APPENDIX 15

Preliminary Low Impact Development Plan (LID)
The Comstock

12826 Philadelphia Street
Whittier, California 90601

Prepared: June 13, 2022
Revised: June 21, 2022

Prepared for
MW Investment Group, LLC
27702 Crown Valley Parkway, Suite D-4-197
Ladera Ranch, California 92694

Prepared by

KHR ASSOCIATES
Consulting Engineers - Surveyors - Planners
17530 Von Karman Avenue - Suite 200
Irvine, California 92614
Telephone: 949-756-6440

PREPARER (ENGINEER) CERTIFICATION

Engineer's Name	James H. Kawamura		
Engineer's Title	President/CEO		
Company	KHR Associates		
Address	17530 Von Karman Avenue, Suite 200, Irvine, CA 92614		
Email	jkawamura@khrdesign.com		
Telephone Number	(949) 756-6440		
I hereby certify that this Low Impact Development Plan is in compliance with, and meets the requirements set forth in, Order No. R4-2012-0175, of the Los Angeles Regional Water Quality Control Board.			
Engineer's Signature	James H. Kawamura	Date	June 21, 2022
Place Stamp Here	REGISTERED PROFESSIONAL ENGINEER JAMES H. KAWAMURA No. C30560 Expiration: 03/31/24 CIVIL STATE OF CALIFORNIA		

PROJECT OWNER'S CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my jurisdiction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for the gathered information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Owner's Name	Matt Waken		
Owner's Title			
Company	MW Investment Group, LLC		
Address	27702 Crown Valley Parkway, Suite D-4-197, Ladera Ranch, CA 92694		
Email	matt@walbern.com		
Telephone Number	(626) 710-6377		
Owner's Signature		Date	

Table of Contents

Section 1 Project Type and Regulations

Zone: UWSP (Uptown Whittier Specific Plan), U-CT (Uptown Center)

Project Area: 0.82 acres (35,915 square feet)

Priority Project Category: Designated Project (Redevelopment Project where 50 percent or more of the impervious surface of a previously developed site is proposed to be altered and the previous development project was not subject to post-construction stormwater quality control measures, and which are developments that result in creation or addition of 5,000 square feet or more of impervious surface on a site that was previously developed as described in Section 2-1 of County of Los Angeles Department of Public Works of Low Impact Development Standards Manual dated February 2014.)

Legal Description: THE LAND REFERRED TO HEREIN BELOW IS SITUATED IN THE CITY OF WHITTIER, COUNTY OF LOS ANGELES, STATE OF CALIFORNIA, AND IS DESCRIBED AS FOLLOWS:

PARCEL 1:
LOTS 7, 8, 9 AND 10 OF NICHOL'S SUBDIVISION, IN THE CITY OF WHITTIER, AS PER MAP RECORDED IN BOOK 31 PAGE 81 OF MISCELLANEOUS RECORDS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

EXCEPT THEREFROM THE INTEREST CONVEYED TO THE CITY OF WHITTIER OVER THE EAST 20 FEET OF LOT 7, BY DEED RECORDED IN BOOK 3404 PAGE 367, OFFICIAL RECORDS.

PARCEL 2:
LOTS 11 AND 12 OF NICHOLS SUBDIVISION, IN THE CITY OF WHITTIER, AS PER MAP RECORDED IN BOOK 31 PAGE 81 OF MISCELLANEOUS RECORDS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

PARCEL 3:
LOT 3 IN BLOCK 22, IN THE CITY OF WHITTIER, AS PER MAP RECORDED IN BOOK 21 PAGES 55 AND 56 OF MISCELLANEOUS RECORDS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

EXCEPT THE EAST 20 FEET THEREOF, AS DEEDED TO THE CITY OF WHITTIER FOR STREET PURPOSES BY DEED RECORDED IN BOOK 4050 PAGE 187 OFFICIAL RECORDS.

PARCEL 4:
THE NORTH 15 FEET OF LOT 4 IN BLOCK 22 OF TOWNSITE OF WHITTIER, IN THE CITY OF WHITTIER, AS PER MAP RECORDED IN BOOK 21 PAGES 55 AND 56 OF MISCELLANEOUS RECORDS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

EXCEPT THE 20 FEET THEREOF, AS DEEDED TO THE CITY OF WHITTIER FOR STREET PURPOSES BY DEED RECORDED IN BOOK 3150 PAGE 399 OFFICIAL RECORDS.

PARCEL 5:
THE SOUTHERLY 35 FEET OF LOT 4 AND ALL OF LOT 5 IN BLOCK 22 OF WHITTIER, IN THE CITY OF WHITTIER, AS PER MAP RECORDED IN BOOK 21 PAGES 55 AND 56 OF MISCELLANEOUS RECORDS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

EXCEPT THE 20 FEET THEREOF, AS DEEDED TO THE CITY OF WHITTIER FOR STREET PURPOSES BY DEED RECORDED IN BOOK 3150 PAGE 399 OFFICIAL RECORDS.

PARCEL 6:
LOT 6 IN BLOCK 22 OF WHITTIER, IN THE CITY OF WHITTIER, AS PER MAP RECORDED IN BOOK 21 PAGES 55 AND 56.

EXCEPT THE EASTERLY 20 FEET THEREOF CONVEYED TO THE CITY OF WHITTIER FOR STREET PURPOSES.

Assessor's Number: APN 8139-024-027

Rain Season: October 1st through April 15th

Watershed: San Gabriel River Watershed

Regulations: National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit (CAS004001, Order No. R4-2012-0175); Los Angeles County Code Title 12, Chapter 84; City of Whittier Municipal Code Chapter 8.36

Regulatory Agents: City of Whittier Director of Public Works, his/her authorized deputy, agent, representative or inspector (including other county departments); County of Los Angeles Department of Public Works; U.S. Environmental Protection Agency; State Water Resources Control Board; and Los Angeles Regional Water Quality Control Board

Section 2 Property Description

All portions of the project site are owned by **MW Investment Group, LLC**. No on-site infrastructures will be transferred to any public agency. The owner is aware of the maintenance responsibilities of the proposed BMPs. A funding mechanism is in place to maintain the BMPs at the frequency stated in the LID Report.

Owner Entity: **MW Investment Group, LLC**
Owner Representative: **Matt Waken**
Address: **27702 Crown Valley Parkway, Suite D-4-197, Ladera Ranch, CA 92694**
Phone Number: **(626) 710-6377**
E-mail: matt@walbern.com

2.1 Existing Conditions

The proposed project is located at 12826 Philadelphia Street, in the City of Whittier, California. The 0.82 acre site is currently occupied by a one-story building (7,197 square feet), surface parking, and landscaping. The site has approximately 34,061 square feet of impervious surfaces and 1,854 square feet of pervious surfaces. The project site is bounded by Philadelphia Street to the north, Comstock Avenue to the east, and commercial uses to the south and west.

2.2 Proposed Conditions

The proposed *The Comstock* multi-family residential development project entails the construction of 52 residential dwelling units on a 0.82 acre (35,915 square feet) site. Proposed site conditions consist of 33,465 square feet (0.77 acres) of impervious area (93%) and 2,450 square feet (0.05 acres) of pervious area (7%). The project will also include miscellaneous improvements including sidewalks, curb, gutter, utilities, storm drains, landscaping, and irrigation.

The site is broken up into 2 Drainage Management Areas (DMAs) that each drain to a biofiltration planter for treatment of the stormwater quality design volume. DMA 1 is approximately 32,804 square feet of the property and consists of the parking lot, walks, landscaping, and a majority of the building that will be treated by 1,506 square feet of biofiltration planter. This biofiltration planter receives runoff through surface flows directed into the planter by curb cuts. The overflow and underdrain of the biofiltration planter directs the stormwater to a detention tank with a pump system for discharge into the MS4 within Philadelphia Street. DMA 2 is approximately 3,111 square feet of building area that drains by roof drains into a 158 square foot biofiltration planter located on the 4th level of the building. The proposed project will also include new curb, gutter, and utilities. No on-site infrastructure will be transferred to any public agencies. The project is not within any known Significant Ecological Areas (SEA).

2.3 Feasibility of Infiltration

According to information taken from the Preliminary Geotechnical Evaluation and Recommendations by LGC Geotechnical, Inc., dated May 17, 2021, the site is not conducive for infiltration due to low infiltration rate results of the on-site soils. The site contains undocumented

artificial fill soils up to a depth of approximately 5 feet below existing grade, underlain by native alluvial soils consisting of primarily silt with varying amounts of sand and clay. Groundwater was not encountered to the maximum depth of approximately 46.5 feet below existing grade. The historic high groundwater is approximately 100 feet below existing grade. Biofiltration planters sized to handle 1.5 times the Design Control Volume (DCV) will be used as the LID treatment method. See **Appendix 6** for the soils report.

Section 3 Hydrologic Setting

3.1 Watershed (Receiving Water)

The project site is located within the San Gabriel River Watershed. The receiving waters directly affected by the proposed project include Coyote Creek North Fork, Coyote Creek, San Gabriel River Reach 1, San Gabriel River Estuary, and San Pedro Bay.

The Clean Water Act Section 303(d) lists the Coyote Creek North Fork as impaired for Indicator Bacteria and Selenium. Coyote Creek is impaired for Dissolved Copper, Indicator Bacteria, Iron, Malathion, pH, and Toxicity. San Gabriel River Reach 1 is impaired for pH and Water Temperature. San Gabriel River Estuary is impaired for Copper, Dioxin, Indicator Bacteria, Nickel, and Dissolved Oxygen. San Pedro Bay is impaired for Chlordane, PCBs, Total DDT (sum of 4,4'- and 2,4'- isomers of DDT, DDE, and DDD), and Toxicity.

The purpose of the practices and devices mentioned within this report is to minimize/eliminate discharge into the municipal separate storm sewer system (MS4) of any above mentioned impairments as well as other site generated pollutants.

3.2 Drainage

The drainage area for the proposed project will meet the requirements as conditioned by the City of Whittier and the County of Los Angeles. On-site runoff will be collected and 1.5 times the first flush (85^{th} percentile (1 inch in Whittier) or ¾ of an inch, whichever is greater during a single rain event) volume will be treated through Biofiltration Planters. Best Management Practices (BMPs) were used to assure that the stormwater leaving the project site is clean at levels acceptable to the state and local jurisdictions. This project site utilizes volume based BMPs sized accordingly to the recommendations of the governing jurisdictions. Following is a LID Summary table of the treatment calculations. See **Appendix 5** for the calculations.

LID SUMMARY

DMA DESIGNATION	BF-1 BMP ID	DMA (SF)	SWQDV (CF)	1.5 X SWQDV (CF)	BF-1 DEPTH SURFACE PONDING (IN)	BF-1 REQUIRED FOOTPRINT (SF)	BF-1 PROVIDED FOOTPRINT (SF)	BF-1 PROVIDED VOLUME (CF)
1	(A)	32,804	2,291	3,437	15	1,462	1,506	3,539
2	(B)	3,111	217	326	12	155	158	332
TOTAL		35,915	2,508	3,763	–	1,617	1,664	3,871

Section 4 Best Management Practices (BMPs)

Best Management Practices (BMPs) describe how the project complies with each post construction water quality management practices. Locations of BMPs are shown on plot plan in Appendix 2.

Pollutant of Concern Summary Table for Multi-Family

Pollutants of Concern	
Suspended Solids	X
Total Phosphorus	
Total Nitrogen	
Total Kjeldahl Nitrogen	
Cadmium, Total	*
Chromium, Total	*
Copper, Total	X
Lead, Total	
Zinc, Total	X

*No available data to determine if these pollutants of concern originate from this land use. Pollutant is assumed to be produced by this land use unless otherwise proven by the project applicant.

4.1 Project Site Anticipated and Potential Pollutants

Stormwater/urban runoff pollutants associated with the project are as follows: Pollutants such as heavy metals, organic compounds, oil and grease, as well as trash and debris, are anticipated due to vehicles and people. On-site landscaped areas have the potential for nutrients, pesticides, sediments, and oxygen demanding substances while pavement has the potential of bacteria to pollute the sites runoff.

The chart above shows what site generating pollutants are of greatest concern by aligning the probable pollutants created by the site's use to that of which the watershed is already in exceedance of. Any pollutant, whether expected or potential, that the site generates which is 303(d) listed for the receiving water is referred to as a pollutant of concern. Pollutants of concern shall be effectively minimized if not eliminated prior to discharge into a MS4.

4.1.1 Description of Water Pollutants

Bacteria and Viruses – Bacteria and Viruses are ubiquitous microorganisms that thrive under certain environmental conditions. Their proliferation is typically caused by the transport of animal or human fecal wastes from the watershed. Water, containing excessive bacteria and viruses, can alter the aquatic habitat and create a harmful environment for humans and aquatic life. In addition, the decomposition of excess organic waste causes increased growth of undesirable organisms in the water.

