TIME:
DATE DRAWN: 7/8/91

SAMPLE SPOON LENGTH/SLEEVE DIA.:
WATER ENCOUNTERED AT: N/A
TOTAL DEPTH: 10 FEET
GROUND SURFACE ELEVATION:
DIAMETER OF BORING: 4 INCHES
DRILL RIG: Hand Auger

DASH/12-90

DIAGNOSTIC ENGINEERING INC.
50 E. Foothill Boulevard, Arcadia, Ca. 91006

NAME: Damson Oil Corporation
SITE: 40 West Horizon Avenue
CITY, STATE: Venice, California
PROJECT NO.: 1A2908AA001

LOG OF TEST BORING

LAB NO.:140- 4440 **PROJECT:** SAN JUAN AVE. - MAIN ST. TO CABRILLO AVE. SEWER REPL.

BORING NO.: MW-1 **ELEV.:** 8' **DATE:** 06-27 & 6-28-95

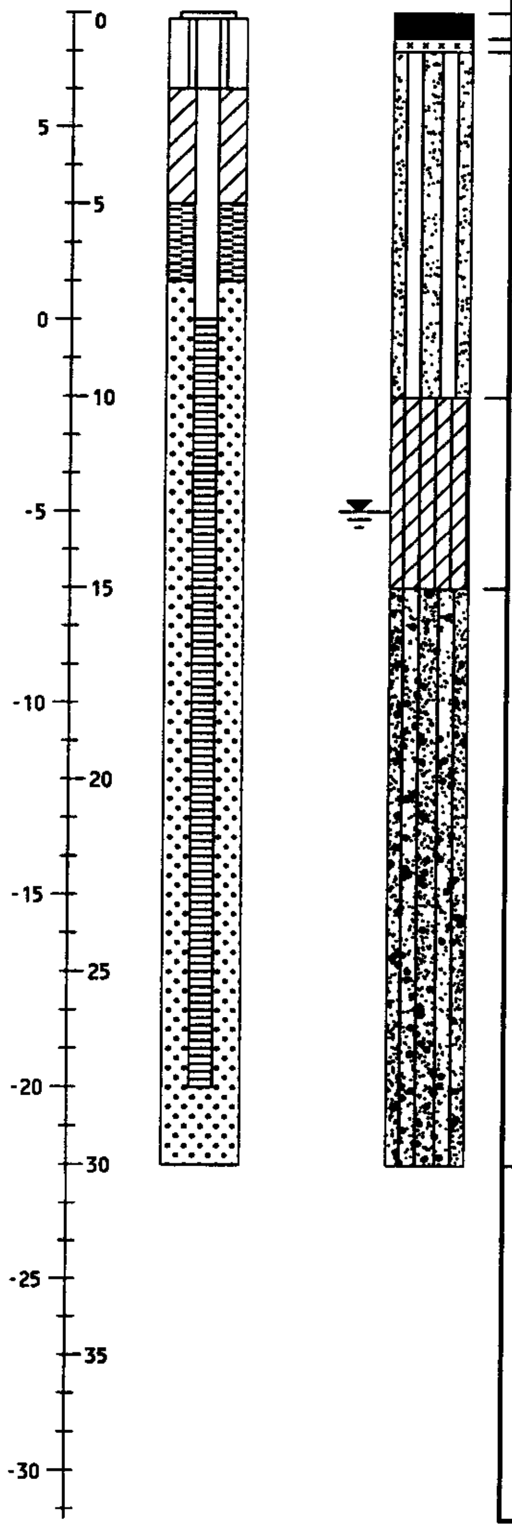
BORING LOCATION: @ C/L Main St. and 55' SE/o C/L Market St. 950280 MW1

DRILL RIG TYPE: CME-75 using 10" diameter hollow stem augers.

DRILLER: Ramirez **LOGGER:** Redlin **ENGINEER:** Haskett

DEPTH TO WATER: 13' **DEPTH TO WATER SEEPAGE:** None

ELEVATION / DEPTH (ft)	WELL DETAILS	SOIL SYMBOLS, SAMPLER SYMBOLS AND BLOWS/INCHES



USCS	Field Description
	8" AC pavement in fair condition.
	4" Crushed Miscellaneous Base material.
SM	Light brown silty sand. Moist and fairly loose. Moisture content is increasing with depth.
CL-ML	Brown silty clay/clayey silt with some sand. Moist and fairly soft. Sand content is increasing with depth. Encountered groundwater at 13' depth, rising to 10' depth.
SW-SM	Light brown well-graded sand with some silt and gravel. Wet and dense.