Nutrients – Nutrients are inorganic substances, such as nitrogen and phosphorus. Excessive discharge of nutrients to water bodies and streams causes eutrophication, where aquatic plants and algae growth can lead to excessive decay of organic matter in the water body, loss of oxygen in the water, release of toxins in sediment, and the eventual death of aquatic organisms. Primary sources of nutrients in urban runoff are fertilizers and eroded soils.

Metals – Metals are raw material components in non-metal products such as fuels, paints, and other coatings. Primary source of metal pollution in stormwater are typically commercially available metals and metal products. Metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and cooling tower systems. At low concentrations naturally occurring in soil, metals are non-toxic. However, at higher concentrations, certain metals can be toxic to aquatic life. Humans can be impacted from contaminated groundwater resources, and bioaccumulation of metals in fish and shellfish. Environmental concerns, regarding the potential for release of metals to the environment, have already led to restricted metal usage in certain applications.

Pesticides – Pesticides (including herbicides) are chemical compounds commonly used to control nuisance growth or prevalence of organisms. Relatively low levels of the active component of pesticides can result in conditions of aquatic toxicity. Excessive or improper application of a pesticide may result in runoff containing toxic levels of its active ingredient.

Organic Compounds – Organic compounds are carbon-based. Commercially available or naturally occurring organic compounds are found in pesticides, solvents, and hydrocarbons. Organic compounds can, at certain concentrations, indirectly or directly constitute a hazard to life or health. When rinsing off objects, toxic levels of solvents and cleaning compounds can be discharged to storm drains. Dirt, grease, and grime retained in the cleaning fluid or rinse water may also adsorb levels of organic compounds that are harmful or hazardous to aquatic life.

Sediments – Sediments are soils or other surficial materials eroded and then transported or deposited by the action of wind, water, ice, or gravity. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, lower young aquatic organisms survival rates, smother bottom dwelling organisms, and suppress aquatic vegetation growth.

Trash and Debris – Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste products on the landscape. The presence of trash and debris may have a significant impact on the recreational value of a water body and aquatic habitat. Trash impacts water quality by increasing biochemical oxygen demand.

Oxygen-Demanding Substances – This category includes biodegradable organic material as well as chemicals that react with dissolved oxygen in water to form other compounds. Proteins, carbohydrates, and fats are examples of biodegradable organic compounds. Compounds such as ammonia and hydrogen sulfide are examples of oxygen-demanding compounds. The oxygen demand of a substance can lead to depletion of dissolved oxygen in a water body and possibly the development of septic conditions.

4.2 Site Design BMPs

Low-Impact Development (LID) practices control rainfall and stormwater runoff at or close to the source protecting surface and groundwater quality, maintaining the integrity of ecosystems, and preserving the physical integrity of receiving waters. The techniques focus on mimicking pre-development hydrology by retaining, detaining, and/or evaporating runoff on-site minimizing the ability for downstream impacts.

LID goals are to increase groundwater recharge, enhance water quality, and prevent degradation to downstream natural drainage courses. This means that development projects shall treat stormwater pollutants, reduce stormwater runoff volume, and promote groundwater infiltration and stormwater reuse in turn protecting water quality and managing water resources.

Conserving Natural Areas

The project area, being previously fully developed, will not be able to adhere to any practices within this category.

Minimize Disturbances to Natural Drainage Patterns

The project area, being previously fully developed, will not be able to adhere to any practices within this category. The proposed project will mimic as closely as possible the drainage patterns of the existing developed site.

Minimizing and Disconnecting Impervious Surfaces

Drive aisles and sidewalks are designed to the minimum widths allowed.

Minimizing Soil Compaction

Soil compaction rates will be determined based upon jurisdictional codes and regulations.

Directing Runoff from Impervious Areas to Infiltration Areas

The soil is not conducive to infiltration, although impervious surfaces will drain to adjacent landscaping where feasible.

Trash Storage Areas

Trash receptacles for the residential units are within the building. Drains in the trash storage areas will be connected to the sanitary sewer.

Integrated Pest Management (IPM) Principles

Pesticides are to be used only after monitoring indicates they are needed according to established guidelines. Pest control materials are selected and applied in manners that minimize risks to human health, non-targeted organisms and the environment. IPM educational materials will be distributed to landscapers. Minimally, educational materials must address the following topics:

- Keeping pests out of buildings and landscaping using barriers, screens and caulking

- Physical pest elimination techniques, such as, weeding, squashing, trapping, washing or pruning out pests;
- Relying on natural enemies to eat pest
- Proper use of pesticides as a last line of defense.

Efficient Irrigation Systems and Landscape Design

Rain shut-off devices will be incorporated into the landscape design and attached to all the irrigation control systems. Each landscape area will be irrigated according to the specific watering needs of the individual vegetation grouped. Flow reducers, shut off valves or similar water pressure based systems will be used and checked yearly to insure they are in proper working order. Broken heads or lines will be replaced within a timely manner.

4.3 Source Control BMPs

Routine Structural BMPs

Name	Included	Not Applicable	Reason for N/A
SD-13 Provide storm drain system stenciling and signage.	X		
Design and construct outdoor material storage areas to reduce pollution introduction.		X	The proposed project site does not contain any outdoor storage areas.
SD-32 Design and construct trash and waste storage areas to reduce pollution introduction.		X	Trash enclosures are within a structure.
SD-12 Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control.	X		
Protect slopes and channels and provide energy dissipation		X	Not necessary for proposed project.
Dock Areas		X	No proposed dock areas.
Maintenance Bays		X	No proposed maintenance bays areas.
Vehicle wash areas		X	Vehicle washing is not allowed.
Outdoor processing areas		X	No proposed outdoor processing areas.
Equipment wash areas		X	No equipment washing is allowed.
Fueling areas		X	No proposed fueling areas.
Hillside landscaping		X	Project is not located in a hillside area.
Wash water control for food preparation areas.		X	No proposed food preparation areas.
Community car wash racks.		X	Vehicle washing is not allowed.

Routine Structural BMPs – Detailed Reference Guide

SD-13 Catch Basin Stenciling

The on-site proposed drop inlets will use City markers that state "No Dumping – Drains to Ocean." Inspections of drop inlet markers shall be done on a bi-annual basis. Re-stenciling shall be done as needed to ensure legibility.

SD-12 Use Efficient Irrigation Systems and Landscaping Design

Landscaping will consist of drought tolerant or native plants, grouped by similar irrigation needs. Any plant materials shall be installed and maintained in a neat, vigorous, and healthy condition. Irrigation will be monitored to establish proper time of watering. Rain shutoff devices and shut off valves/flow reducers will be used to prevent erosion, over watering, and prolong plant life. The irrigation system shall minimize excess irrigation and irrigation runoff throughout the project site. Landscaping and irrigation systems will be inspected monthly and maintained as needed.

Routine Non-Structural BMPs – Detailed Reference Guide

Education

Educational materials for good housekeeping practices, this report, as well as other applicable stormwater BMP materials will be distributed by the owner to all employees and contractors that will perform any task affiliated with the BMPs mentioned within this report. Materials will be presented upon hire and materials review will be done annually.

Activity Restrictions

No outdoor storage shall be permitted.
No hosing down of any paved surfaces will occur where the result would be the flow of non-stormwater into the street or storm drains.
No dumping of any waste into drop inlets or catch basins.
No blowing or sweeping of debris such as leaf litter, grass clippings, miscellaneous litter, etc. into catch basins, curb inlets, or streets.
These and any other restrictions shall be adhered to daily.

Common Landscape Management

Maintenance shall include trimming, mowing, weeding, removal of litter, fertilizing, water conservation, and replacement of dead, diseased, or dying plants. Any plant materials shall be installed and maintained in a neat, vigorous, and healthy condition. Irrigation will be monitored to establish proper time of watering. Landscape waste will be properly disposed of. Any fertilizer or pesticides used will be done so sparingly, according to Federal, State, and County standards, and applied in accordance with the directions on the label. Landscape Management shall be performed on a monthly basis. Irrigation Management shall be done in accordance with the landscapes watering schedule.

BMP Maintenance

BMP maintenance refers to the proper inspection and maintenance of all Routine Structural BMPs, Non-Structural BMPs, and Treatment Control BMPs mentioned within this report at the frequencies specified. Record of inspections and maintenances shall be made and kept on-site. BMP Maintenance shall be adhered to on a daily basis. See **Appendix 2** for locations of BMPs.

Common Area Litter Control

Routine maintenance shall consist of litter control throughout entire site, closing trash can lids, cleaning area around trash can, emptying trash containers throughout the site and inspecting and implementing the Best Management Practices. Common Area Litter Control shall be adhered to on a weekly basis.

Employee Training

Training will begin with a general review and explanation of stormwater/urban runoff and its effect on the environment. Applicable Federal, State, and City stormwater requirements will be discussed including stormwater discharge prohibitions, and wastewater discharge requirements. New employees/contractors are given a basic orientation on all aspects of pollution preventative measures, and shall begin training immediately after hire (i.e. within 30 days of the start date) and will be required to attend meetings thereafter, as scheduled by the property owner. An annual BMP meeting, at a minimum, will be conducted on preventative measures, inspection, and maintenance. This LID report shall be reviewed at the meetings. Documentation of training as well as the individuals responsible for preparation, implementation, and compliance shall be kept on-site.

Street Sweeping Private Streets and Parking Lots

Surface inspection of the parking lot area shall be performed at least on a monthly basis. The parking lot areas shall be swept and cleaned monthly to prevent potential debris and pollutants from entering into storm drain system. Washing of streets and parking lots is prohibited.

4.4 LID BMPs

Treatment control BMPs are the last ditch effort to remove any pollutants introduced into the runoff prior to being discharged from the site. Preventing or stopping pollution at the source is more effective than trying to clean up and repair a polluted water body. Refer to **Appendix 5** for BMP Calculations.

BF-1 Biofiltration Planter

Biofiltration/Infiltration Planters are typically enclosed planter boxes used to detain and treat runoff. The biofiltration planters used for the project site were designed using the City of San Diego Standard (BF-1: Biofiltration per The City of San Diego Storm Water Standards manual, Dated October 1, 2018)). Inspection and maintenance shall be performed on a monthly basis. Maintenance shall be performed as needed, monthly, and after every rain event. Maintenance shall include removal of trash, debris, accumulated sediment, and diseased or dying vegetation, tilling areas of ponding, and replacement of mulch. The planters are to be designed to drain approximately 5 inches per hour and shall not have standing water. If planters do not drain within 48 hours, then

till the soil and replant the vegetation. Refer to **Appendix 4** for more information and **Appendix 2** for locations.

4.5 Treated pollutants by BMPs

BF-1 Biofiltration Planter

Pollutant of Concern	Treated by Biofiltration?
Suspended solids	No
Total phosphorus	No
Total nitrogen	Yes
Total Kjeldahl nitrogen	Yes
Cadmium, total	No
Chromium, total	Yes
Copper, total	No
Lead, total	Yes
Zinc, total	No

The owner is aware of the maintenance responsibilities of the proposed BMPs. A funding mechanism is in place to maintain the BMPs at the frequency stated in the LID Report.

Owner Entity: **MW Investment Group, LLC**
Owner Representative: **Matt Waken**
Address: **27702 Crown Valley Parkway, Suite D-4-197, Ladera Ranch, CA 92694**
Phone Number: **(626) 710-6377**
E-mail: **matt@walbern.com**

Section 5 Inspection/Maintenance of BMPs

5.1 Inspection and Maintenance Responsibility

The owner is aware of the maintenance responsibilities of the proposed BMPs. A funding mechanism is in place to maintain the BMPs at the frequency stated in the LID Report.

Owner Entity: **MW Investment Group, LLC**
Owner Representative: **Matt Waken**
Address: **27702 Crown Valley Parkway, Suite D-4-197, Ladera Ranch, CA 92694**
Phone Number: **(626) 710-6377**
E-mail: **matt@walbern.com**

A qualified and trained representative who can perform and maintain the Best Management Practices for the site shall perform inspections and maintenance. Any transfer of ownership does not nullify the responsibility of BMP inspections and maintenance. The new owners shall maintain the Best Management Practices and their requirements as described in this report. In case of emergency, the BMPs representative contact information, with name, number, address and area of responsibility will be kept on site. Training documentation is to be provided by the owner and representative.

5.2 Inspection and Maintenance Arrangements

Inspection and Maintenance Arrangements are the responsibility of the owner. Throughout the course of the year, inspection and maintenance of the BMPs shall occur at the times designated within this report. During site inspection, any damaged BMPs shall be replaced and/or repaired as soon as possible to maintain the BMPs effectiveness. The rainy season for this area is from October 1st through April 15th.