Encountered groundwater at 13' depth.

Installed 4" diameter monitoring well to 28' depth.

Well Construction

0'-2' depth Concrete Cap (Isolate Well)

2'-5' depth Silty Sand Backfill

5'-7' depth Bentonite Pellet Cap (Isolate Slotted Casing)

7'-30' depth No. 3 Filter Sand (Encasing 20' of Slotted Casing from 8' to 28' depth.)

928580001

BORING B-1

LABORATORY TEST DATA

Depth in Feet	Tests Reported Elsewhere	Atterberg Limits: Liquid Limit (%)	Atterberg Limits: Plasticity Index (%)	Strength Test Data: Type of Test	Strength Test Data: Normal or Confining Pressure (PSF)	Strength Test Data: Shear Strength (PSF)	Strength Test Data: Deviator Stress (PSF)	Moisture Content (%)	Dry Density (PCF)	Blows/Ft.	Sample
0											
	SA							2	99	18	■
5	-200 (2)							18	101	14	■
								13	98	13	■
10								3	106	7	■
15	-200 (56)							25	103	6	■
20								13	120	19	■
25								9	130	31	■
30								9	131	74	■
35								10	121	52	■
40								55	66	23	■
45											

Symbol	Description
	12-inch asphalt pavement and base material
SP	Light brown fine to medium sand (loose) (FILL)
	Grades with fine gravel
SP	Brown fine to medium sand with trace of silt (loose)
	Grades with silt lenses
SM/SP	Gray silty fine sand (loose)
	Grades brown below 20 feet
SM	Brown silty fine to coarse sand with some gravel (medium dense to dense)
	Grades to very dense
CL	Yellowish-brown silty clay (stiff to very stiff)

Boring completed to a depth of 40.5 feet on February 27, 1990
Ground water obseved at a depth of 5.5 feet on February 28, 1990
Backfilled with soil and asphalt placed on top

LOG OF BORING

PROPOSED STUDIO FACILITY
Venice, California
For Mr. Robert Graham

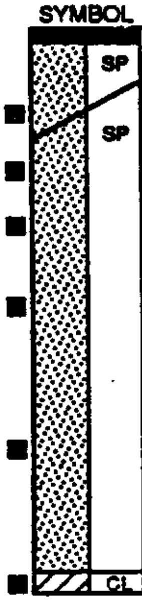
Dames & Moore
PLATE 5

928580002

BORING B-2

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	BLOWS/FT.	SAMPLE
0											
								19		11	■
5								12	106	6	■
	-200 (0.5)							3	99	11	■
10								9	104	9	■
15								24	105	17	■
20				DS/CU	2000 3000 4000	2160 2688 2952		24	105	20	■
25											

SYMBOL



DESCRIPTION

6-inch asphalt pavement

Brown fine to medium sand with some silt (loose) — FILL

Brown fine to medium sand with some silt (very loose to loose)

Grades with less silt and light brown

Grades grayish-brown and with more fines

Brown silty clay (stiff to very stiff)

Boring completed to a depth of 20.5 feet on February 27, 1990

Ground water obseved at a depth of 6.0 feet on February 28, 1990

Backfilled with soil and asphalt placed on top

LOG OF BORING

PROPOSED STUDIO FACILITY

Venice, California

For Mr. Robert Graham

Dames & Moore

PLATE 6

SAMPLE NUMBER	PENETRATION BLOW COUNT	SAMPLE	UNIFIED SOIL CLASS	LITHOLOGY	**BORING NO. B6** Part 1 of 1 **AREA 4** Production Pumps 917550OB6 DESCRIPTION	WELL DETAIL-BACKFILL	FEET
					12" Concrete Slab		0
B6-3			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor. Auger Refusal at 3 Feet, Large Rock or Asphalt Block.		
							5
							10
							15
							20
							25

SUPERVISED BY: John Nicolich
LOGGED BY: Dan Louks
DATE STARTED: TIME:
DATE FINISHED: TIME:
DATE DRAWN: 7/8/91