5.3 Reporting Standards

Attachments, inspection logs and Checklist of Activities are to be used for documentation and proof of maintaining the Best Management Practices. As needed, forms can be revised to meet the requirements for the County or State agencies. Additionally, Spills and the Material Inventory list along with a sampling Event Reporting Form should be used. If requested by the County these reporting standards shall be enforced and filed to the State.

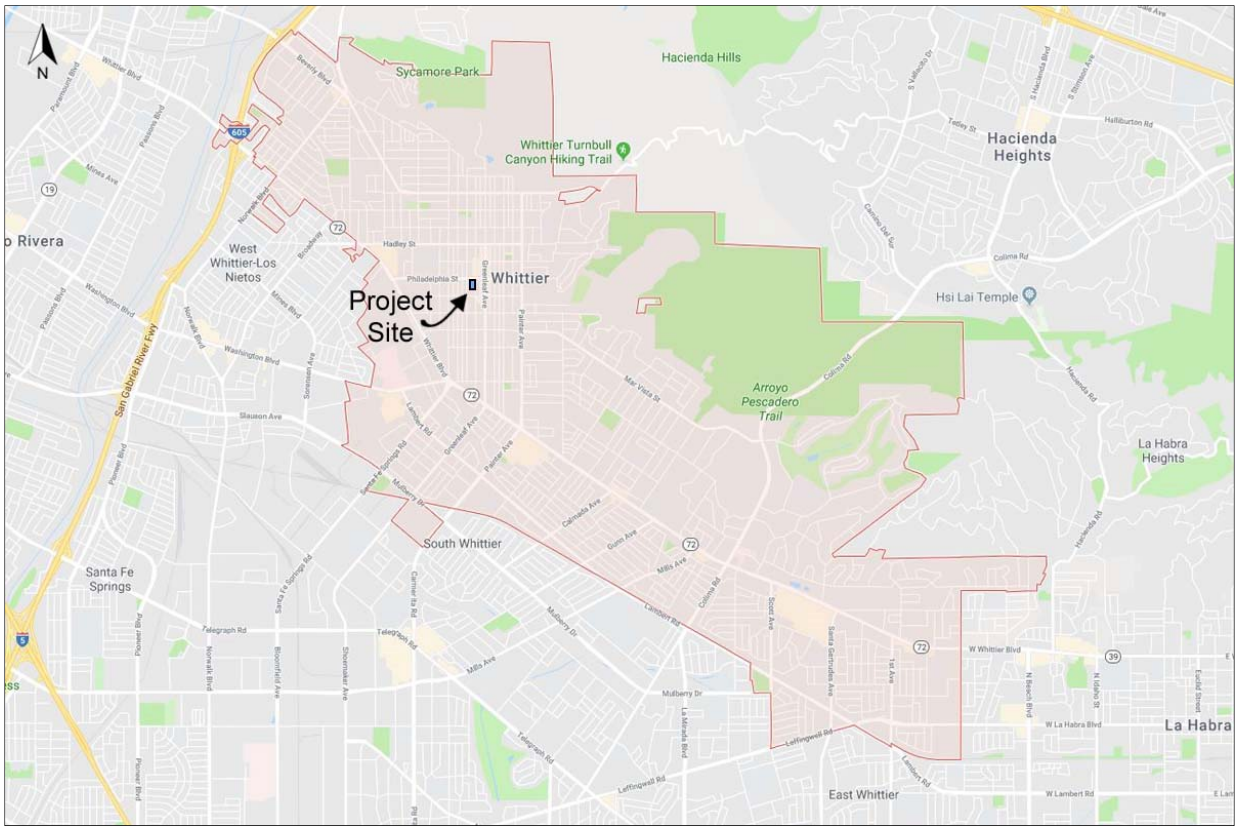
All inspections and maintenance required by this report and any LID violations found shall be reported and documented for the purposes of maintaining the Best Management Practices and their requirements. The inspection and maintenance log shall be kept on-site. The log is critical for proving water quality compliance. The log shall be made available on-site and shall be reviewed and inspected upon request by governing agencies. Any reports and logs shall be maintained for three years and shall include the inspector, date, observation location of best management practices and locations of inadequate and improper BMPs, along with any additional BMPs that are used and needed. The report shall require the signature of the qualified inspector.

5.4 Post-Construction Best Management Practices

Locations of BMPs are on plot plan in **Appendix 2**. Maintenance Covenant can be found in **Appendix 7** of this report.

BMP#	BMP Name	BMP Location	Inspection & Maintenance Frequency
Structural Treatment Control			
SD-12	Irrigation & Landscaping	Designated on BMP Exhibit	Weekly Basis
SD-13	Catch Basin Inspection & Maintenance	Designated on BMP Exhibit	Quarterly Re-stencil every 5 years
Non-Structural Treatment Control			
	Educational Materials	Manager's Office	Upon hire and annually
	Activity Restriction	Manager's Office	Daily basis
	Common Landscape Management	Designated on BMP Exhibit	Monthly basis
	BMP Maintenance	Manager's Office	Daily basis
	Common Litter Control	Throughout the property	Weekly Basis
	Employee Training	Manager's Office	Upon hire and annually
	Sweeping of Parking Lots	Designated on BMP Exhibit	Every 2 weeks and once within 5 days of October 1st
Treatment Control			
BF-1	Biofiltration Planter Inspection	Designated on BMP Exhibit	Monthly, before, during, after rain storm
BF-1	Biofiltration Planter Maintenance	Designated on BMP Exhibit	Monthly basis, after rain storm
	CMP Inspection	Designated on BMP Exhibit	Quarterly
	CMP Maintenance	Designated on BMP Exhibit	Annually

Appendix 1 Area/Vicinity Map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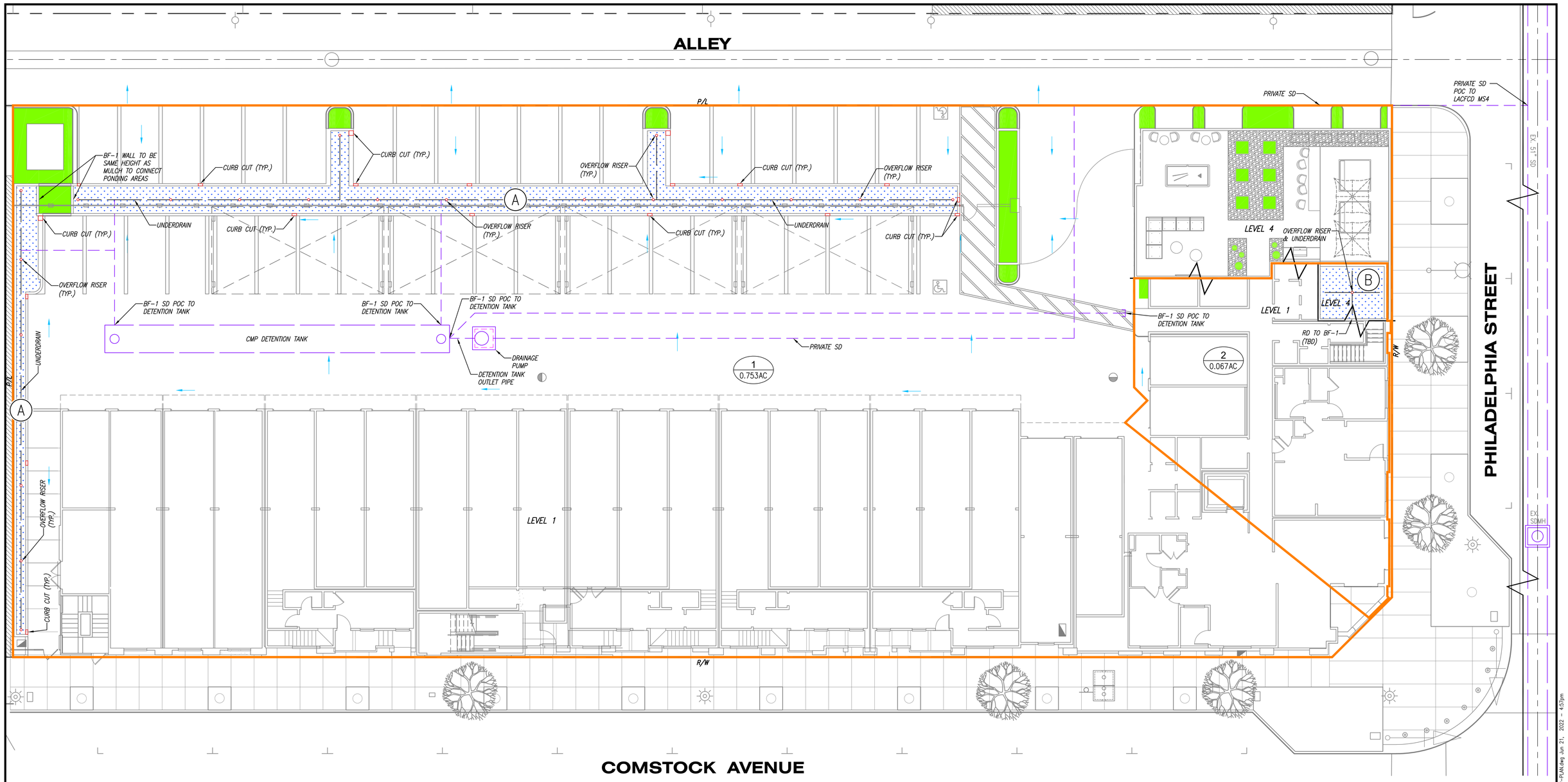
Whittier Turnbull Canyon Hiking Trail
Hacienda Heights
West Whittier-Los Nietos
Whittier
Project Site
Hsi Lai Temple
Arroyo Pescadero Trail
La Habra Heights
South Whittier
Santa Fe Springs
East Whittier
La Habra
San Gabriel River Fwy


Philadelphia Street
Milton Avenue
Comstock Avenue
Greenleaf Avenue
Wardman Street
N

Appendix 2 Plot Plan/BMPs Locations



COMSTOCK AVENUE

SITE INFORMATION:

TOTAL AREA:	35,915 SF	(0.82 AC)
TOTAL IMPERVIOUS AREA:	33,465 SF	(0.77 AC)
TOTAL PERVIOUS AREA:	2,450 SF	(0.05 AC)
TOTAL SWQDV:	2,508 CF	
TOTAL SWQDV x 1.5:	3,763 CF	
TOTAL MINIMUM BF-1 AREA:	1,617 SF	
PROVIDED BF-1 AREA:	1,664 SF	
PROVIDED BF-1 VOLUME:	3,871 CF	

LEGEND

DESCRIPTION	SYMBOL
PERMEABLE AREA (LANDSCAPE AREA)	
BF-1: BIOFILTRATION PLANTER	
SURFACE FLOW DIRECTION	
DRAINAGE MANAGEMENT AREA (DMA)	
BF-1 BMP ID#	X
DMA ID DMA AREA	- X.XXAC

LID SUMMARY

DMA DESIGNATION	BF-1 BMP ID	DMA (SF)	SWQDV (CF)	1.5 X SWQDV (CF)	BF-1 DEPTH SURFACE PONDING (IN)	BF-1 REQUIRED FOOTPRINT (SF)	BF-1 PROVIDED FOOTPRINT (SF)	BF-1 PROVIDED VOLUME (CF)
1	A	32,804	2,291	3,437	15	1,462	1,506	3,539
2	B	3,111	217	326	12	155	158	332
TOTAL		35,915	2,508	3,763	–	1,617	1,664	3,871

0 5 10 20 30

SCALE: 1"=10' DATE: 06/06/22

NOTICE TO CONTRACTOR

CONTRACTOR HEREBY AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING THE SAFETY OF PERSONS AND PROPERTIES; THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS; AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY, AND HOLD HARMLESS THE OWNER AND ENGINEER FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT EXCEPT FOR LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE OWNER OR ENGINEER.