SAMPLE SPOON LENGTH/SLEEVE DIA.:
WATER ENCOUNTERED AT: N/A
TOTAL DEPTH: 3 FEET
GROUND SURFACE ELEVATION:
DIAMETER OF BORING: 4 INCHES
DRILL RIG: Hand Auger

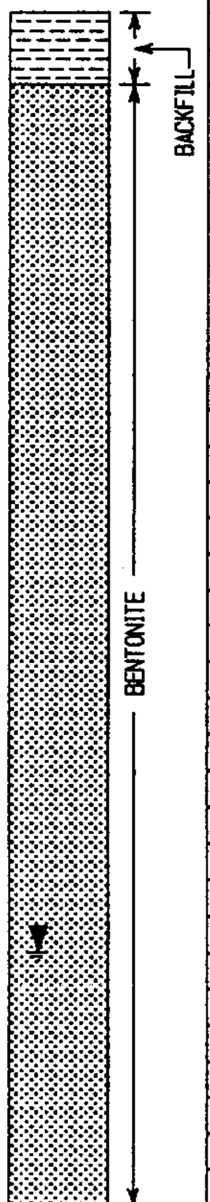
DASH/12-90

DIAGNOSTIC ENGINEERING INC.
50 E. Foothill Boulevard, Arcadia, Ca. 91006

NAME: Damson Oil Corporation
SITE: 40 West Horizon Avenue
CITY, STATE: Venice, California
PROJECT NO.: 1A2908AA001

LOG OF BORING B-15A

BORING / WELL CONSTRUCTION



DEPTH (FEET)	INTERVAL	BLOW COUNT	USCS DESIGNATION	SOIL DESCRIPTION	SAMPLE ID	FIELD PID / FID	LABORATORY 8020 BTEX	8015g	8015m	418.1	8240
0–3			SP	SAND, FINE TO MEDIUM GRAINED, TRACE CLAY BINDER, SOME SMALL PEBBLES, SLIGHTLY MOIST, MEDIUM DENSE, DARK BROWN, NO PRODUCT ODOR.							
3–9			SP	SAND, FINE TO MEDIUM GRAINED, SLIGHTLY MOIST, MEDIUM DENSE, DARK BROWN, NO PRODUCT ODOR.							
5–6.5	5–6.5	20 26 30			B15-5	0	ND ND ND ND			250	
9–16.5			SP	SAND, FINE TO MEDIUM GRAINED, WET, MEDIUM DENSE, LIGHT BROWN, NO PRODUCT ODOR.							
10–11.5	10–11.5	18 23 25			B15-10	0	ND ND ND ND			2300	
15–16.5	15–16.5	19 22 23			B15-15	0				ND	ND

ANALYSES (mg/Kg) ppm

SURFACE ELEVATION: UNKNOWN
TOTAL DRILL DEPTH: 15 ft.
FINAL SAMPLE DEPTH: 1.5 ft.
TOTAL DEPTH: 16.5 ft.
TYPE OF SAMPLER: 3" O.D. MODIFIED PORTER SAMPLER

DATE DRILLED: 12-5-91
LOGGED BY: DEBBIE WILSON
SUPERVISED BY: RICK PILAT
DIAMETER OF BORING: 8 in.
WATER ENCOUNTERED AT: ±13 ft.

ACTIVE LEAK TESTING, INC.
1300 SOUTH BEACON STREET SUITE #120
SAN PEDRO, CA 90731

CLIENT: DAMSON OIL CORP.
1 MARKET STREET
VENICE, CA.

SAMPLE NUMBER	PENETRATION BLOW COUNT	SAMPLE	UNIFIED SOIL CLASS	LITHOLOGY	BORING NO. B2 — AREA 7 Open Storage Area — Part 1 of 1 — 917550OB2 — DESCRIPTION	WELL DETAIL-BACKFILL	FEET
B2-4			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor. Auger Refusal at 4 Feet - Large Rock		0–4

FEET: 0, 5, 10, 15, 20, 25

SUPERVISED BY: John Nicolich
LOGGED BY: Dan Louks
DATE STARTED: TIME:
DATE FINISHED: TIME:
DATE DRAWN: 7/8/91