REVISIONS

NO.	DATE:	DESCRIPTION	APPROVAL

PREPARED BY:
KHR ASSOCIATES
CONSULTING ENGINEERS/SURVEYORS/PLANNERS
17530 Von Karman Avenue - Suite 200 Irvine, California 92614
(949) 756-6440

UNDER THE SUPERVISION OF: JAMES H. KAWAMURA (R.C.E. 30560)

REGISTERED PROFESSIONAL ENGINEER JAMES H. KAWAMURA No. C 30560 Expiration: 03/31/24 CIVIL STATE OF CALIFORNIA

LID BMP EXHIBIT

THE COMSTOCK
12826 PHILADELPHIA STREET
WHITTIER, CA 90601

PROJECT NUMBER
-

SHEET NO.
1 OF 1

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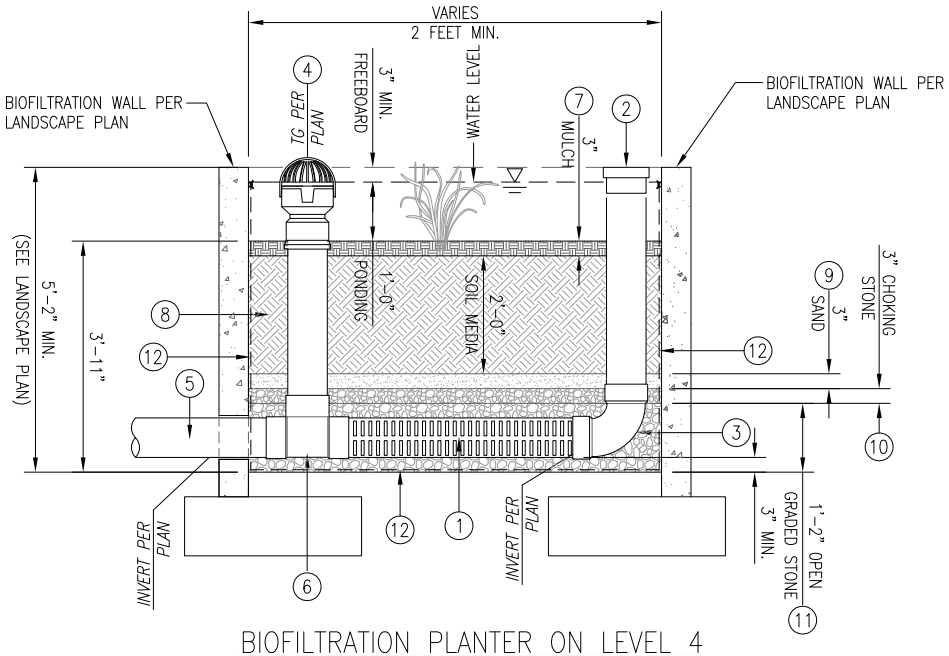
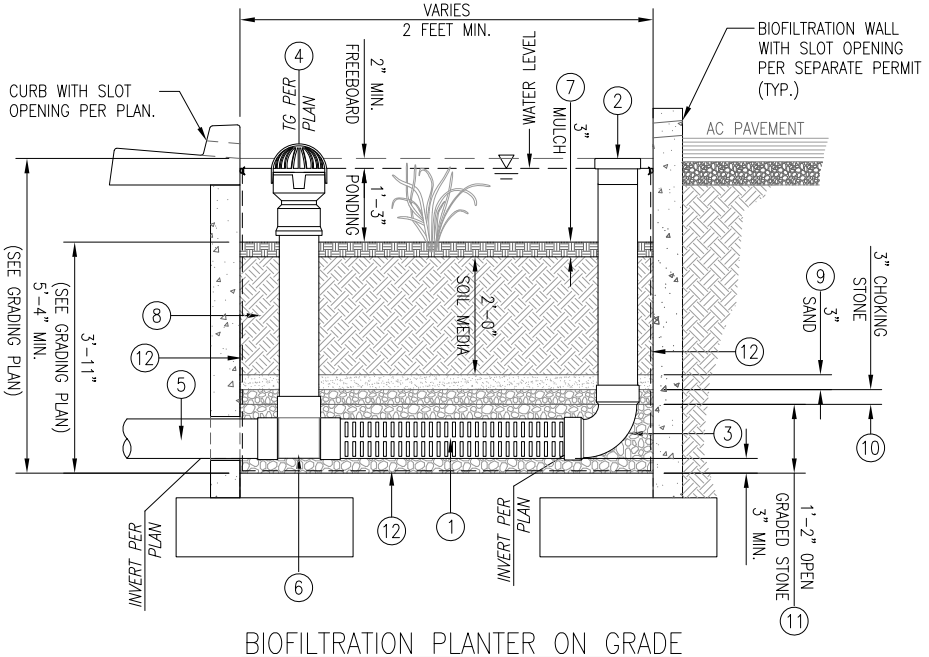


BIOFILTRATION PLANTER ON LEVEL 4



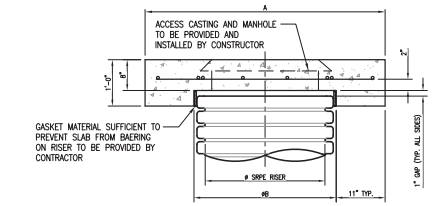
BIOFILTRATION PLANTER ON GRADE

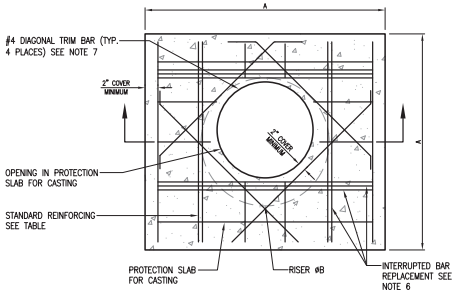
BIOFILTRATION BASIN LEGEND:

1. 8" DIA. SLOTTED SCH. 80 PVC PIPE (PER ASTM D3034) WRAPPED IN MIRAFI 140N FABRIC "SOCK", PROVIDE CLEANOUT AT ALL TERMINIST ENDS. PIPE IS TO BE LAID FLAT ATOP 3-INCHES OF OPEN GRADED GRAVEL.
2. 8" DIA. SCH. 40 PVC CLEANOUT TO 16" ABOVE FINISH GRADE. PROVIDE SEALED CAP.
3. 8" x 90° SCH. 80 PVC BEND.
4. 8" DIA. NYLOPLAST INLET ADAPTOR WITH 8" DIA. NYLOPLAST DUCTILE IRON DOME GRATE, W/ 8" DIA. PVC SCH. 80 PIPE RISER.
5. OUTLET PIPE PER STORM DRAIN PLANS.
6. 8" x 8" x 8" SCH. 80 PVC TEE.
9. CLEAN & WASHED SAND BEDDING PER ASTM 33
10. CLEAN & WASHED NO. 8 CHOKING STONE
11. CLEAN & WASHED NO. 57 OPEN GRADED STONE
12. NONWOVEN "MIRAFI S1200" GEOTEXTILE FABRIC OVER 40-MIL GEOSYNTHETIC NON-PERMEABLE MEMBRANE. EXTEND FABRIC & MEMBRANE UP PLANTER WALLS AND SECURE TO WALL WITH TERMINATION BAR.
7. MULCH LAYER PER LANDSCAPE ARCHITECT'S PLANS.
8. SOIL MEDIA PLANTING AREA SHOULD CONSIST OF 60%-80% FINE SAND AND 20%-30% COMPOST TO ACHIEVE A MIN. INFILTRATION RATE OF 5-INCHES PER HOUR. PLANTER PER LANDSCAPE ARCHITECT'S PLANS.

BIOFILTRATION PLANTER DETAILS

SCALE: NONE





MANHOLE CAP DETAIL

MANHOLE CAP NOTES:

1. DESIGN IN ACCORDANCE WITH AASHTO, LATEST EDITION.
2. DESIGN LOAD HS25.
3. EARTH COVER = 1' MAX.
4. CONCRETE STRENGTH = 3,500 PSI
5. REINFORCING STEEL = ASTM A615, GRADE 60.
6. PROVIDE ADDITIONAL REINFORCING AROUND OPENINGS EQUAL TO THE BARS INTERRUPTED, HALF EACH SIDE. ADDITIONAL BARS TO BE IN THE SAME PLANE.
7. TRIM OPENING WITH DIAGONAL #4 BARS, EXTEND BARS A MINIMUM OF 12" BEYOND OPENING, BEND BARS AS REQUIRED TO MAINTAIN BAR COVER.
8. PROTECTIVE SLAB AND ALL MATERIALS TO BE PROVIDED AND INSTALLED BY CONTRACTOR.
9. DETAIL DESIGN BY DELTA ENGINEERING, BINGHAMTON, NY.

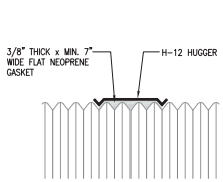
REINFORCING TABLE

ØSRPE RISER	A	ø B	REINFORCING	**BEARING PRESSURE (PSF)
24"	ø 4' 4' X 4'	26"	#5 @ 12" OCEW #5 @ 12" OCEW	2,410 1,780
30"	ø 4'-6" 4'-6" X 4'-6"	32"	#5 @ 12" OCEW #5 @ 12" OCEW	2,120 1,530
36"	ø 5' 5' X 5'	38"	#5 @ 10" OCEW #5 @ 10" OCEW	1,890 1,350
42"	ø 5'-6" 5'-6" X 5'-6"	44"	#5 @ 10" OCEW #5 @ 9" OCEW	1,720 1,210
48"	ø 6' 6' X 6'	50"	#5 @ 9" OCEW #5 @ 8" OCEW	1,600 1,110

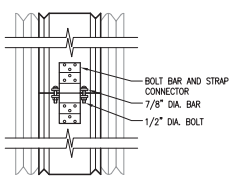
** ASSUMED SOIL BEARING CAPACITY

HUGGER BAND GENERAL NOTES:

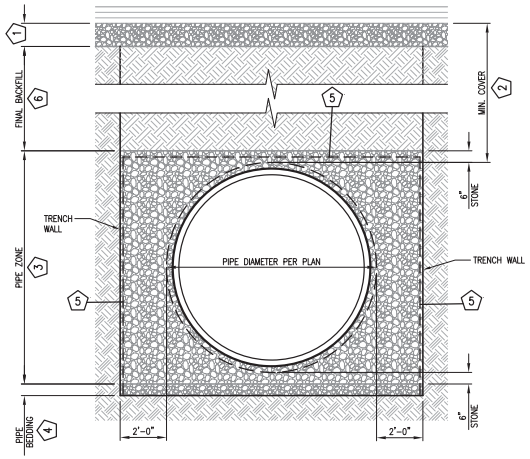
1. REFER TO CONTECH BAND SELECTION GUIDE FOR BAND WIDTH, GAGE, AND FASTENER TYPES.
2. BANDS FOR PIPE-ARCH ARE THE SAME AS FOR EQUIVALENT DIAMETER ROUND PIPE.
3. BANDS ARE NORMALLY FURNISHED AS FOLLOWS:
   12" THRU 48" 1-PIECE
   54" THRU 96" 2-PIECE
   102" THRU 144" 3-PIECES
4. BAND FASTENERS ARE ATTACHED WITH SPOT WELDS, RIVETS OR HAND WELDS.



FLAT GASKET



HUGGER BAND CONNECTION DETAIL



TANK BACKFILL SECTION A-A

SPECIFICATION FOR CORRUGATED STEEL PIPE-ALUMINIZED TYPE 2 STEEL

SCOPE

THIS SPECIFICATION COVERS THE MANUFACTURE AND INSTALLATION OF THE CORRUGATED STEEL PIPE (CSP) DETAILED IN THE PROJECT PLANS.

MATERIAL

THE ALUMINIZED TYPE 2 STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M274 OR ASTM A929.

PIPE

THE CSP SHALL BE MANUFACTURED IN ACCORDANCE WITH THE APPLICABLE REQUIREMENTS OF AASHTO M36 OR ASTM A760. THE PIPE SIZES, GAGES AND CORRUGATIONS SHALL BE AS SHOWN ON THE PROJECT PLANS.

ALL FABRICATION OF THE PRODUCT SHALL OCCUR WITHIN THE UNITED STATES.

HANDLING AND ASSEMBLY

SHALL BE IN ACCORDANCE WITH RECOMMENDATIONS OF THE NATIONAL CORRUGATED STEEL PIPE ASSOCIATION (NCSPA)

INSTALLATION

SHALL BE IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SECTION 26, DIVISION II OR ASTM A798 AND IN CONFORMANCE WITH THE PROJECT PLANS AND SPECIFICATIONS. IF THERE ARE ANY INCONSISTENCIES OR CONFLICTS THE CONTRACTOR SHOULD DISCUSS AND RESOLVE WITH THE SITE ENGINEER.

IT IS ALWAYS THE RESPONSIBILITY OF THE CONTRACTOR TO FOLLOW OSHA GUIDELINES FOR SAFE PRACTICES.

PRIOR TO PLACING THE BEDDING, THE FOUNDATION MUST BE CONSTRUCTED TO A UNIFORM AND STABLE GRADE. IN THE EVENT THAT UNSUITABLE FOUNDATION MATERIALS ARE ENCOUNTERED DURING EXCAVATION, THEY SHALL BE REMOVED AND BROUGHT BACK TO THE GRADE WITH A FILL MATERIAL AS APPROVED BY THE SOILS ENGINEER. ONCE THE FOUNDATION PREPARATION IS COMPLETE, THE 4-6 INCHES OF A WELL-GRADED GRANULAR MATERIAL SHALL BE PLACED AS THE BEDDING.

BACKFILL

THE BACKFILL MATERIAL SHALL BE FREE-DRAINING ANGULAR WASHED STONE ¾"-2" PARTICLE SIZE. MATERIAL SHALL BE PLACED IN 8"-10" MAXIMUM LIFTS. MATERIAL SHALL BE WORKED INTO THE PIPE HAUNCHES BY MEANS OF SHOVEL – SLICING, RODDING, AIR-TAMPER, VIBRATORY ROD, OR OTHER EFFECTIVE METHODS COMPACTION IS CONSIDERED ADEQUATE WHEN NO FURTHER YIELDING OF THE MATERIAL IS OBSERVED UNDER THE COMPACTOR, OR UNDER FOOT, AND THE PROJECT ENGINEER OR HIS REPRESENTATIVE IS SATISFIED WITH THE LEVEL OF COMPACTION. INADEQUATE COMPACTION CAN LEAD TO EXCESSIVE DEFLECTIONS WITHIN THE SYSTEM AND SETTLEMENT OF THE SOILS OVER THE SYSTEM. BACKFILL SHALL BE PLACED SUCH THAT THERE IS NO MORE THAN A TWO-LIFT DIFFERENTIAL BETWEEN THE SIDES OF ANY PIPE IN THE SYSTEM AT ALL TIMES DURING THE BACKFILL PROCESS. BACKFILL SHALL BE ADVANCED ALONG THE LENGTH OF THE SYSTEM AT THE SAME RATE TO AVOID DIFFERENTIAL LOADING ON ANY PIPES IN THE SYSTEM.

EQUIPMENT USED TO PLACE AND COMPACT THE BACKFILL SHALL BE OF A SIZE AND TYPE SO AS NOT TO DISTORT, DAMAGE, OR DISPLACE THE PIPE. ATTENTION MUST BE GIVEN TO PROVIDING ADEQUATE MINIMUM COVER FOR SUCH EQUIPMENT, AND MAINTAINING BALANCED LOADING ON ALL PIPES IN THE SYSTEM, DURING ALL SUCH OPERATIONS.

OTHER ALTERNATE BACKFILL MATERIAL MAY BE ALLOWED DEPENDING ON SITE SPECIFIC CONDITIONS. REFER TO TYPICAL BACKFILL DETAIL FOR MATERIAL REQUIRED.

KEY: (X)

1. AGGREGATE ROAD BASE PER GRADING PLANS
2. 12" MIN. FOR DIAMETERS THROUGH 96"; 18" MIN. FOR DIAMETERS FROM 102" AND LARGER MEASURED TO TOP OF RIGID OR BOTTOM OF FLEXIBLE PAVEMENT.
3. FREE DRAINING ANGULAR WASHED STONE 3/4" TO 2" PARTICLE SIZE. DENSIFIED PER GEOTECHNICAL REPORT.
4. WELL GRADED GRANULAR BEDDING, ROUGHLY SHAPED TO FIT THE BOTTOM OF PIPE 4" TO 6" IN DEPTH.
5. CONTECH C-40 NON-WOVEN GEOTEXTILE REQUIRED, WRAPPING AROUND ALL SIDES OF TRENCH.
6. FINAL BACK FILL MATERIAL PLACED IN 8" LIFTS AND COMPACTED TO 90% PER PROJECT SOILS REPORT, GRADING PLANS AND SPECIFICATIONS.

GENERAL NOTES:

1. REFER TO CONTECH BAND SELECTION GUIDE FOR BAND WIDTH, GAGE, AND FASTENER TYPES.
2. BANDS FOR PIPE-ARCH ARE THE SAME AS FOR EQUIVALENT DIAMETER ROUND PIPE.
3. BANDS ARE NORMALLY FURNISHED AS FOLLOWS:
   12" THRU 48" 1-PIECE
   54" THRU 96" 2-PIECE
   102" THRU 144" 3-PIECES
4. BAND FASTENERS ARE ATTACHED WITH SPOT WELDS, RIVETS OR HAND WELDS.
5. REROLLED ANNULAR END CORRUGATIONS ARE NORMALLY 2-2/3" X 1/2".
6. DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.

NOTES:

1. THE DETENTION SYSTEM SHOWN ON THESE PLANS SHALL BE SEALED OFF FROM ANY CONSTRUCTION DEBRIS AND STORMWATER, OR ANY OTHER RUNOFF, UNTIL THE SITE IS FUNCTIONAL OR UNTIL SUCH TIME THE RUNOFF DISCHARGING INTO THE INFILTRATION SYSTEM IS ANTICIPATED TO CARRY AN EQUIVALENT AMOUNT OF SEDIMENT AS IS INTENDED PER THE DESIGN IN FULLY OPERATIONAL CONDITIONS, THEREFORE, NOT IMPEDING THE PROPER OPERATION OF THE INFILTRATION SYSTEM.
2. MANHOLE SHAFTS SHALL BE SUPPLIED WITH AN PERMANENTLY ATTACHED LADDER SYSTEM THAT MEETS CAL OHSA REQUIREMENTS.

SCALE: NONE

CONTECH CMP DETENTION TANK SYSTEM - GENERAL NOTES

Appendix 3 Educational Material

Efficient Irrigation SD-12

Design Objectives

- ✓ Maximize Infiltration
- ✓ Provide Retention
- ✓ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Storm Drain Signage SD-13

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ✓ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING –

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DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.
- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Building & Grounds Maintenance SC-41

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

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- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Training

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Other Considerations

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

Maintenance

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Parking/Storage Area Maintenance SC-43

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas and storage areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook)
- Keep accurate maintenance logs to evaluate BMP implementation.

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SC-43 Parking/Storage Area Maintenance

Suggested Protocols

General

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.
- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Discharge soapy water remaining in mop or wash buckets to the sanitary sewer through a sink, toilet, clean-out, or wash area with drain.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel, and dispose of litter in the trash.

Surface Cleaning

- Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- Follow the procedures below if water is used to clean surfaces:
  - Block the storm drain or contain runoff.
  - Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
  - Dispose of parking lot sweeping debris and dirt at a landfill.
- Follow the procedures below when cleaning heavy oily deposits:
  - Clean oily spots with absorbent materials.
  - Use a screen or filter fabric over inlet, then wash surfaces.

- Do not allow discharges to the storm drain.
- Vacuum/pump discharges to a tank or discharge to sanitary sewer.
- Appropriately dispose of spilled materials and absorbents.

Surface Repair

- Preheat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.
- Use only as much water as necessary for dust control, to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Inspection

- Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.
- Inspect cleaning equipment/sweepers for leaks on a regular basis.

Training

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Other Considerations

Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

SC-43 Parking/Storage Area Maintenance

Requirements

Costs

Cleaning/sweeping costs can be quite large. Construction and maintenance of stormwater structural controls can be quite expensive as well.

Maintenance

- Sweep parking lot regularly to minimize cleaning with water.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Clean parking facilities regularly to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

Supplemental Information

Further Detail of the BMP

Surface Repair

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Only use only as much water as is necessary for dust control to avoid runoff.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Drainage System Maintenance SC-44

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and stormwater that may contain certain pollutants. The protocols in this fact sheet are intended to reduce pollutants reaching receiving waters through proper conveyance system operation and maintenance.

Targeted Constituents

Sediment	✓
Nutrients	
Trash	✓
Metals	
Bacteria	✓
Oil and Grease	
Organics	

Approach

Pollution Prevention

Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Suggested Protocols

Catch Basins/Inlet Structures

- Staff should regularly inspect facilities to ensure compliance with the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC34 Waste Handling and Disposal).

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- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS.

Illicit Connections and Discharges

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:
  - Is there evidence of spills such as paints, discoloring, etc?

- Are there any odors associated with the drainage system?
- Record locations of apparent illegal discharges/illicit connections?
- Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- Eliminate the discharge once the origin of flow is established.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Illegal Dumping

- Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties
- Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Allow only properly trained individuals to handle hazardous materials/wastes.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).

- OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).

- Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Spill Response and Prevention

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.
- Refer to fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Other Considerations (Limitations and Regulations)

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and prohibition against disposal of flushed effluent to sanitary sewer in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget.
- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The primary cost is for staff time. Cost depends on how aggressively a program is implemented. Other cost considerations for an illegal dumping program include:

  - Purchase and installation of signs.

  - Rental of vehicle(s) to haul illegally-disposed items and material to landfills.

  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.

  - Purchase of landfill space to dispose of illegally-dumped items and material.

- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.

Supplemental Information

Further Detail of the BMP

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing resuspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm sewer flushing.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

Ferguson, B.K. 1991. Urban Stream Reclamation, p. 324-322, Journal of Soil and Water Conservation.

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Storm Drain System Cleaning. On line:
http://www.epa.gov/npdes/menuofbmps/poll_16.htm

Appendix 4 LID BMPs

5.5.3 Biofiltration BMP Category

Biofiltration BMPs are shallow basins filled with treatment media and drainage rock that treat storm water runoff by capturing and detaining inflows prior to controlled release through minimal incidental infiltration, evapotranspiration, or discharge via underdrain or surface outlet structure. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and/or vegetative uptake. Biofiltration BMPs can be designed with or without vegetation, provided that biological treatment processes are present throughout the life of the BMP via maintenance of plants, media base flow, or other biota-supporting elements. By default, BMP BF-1 shall include vegetation unless it is demonstrated, to the satisfaction of the City Engineer, that effective biological treatment process will be maintained without vegetation. Typical biofiltration components include a media layer with associated filtration rates, drainage layer with associated in-situ soil infiltration rates, underdrain, inflow and outflow control structures, and vegetation, with an optional impermeable liner installed on an as needed basis due to site constraints.

Selection: Biofiltration BMPs shall be selected if the project site feasibility analysis performed according to **Section 5.4.2** determines a No Infiltration Feasibility Condition.

Design: **Appendix B.5** has a worksheet for sizing biofiltration BMPs and **Appendix E** provides fact sheets to design the biofiltration BMP. Figure 5-9 shows the schematic of a biofiltration Basin.

BMP option under this category:

- BF-1: Biofiltration
- BF-2: Nutrient Sensitive Media Design
- BF-3: Proprietary Biofiltration

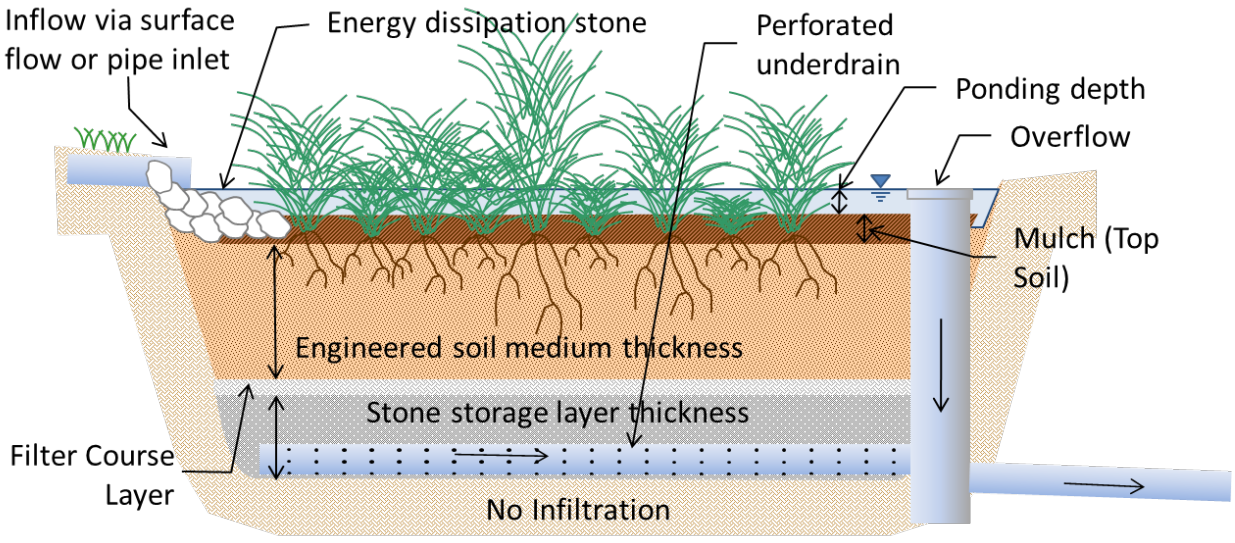

Figure 5-9. Schematic of a Typical Biofiltration Basin

B.5 Biofiltration BMPs

Biofiltration BMPs must be sized using one of the following sizing methods:

- **Option 1**: Treat 1.5 times the portion of the DCV not reliably retained onsite, **OR**
- **Option 2**: Treat 1.0 times the portion of the DCV not reliably retained onsite; and additionally check that the system has a total static (i.e., non-routed) storage volume, including pore spaces and pre-filter detention volume, equal to at least 0.75 times the portion of the DCV not reliably retained onsite.