SAMPLE SPOON LENGTH/SLEEVE DIA.:
WATER ENCOUNTERED AT: N/A
TOTAL DEPTH: 4 FEET
GROUND SURFACE ELEVATION:
DIAMETER OF BORING: 4 INCHES
DRILL RIG: Hand Auger

DASH/12-90

DIAGNOSTIC ENGINEERING INC.
50 E. Foothill Boulevard, Arcadia, Ca. 91006

NAME: Damson Oil Corporation
SITE: 40 West Horizon Avenue
CITY, STATE: Venice, California
PROJECT NO.: 1A2908AA001

BORING NO. B3
AREA 3 LACT Unit

9175500B3

SAMPLE NUMBER	PENETRATION BLOW COUNT	SAMPLE	UNIFIED SOIL CLASS	LITHOLOGY	DESCRIPTION	WELL DETAIL-BACKFILL	FEET
							0
B3-5			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		5
B3-10			SP		SAND, Light Brown, Loosely Consolidated, Well Sorted, Medium Grained, No Odor		10
							15
							20
							25

SUPERVISED BY: John Nicolich
LOGGED BY: Dan Louks
DATE STARTED: TIME:
DATE FINISHED: TIME:
DATE DRAWN: 7/8/91

SAMPLE SPOON LENGTH/SLEEVE DIA.:
WATER ENCOUNTERED AT: N/A
TOTAL DEPTH: 10 FEET
GROUND SURFACE ELEVATION:
DIAMETER OF BORING: 4 INCHES
DRILL RIG: Hand Auger

DASH/12-90

DIAGNOSTIC ENGINEERING INC.
50 E. Foothill Boulevard, Arcadia, Ca. 91006

NAME: Damson Oil Corporation
SITE: 40 West Horizon Avenue
CITY, STATE: Venice, California
PROJECT NO.: 1A2908AA001

911550B11A

LOG OF BORING B-11A

Depth (feet)	Interval	Blow Count	USCS Designation	Soil Description	Sample ID	Field: PID / FID	Laboratory: 8020 BTEX	8015g	8015m	418.1	LEAD
0				ASPHALT PAVEMENT 4 INCHES THICK.							
0.5–3			SP	SAND, FINE TO MEDIUM GRAINED, TRACE CLAY BINDER, SOME SMALL PEBBLES, SLIGHTLY MOIST, LOOSE TO MEDIUM DENSE, DARK BROWN, NO PRODUCT ODOR.							
3–9			SP	SAND, FINE TO MEDIUM GRAINED, SLIGHTLY MOIST, MEDIUM DENSE, LIGHT BROWN, NO PRODUCT ODOR.							
5	5–6.5	10 11 13			B11-5	0	ND ND ND ND			ND	
9–13			SP	SAND, FINE TO MEDIUM GRAINED, SLIGHTLY MOIST, MEDIUM DENSE, BLACK, STRONG PRODUCT ODOR.							
10	10–11.5	13 16 25			B11-10	5000	ND ND 4.10 23.0			ND	
13–16.5			SP	SAND, FINE TO MEDIUM GRAINED, SLIGHTLY MOIST, MEDIUM DENSE, DARK BROWN TO BLACK, STRONG PRODUCT ODOR.							
15	15–16.5	15 30 30			B11-15	1	ND ND ND ND			250	

ANALYSES (mg/Kg) ppm

BORING / WELL CONSTRUCTION: BACKFILL (0–1 ft); BENTONITE (1–16.5 ft)

SURFACE ELEVATION: UNKNOWN
TOTAL DRILL DEPTH: 15 ft.
FINAL SAMPLE DEPTH: 1.5 ft.
TOTAL DEPTH: 16.5 ft.
TYPE OF SAMPLER: 3" O.D. MODIFIED PORTER SAMPLER

DATE DRILLED: 12-5-91
LOGGED BY: DEBBIE WILSON
SUPERVISED BY: RICK PILAT
DIAMETER OF BORING: 8 in.
WATER ENCOUNTERED AT: 13 ft.

ALT
ACTIVE LEAK TESTING, INC.
1300 SOUTH BEACON STREET SUITE #120
SAN PEDRO, CA 90731

CLIENT: DAMSON OIL CORP.
1 MARKET STREET
VENICE, CA.