When using sizing Option 1 a routing period of 6 hours is allowed. The routing period was estimated based on 50th percentile storm duration for storms similar to 85th percentile rainfall depth. It was estimated based on inspection of continuous rainfall data from Lake Wohlford, Lindbergh and Oceanside rain gages.

The MS4 Permit specifies (Footnote 29) that the hydraulic loading rate and other biofiltration design criteria must be selected such that **storm water retention and pollutant removal** are maximized. To meet this provision, this manual includes specific criteria for design of biofiltration BMPs. Among other criteria, a minimum footprint sizing factor of 3 percent (BMP footprint area as percent of contributing area times adjusted runoff factor) and a volume retention performance standard (Figure B.5-2) based on the reliable infiltration rate at the site (i.e. measured infiltration rate/factor of safety of 2) is specified. **Appendix B.5.3** provides the technical rationale for the 3 percent minimum sizing factor and the volume retention performance standard.

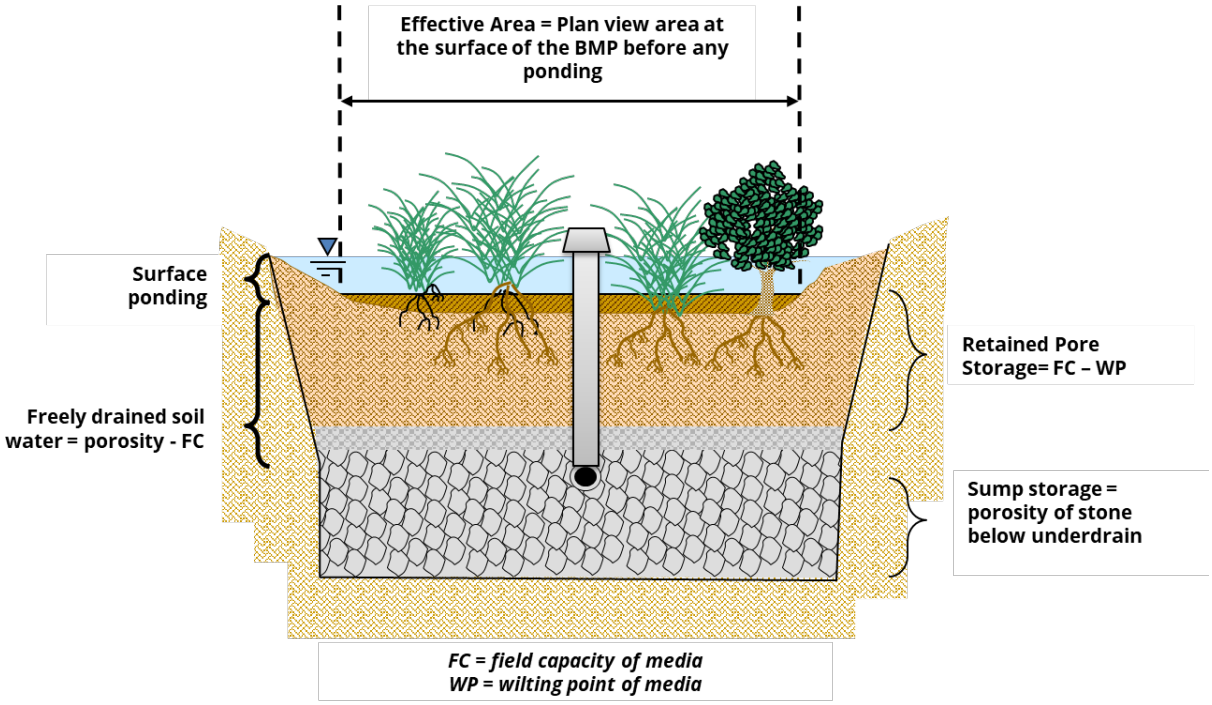

Figure B.5-1 Explanation of Biofiltration Volume Compartments for Sizing Purposes

Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

Note: For sizing calculations, it shall be assumed that only 50% of the retained pore storage (field capacity – wilting point) is available for evapotranspiration to account for typical irrigation practices.

The numeric sizing criteria in this appendix are subdivided into:

- **Appendix B.5.1:** Standard[1] biofiltration BMP sizing; and
- **Appendix B.5.2:** Non-Standard[2] and Compact[3] biofiltration BMP sizing.

If a BMP meets the criteria in **Appendix B.5.1**, then it is considered compliant with the required pollutant control performance standard (i.e., for both retention and pollutant removal). It is not necessary to complete worksheets in this appendix for BMPs that meet the criteria in **Appendix B.5.1**. The volume retention performance standard for biofiltration BMPs is presented in **Figure B.5-2.**.

When mapped hydrologic soil groups are used for feasibility screening, applicants are allowed to use the following reliable infiltration rates for sizing partial retention BMPs:

- Reliable infiltration rate for NRCS Type D soils = 0.05 in/hr.
- Reliable infiltration rate for NRCS Type C soils = 0.15 in/hr.

The applicant also has an option to perform infiltration testing in lieu of using the rates listed above.

If an applicant performs site-specific testing using a device that has a precision of 0.1 in/hr. and determines that the average measured infiltration rates in the DMA are less than 0.1 in/hr., then the applicant is allowed to size the biofiltration BMP assuming the DMA is a "No Infiltration Condition". In instances where the actual infiltration is not measured because the testing device has a precision of 0.1 in/hr., if the applicant elects to propose a non-standard or a compact biofiltration BMP then a reliable infiltration rate of 0.025 in/hr. must be used to size site design BMPs when there are no geotechnical and/or groundwater hazards identified in **Appendix C**.

If there are geotechnical and/or groundwater hazards identified in **Appendix C**, then the applicant must use a reliable infiltration rate of 0.0 in/hr. for estimating the target volume retention and sizing equivalent site design BMPs.

The required performance standards for different biofiltration BMPs are summarized in **Table B.5-1**.

[1] Standard biofiltration BMPs have a media filtration rate equal to or smaller than 5 in/hr. and a media surface area of 3% of contributing area times adjusted runoff factor or greater.

[2] Non-Standard biofiltration BMPs have a media filtration rate equal to or smaller than 5 in/hr. and a media surface area smaller than 3% of contributing area times adjusted runoff factor.

[3] Compact (high rate) biofiltration BMPs have a media filtration rate greater than 5 in/hr. and a media surface area smaller than 3% of contributing area times adjusted runoff factor. Compact biofiltration BMPs are typically proprietary BMPs that may qualify as biofiltration.

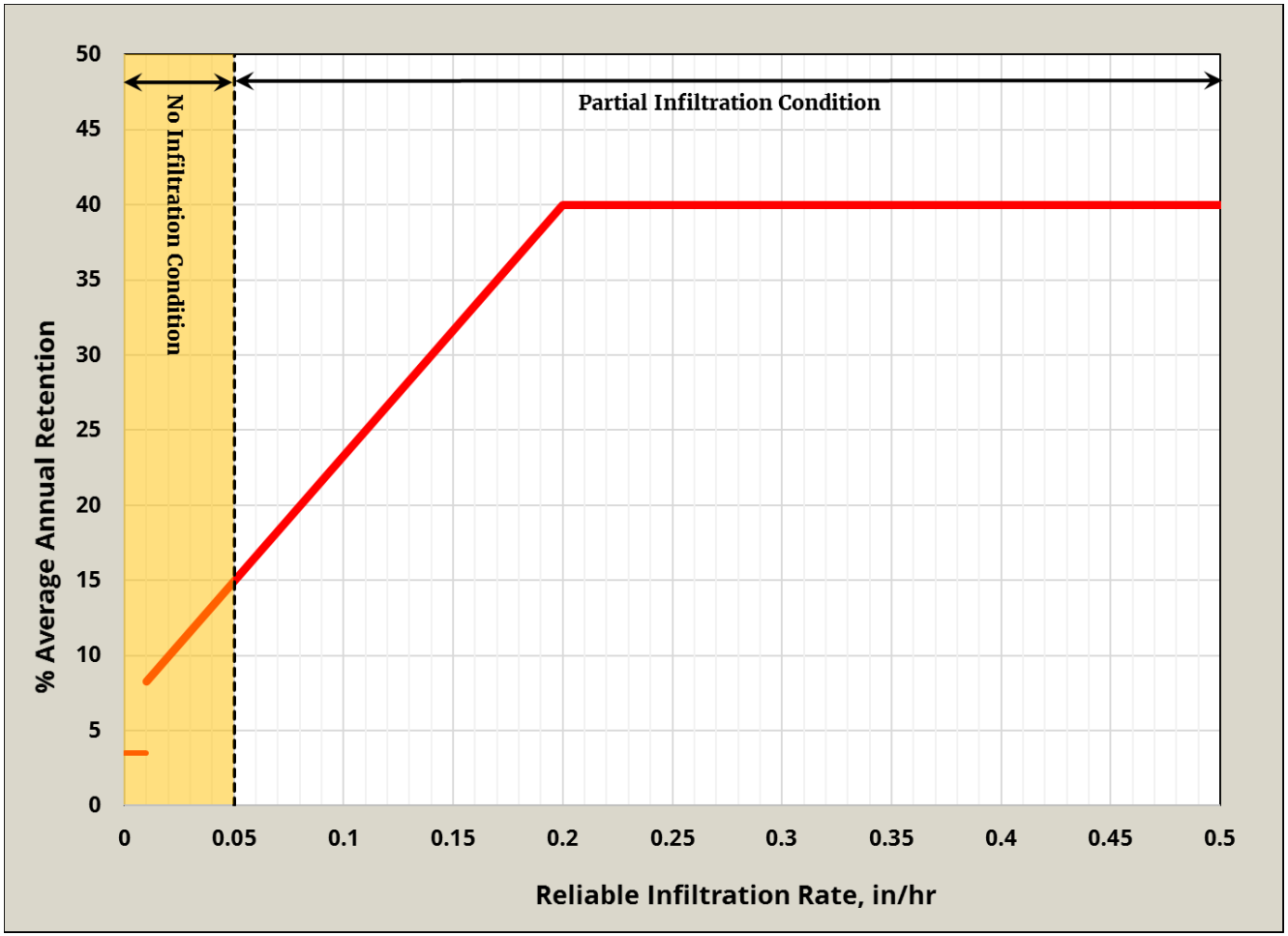

Figure B.5-2 Volume Retention Performance Standard for Partial Infiltration Condition

Note:

For biofiltration BMP sizing, the reliable infiltration rate must be calculated using a factor of safety of 2 i.e., **Reliable infiltration rate = Measured infiltration rate/2**

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Table B.5-1. Summary of Biofiltration Performance Standards

Infiltration Feasibility Condition	Performance Standard
Partial Infiltration Condition (Based on Worksheet C.4-1: Form I-8A and Worksheet C.4-2: Form I-8B) [There is no hierarchy in selecting the type of biofiltration BMP as long as the performance standard for the selected biofiltration BMP is met]	**Standard Biofiltration BMPs:** BMPs must meet the criteria in Appendix B.5.1.1
	Non-Standard Biofiltration BMPs: Pollutant Removal: BMP must be sized using Worksheet B.5-1 and Worksheet B.5-4; **AND** Volume Retention: DMA must meet the target volume retention calculated using Worksheet B.5-2 (based on Figure B.5-2). Compliance with volume retention requirements can be documented using Worksheet B.5-3 (to estimate retention from the BMP) and/or Worksheet B.5-7 (if dispersion and/or amended soils are proposed) and/or by implementing other site design BMPs (e.g. rain barrels, trees, etc.).
	Compact Biofiltration BMPs: Pollutant Removal: BMP must meet the criteria in Appendix F. Form I-10 must be completed and submitted with the PDP SWQMP; **AND** Volume Retention: DMA must meet the target volume retention calculated using Worksheet B.5-2 (based on Figure B.5-2). Compliance with volume retention requirements can be documented using Worksheet B.5-3 (to estimate retention from the BMP) and/or Worksheet B.5-7 (if dispersion and/or amended soils are proposed) and/or by implementing other site design BMPs (e.g. rain barrels, trees, etc.).

Infiltration Feasibility Condition	Performance Standard
No Infiltration Condition (Based on Infiltration Feasibility Condition Letter and/or Worksheet C.4-1: Form I-8A and/or Worksheet C.4-2: Form I-8B) [There is no hierarchy in selecting the type of biofiltration BMP as long as the performance standard for the selected biofiltration BMP is met]	**Standard Biofiltration BMPs:** BMPs must meet the criteria in Appendix B.5.1.2
	Non-Standard Biofiltration BMPs: Pollutant Removal: BMP must be sized using Worksheet B.5-1 and Worksheet B.5-4; **AND** Volume Retention: DMA must meet the target volume retention calculated using Worksheet B.5-2 (based on Figure B.5-2). Compliance with volume retention requirements can be documented by: • DMA has a combined BMP footprint and landscaped area (that meet the criteria in SD-B and SD-F factsheet) of 3% of contributing area times adjusted runoff factor or greater. The landscaped area must have an impervious area to pervious area ratio greater than 1.5:1. This can be documented using Worksheet B.5-6. [OR] • Applicant has an option to use other site design BMPs that will meet the target volume retention calculated using Worksheet B.5-2. This can be documented using Worksheet B.5-6 and/or Worksheet B.5-7.
	Compact Biofiltration BMPs: Pollutant Removal: BMP must meet the criteria in Appendix F. Form I-10 must be completed and submitted with the PDP SWQMP; **AND** Volume Retention: DMA must meet the target volume retention calculated using Worksheet B.5-2 (based on Figure B.5-2). Compliance with volume retention requirements can be documented by: • DMA has a combined BMP footprint and landscaped area (that meet the criteria in SD-B and SD-F factsheet) of 3% of contributing area times adjusted runoff factor or greater. The landscaped area must have an impervious area to pervious area ratio greater than 1.5:1. This can be documented using Worksheet B.5-6. [OR] • Applicant has an option to use other site design BMPs that will meet the target volume retention calculated using Worksheet B.5-2. This can be documented using Worksheet B.5-6 and/or Worksheet B.5-7.

B.5.1 Standard Biofiltration BMP Sizing

B.5.1.1 Standard Biofiltration Sizing for Partial Infiltration Condition

If a BMP meets the following criteria and the design criteria in PR-1 fact sheet (**Appendix E.17**), then the BMP is considered to meet its pollutant control performance standard.

1. DMA is categorized as "partial infiltration condition". Completed Worksheet C.4-1: Form I-8A and Worksheet C.4-2: Form I-8B are submitted with the PDP SWQMP;
2. BMP has a media surface area of 3% of contributing area times adjusted runoff factor or greater and does not have an impermeable liner on the bottom of the BMP;
3. Additional documentation (**Worksheet B.5-1**) that show the pollutant control requirements are met is included in the SWQMP submittal if the media filtration rate of the BMP is outlet controlled (example for outlet control: underdrain outlet retrofitted with an orifice cap that controls the filtration flow rate); **AND**
4. BMP provides an aggregate storage thickness greater than the thickness specified in **Table B.5-2** below the underdrain invert.

Table B.5-2. Reliable infiltration rate versus required aggregate storage

Reliable Infiltration Rate (in/hr.)	Minimum Aggregate Storage Thickness (inches) below the underdrain invert
≥ 0.05 in/hr. and ≤ 0.10 in/hr.	6 inches
> 0.10 in/hr. and ≤ 0.15 in/hr.	12 inches
> 0.15 in/hr. and < 0.50 in/hr.	18 inches

Note: For biofiltration BMP sizing, the design infiltration rate must be calculated using a factor of safety of 2 i.e., **Reliable infiltration rate = Measured infiltration rate/2.**

When mapped hydrologic soil groups are used for feasibility screening, applicants are allowed to use the following reliable infiltration rates for sizing partial retention BMPs:

- Reliable infiltration rate for NRCS Type D soils = 0.05 in/hr.
- Reliable infiltration rate for NRCS Type C soils = 0.15 in/hr.

The applicant also has an option to perform infiltration testing in lieu of using the rates listed above.

To document compliance applicant must include the following information in the SWQMP submittal for each standard BMP:

- Required BMP Footprint = Area draining to the BMP * Adjusted runoff factor * 0.03;
- Provided BMP Footprint;
- Reliable Infiltration rate;
- Provided aggregate storage thickness below the underdrain invert;
- Documentation that shows the BMP meets the requirements in PR-1 fact sheet (**Appendix E.17**); and
- Completed Worksheet B.5-1 if the BMP is the outlet controlled. Worksheet B.5-1 is not required if the BMP is not outlet controlled.

B.5.1.2 Standard Biofiltration Sizing in No Infiltration Condition

If a BMP meets the following criteria and the design criteria in BF-1 fact sheet (**Appendix E.18**), then the BMP is considered to meet its pollutant control performance standard.

1. DMA is categorized as "no infiltration condition". Completed "Infiltration Feasibility Condition Letter" or Worksheet C.4-1: Form I-8A or Worksheet C.4-2: Form I-8B that supports the categorization submitted with the PDP SWQMP;

2. BMP has a media surface area of 3% of contributing area times adjusted runoff factor or greater and has an impermeable liner on the bottom of the BMP (applicant also has an option to not install an impermeable liner on the bottom of the BMP if there are no geotechnical/groundwater hazards identified while completing forms in **Appendix C**); **AND**

3. Additional documentation (**Worksheet B.5-1**) that show the pollutant control requirements are met is included in the SWQMP submittal if the media filtration rate of the BMP is outlet controlled (example for outlet control: underdrain outlet retrofitted with an orifice cap that controls the filtration flow rate).

To document compliance applicant must include the following information in the SWQMP submittal for each standard BMP:

- Required BMP Footprint = Area draining to the BMP * Adjusted runoff factor * 0.03;
- Provided BMP Footprint;
- Documentation that shows the BMP meets the requirements in BF-1 fact sheet (**Appendix E.18**); and
- Completed Worksheet B.5-1 if the BMP is the outlet controlled. Worksheet B.5-1 is not required if the BMP is not outlet controlled.

BMPs that meet the criteria in **Appendix B.5.1** are not required to complete and submit Worksheets in **Appendix B.5.2** in the PDP SWQMP submittal (except in scenarios where the biofiltration BMP is outlet controlled in this case applicant must complete Worksheet B.5-1 and include in the SWQMP submittal).

B.5.2 Non-Standard and Compact Biofiltration BMP Sizing

The following worksheets were developed for project applicants electing to use non-standard non-proprietary biofiltration BMPs and/or use compact biofiltration BMPs.

- **Worksheet B.5.1**: Sizing Method for Pollutant Removal Criteria
- **Worksheet B.5.2**: Sizing Method for Volume Retention Criteria
- **Worksheet B.5.3**: Volume Retention from Biofiltration with Partial Retention BMPs
- **Worksheet B.5.4**: Alternative Minimum Footprint Sizing Factor for Non-Standard Biofiltration
- **Worksheet B.5.5**: Optimized Biofiltration BMP Footprint when Downstream of a Storage Unit
- **Worksheet B.5.6**: Volume Retention for No Infiltration Condition
- **Worksheet B.5.7**: Volume Retention from Amended Soils

Notes:

1. Project applicants that meet the criteria in Appendix B.5.1 are not required to complete the worksheets in Appendix B.5.2.
2. Project applicants have an option to perform continuous simulation (following guidelines in Appendix G) to document conformance with the performance standard from Chapter 2 in lieu of using the worksheets in Appendix B.5.2.
    - If an applicant elects to perform continuous simulation, the applicant must model both the standard configuration (impervious footprint draining to a 3% biofiltration BMP) and the proposed configuration to show that proposed configuration would achieve volume reduction equal to or greater than the standard configuration. The modeling analysis must be documented in the PDP SWQMP.

Design Assumptions:

For the footprint of non-proprietary BMPs, applicants are allowed to use the plan view area at the surface of the BMP before any ponding, when performing sizing calculations using worksheets presented in **Appendix B.5.2**.

One of the following two methods may also be acceptable:

- **Method 1: Effective area/effective depth method**. This method involves determining the effective depth of water stored in the BMP and identifying the effective area at that elevation. For systems with vertical walls, the effective area is simply the plan view area. For systems with side slopes, the effective area can be approximated as the plan view area inundated when the ponded depth is half full. This is the area of the contour at an elevation half way between the surface of the BMP and the overflow elevation.
- **Method 2: Area takeoff/trapezoidal method**. For more complex BMP geometries, it may be necessary to perform area takeoffs at regular contour intervals within the BMP and apply trapezoidal geometry calculations. The effectively breaks the BMP into horizontal slices. Each horizontal "slice" would have a vertical thickness, an average surface area, and an effective porosity. The product of these values is the storage volume in the slice. The sum of all slices is the total storage volume. The effective area can then be estimated by dividing the total storage volume with depth.

In both methods, volume should only be tabulated below the overflow or bypass elevation of the BMP. Surcharge or freeboard storage should not be included in calculations. When one of the above two methods are used detailed calculations must be included in the SWQMP submittal.

Area draining to the BMP must also include the area of the BMP. Use runoff factor for impervious area (i.e. concrete or asphalt) for the area of the BMP to determine the composite runoff factor for the DMA.

If an applicant performs site-specific testing using a device that has a precision of 0.1 in/hr. and determines that the measured infiltration rates in the DMA are less than 0.1 in/hr., then the applicant is allowed to size the biofiltration BMP assuming the DMA is a "No Infiltration Condition". In instances where the actual infiltration is not measured because the testing device has a precision of 0.1 in/hr., if the applicant elects to propose a non-Standard or a compact biofiltration BMP then a reliable infiltration rate of 0.025 in/hr. must be used to size site design BMPs when there are no geotechnical and/or groundwater hazards identified in **Appendix C**.

If there are geotechnical and/or groundwater hazards identified in **Appendix C**, then the applicant must use a reliable infiltration rate of 0.0 in/hr. for estimating the target volume retention and sizing equivalent site design BMPs.

The 36-hour drawdown percent capture nomograph that can be used to estimate the fraction of the DCV that must be retained to meet the average annual capture performance standard is presented in **Figure B.5-3** below.

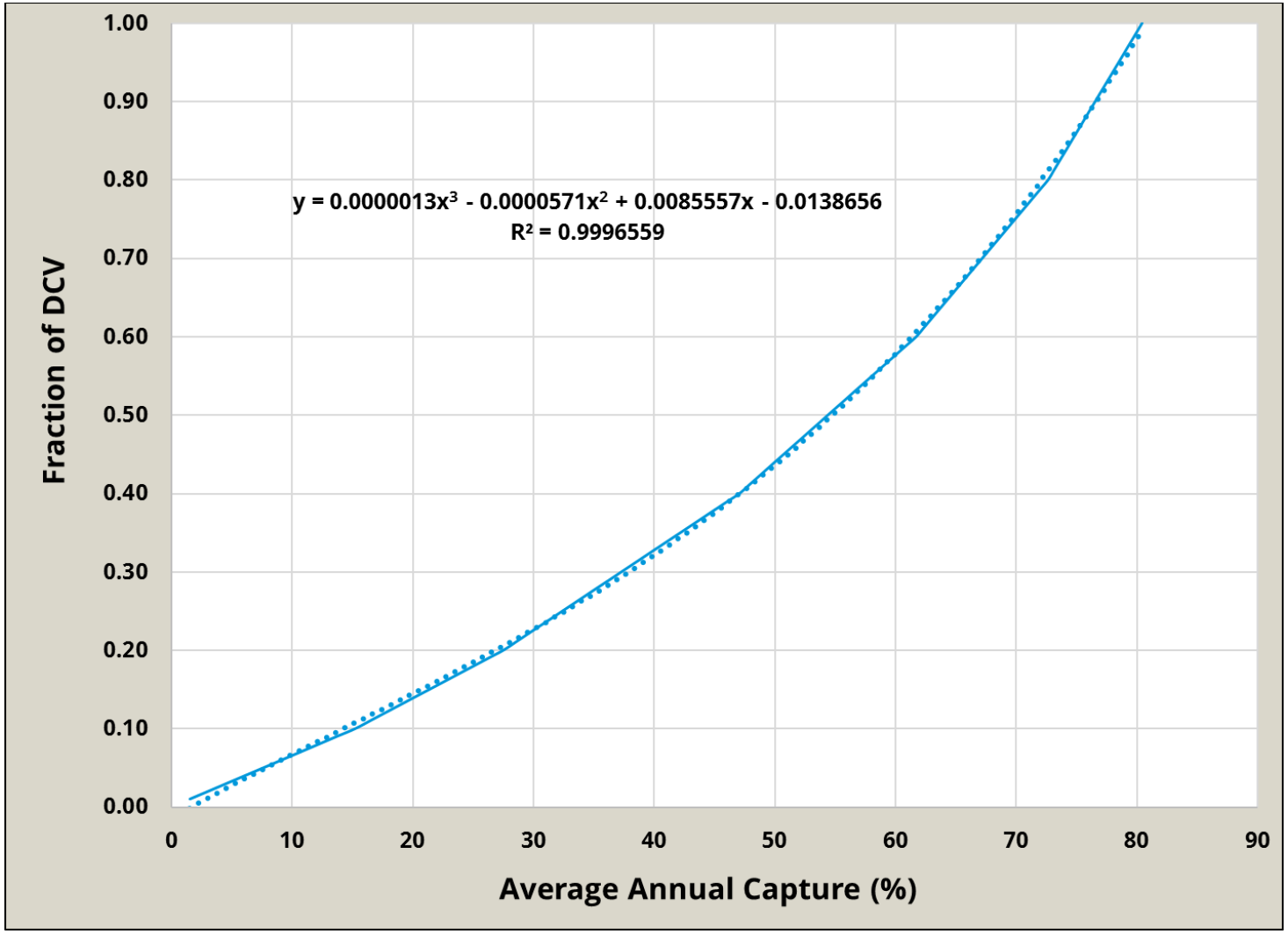

Figure B.5-3. Fraction of DCV versus Average Annual Capture

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Worksheet B.5-1: Sizing Method for Pollutant Removal Criteria

Sizing Method for Pollutant Removal Criteria		Worksheet B.5-1	
1	Area draining to the BMP		sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)		
3	85th percentile 24-hour rainfall depth		inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]		cu. ft.
BMP Parameters			
5	Surface ponding [6 inch minimum, 12 inch maximum]		inches
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations		inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical) – use 0 inches if the aggregate is not over the entire bottom surface area		inches
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area		inches
9	Freely drained pore storage of the media	0.2	in/in
10	Porosity of aggregate storage	0.4	in/in
11	Media filtration rate to be used for sizing (maximum filtration rate of 5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate (includes infiltration into the soil and flow rate through the outlet structure) which will be less than 5 in/hr.)		in/hr.
Baseline Calculations			
12	Allowable routing time for sizing	6	hours
13	Depth filtered during storm [Line 11 x Line 12]		inches
14	Depth of Detention Storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]		inches
15	Total Depth Treated [Line 13 + Line 14]		inches
Option 1 – Biofilter 1.5 times the DCV			
16	Required biofiltered volume [1.5 x Line 4]		cu. ft.
17	Required Footprint [Line 16/ Line 15] x 12		sq. ft.
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
18	Required Storage (surface + pores) Volume [0.75 x Line 4]		cu. ft.
19	Required Footprint [Line 18/ Line 14] x 12		sq. ft.
Footprint of the BMP			
20	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Line 11 in Worksheet B.5-4)		
21	Minimum BMP Footprint [Line 1 x Line 2 x Line 20]		sq. ft.
22	Footprint of the BMP = Maximum (Minimum (Line 17, Line 19), Line 21)		sq. ft.
23	Provided BMP Footprint		sq. ft.
24	Is Line 23 ≥ Line 22? If Yes, then footprint criterion is met. If No, increase the footprint of the BMP.	☐ Yes	☐ No

E.18 BF-1 Biofiltration

Location: 43rd Street and Logan Avenue, San Diego, California

MS4 Permit Category
Biofiltration
Manual Category
Biofiltration
Applicable Performance Standard
Pollutant Control Flow Control
Primary Benefits
Treatment Volume Reduction (Incidental) Peak Flow Attenuation (Optional)

Description

Biofiltration (Bioretention with underdrain) facilities are vegetated surface water systems that filter water through vegetation, and soil or engineered media prior to discharge via underdrain or overflow to the downstream conveyance system. Bioretention with underdrain facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. Because these types of facilities have limited or no infiltration, they are typically designed to provide enough hydraulic head to move flows through the underdrain connection to the storm drain system. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and plant uptake.

Typical bioretention with underdrain components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer (aka choking layer) consisting of aggregate to prevent the migration of fines into uncompacted native soils or the aggregate storage layer
- Aggregate storage layer with underdrain(s)
- Impermeable liner or uncompacted native soils at the bottom of the facility
- Overflow structure

Design Adaptations for Project Goals

Biofiltration Treatment BMP for storm water pollutant control. The system is lined or un-lined to provide incidental infiltration, and an underdrain is provided at the bottom to carry away filtered runoff. This configuration is considered to provide biofiltration treatment via flow through the media layer. Storage provided above the underdrain within surface ponding, media, and aggregate storage is considered included in the biofiltration treatment volume. Saturated storage within the aggregate storage layer can be added to this design by raising the underdrain above the bottom of the aggregate storage layer or via an internal weir structure designed to maintain a specific water level elevation.

Integrated storm water flow control and pollutant control configuration. The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer above the underdrain. This will allow for significant detention storage, which can be controlled via inclusion of an outlet structure at the downstream end of the underdrain.

Recommended Siting Criteria

	Siting Criteria	Intent/Rationale
□	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
□	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
□	Contributing tributary area shall be ≤ 5 acres (≤ 1 acre preferred).	Bigger BMPs require additional design features for proper performance. Contributing tributary area greater than 5 acres may be allowed at the discretion of the City Engineer if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimizing short circuiting of flows in the BMP and 2) incorporate additional design features requested by the City Engineer for proper performance of the regional BMP.
□	Finish grade of the facility is ≤ 2%.	Flatter surfaces reduce erosion and channelization within the facility.

Example Schematic Design – Plan and Section View

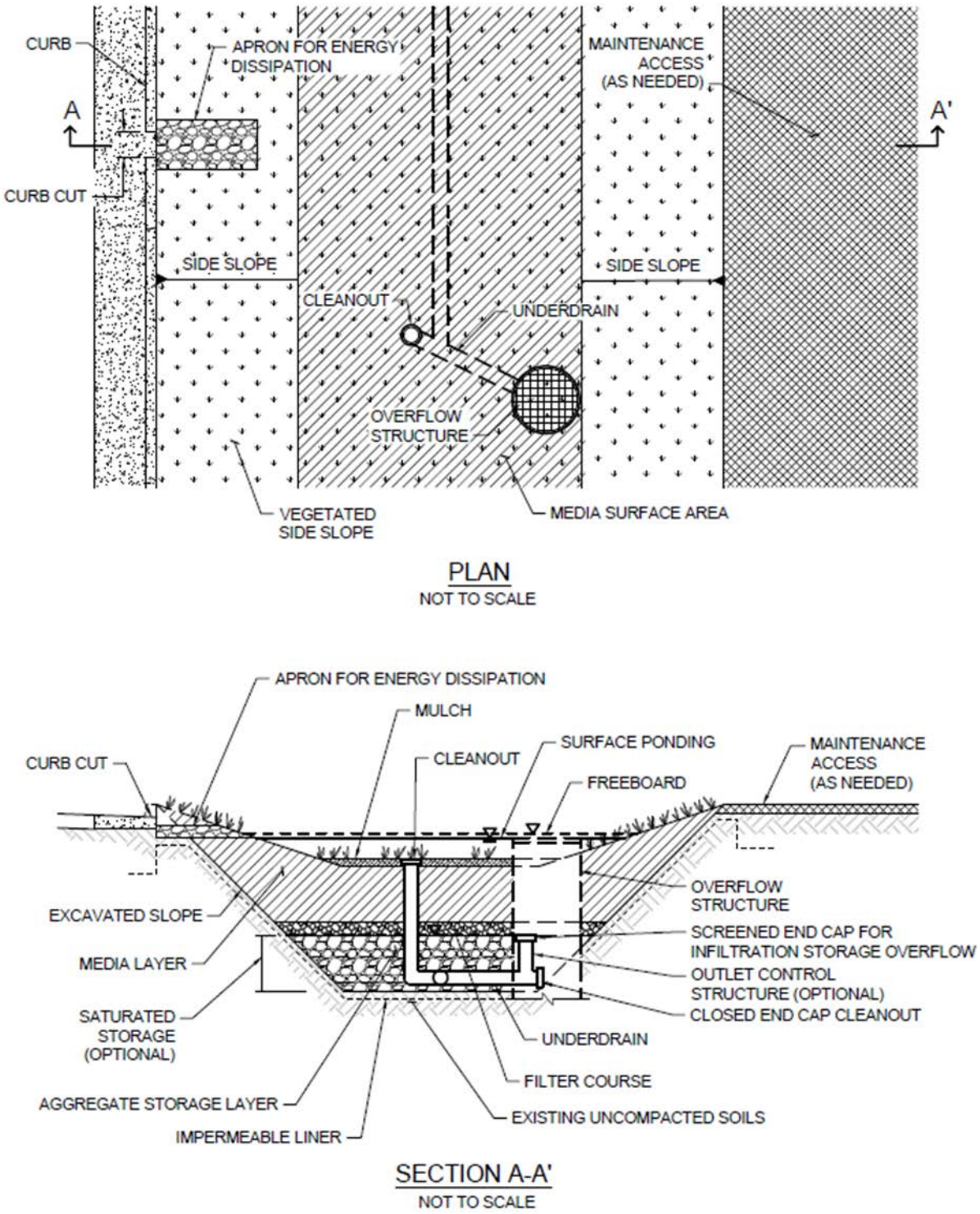

Figure E.18-1 : Typical Plan and Section View of a Biofiltration BMP

Recommended BMP Component Dimensions

BMP Component	Dimension	Intent/Rationale
Freeboard	≥ 2 inches	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
Surface Ponding	≥ 6 and ≤ 12 inches	The minimum ponding depth is required so that the runoff is uniformly spread throughout the basin (minimizes the likelihood of short circuiting). Deep surface ponding raises safety concerns. When the BMP is adjoining walkways the minimum surface ponding depth can be reduced to 4 inches. Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of the City Engineer if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18" will require a fence) and 3) potential for elevated clogging risk is evaluated (Worksheet B.5.4).
Ponding Area Side Slopes	3H:1V or shallower	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
Mulch	≥ 3 inches	Mulch will suppress weeds and maintain moisture for plant growth.
Media Layer	≥ 18 inches	A deep media layer provides additional filtration and supports plants with deeper roots. Where the minimum depth of 18 inches is used, only shallow-rooted species shall be planted. A minimum 24-inch media layer shall typically be required to support vegetation, with a minimum 36-inch media layer depth required for trees.
Filter Course	6 inches	To reduce clogging potential, a two-layer filter course (aka choking stone system) is used consisting of one 3" layer of clean and washed ASTM 33 Fine Aggregate Sand overlying a 3" layer of ASTM No 8 Stone (Appendix F.4). This specification has been developed to maintain permeability while limiting the migration of media material into the stone reservoir and underdrain system.
Underdrain Diameter	≥ 8 inches	Minimum diameter required for maintenance by City crews. For privately maintained BMPs, a minimum underdrain diameter of 6 inches is allowed.
Cleanout Diameter	≥ 8 inches	Facilitates simpler cleaning, when needed. For privately maintained BMPs, cleanout diameter of 6 inches is allowed.

Deviations to the recommended BMP component dimensions may be approved at the discretion of the City Engineer if it is determined to be appropriate.

Design Criteria and Considerations

Bioretention with underdrain must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

	Design Criteria	Intent/Rationale
Surface Ponding		
□	Surface ponding is limited to a 24-hour drawdown time.	Surface ponding limited to 24 hour for plant health. Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of the City Engineer if certified by a landscape architect or agronomist.
Vegetation		
□	Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.26.	Plants suited to the climate and ponding depth are more likely to survive.
□	An irrigation system with a connection to water supply should be provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
Mulch		
□	A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows the beneficial microbes to multiply.
Media Layer		
□	Media maintains a minimum filtration rate of 5 in/hr. over lifetime of facility. Additional Criteria for media hydraulic conductivity described in the bioretention soil media model specification (Appendix F.3)	A filtration rate of at least 5 inches per hour allows soil to drain between events. The initial rate should be higher than long term target rate to account for clogging over time. However an excessively high initial rate can have a negative impact on treatment performance, therefore an upper limit is needed.

	Design Criteria	Intent/Rationale
□	Media shall be a minimum 18 inches deep for filtration purposes, with a minimum 24-inch media layer depth typically required to support vegetation and a minimum 36-inch media layer depth required for trees. Media shall meet the following specifications. Model bioretention soil media specification provided in Appendix F.3 or County of San Diego Low Impact Development Handbook: Appendix G - Bioretention Soil Specification (June 2014, unless superseded by more recent edition). Alternatively, for proprietary designs and custom media mixes not meeting the media specifications, the media meets the pollutant treatment performance criteria in Section F.1.	A deep media layer provides additional filtration and supports plants with deeper roots. Standard specifications shall be followed. For non-standard or proprietary designs, compliance with Appendix F.1 ensures that adequate treatment performance will be provided.
□	Media surface area is 3% of contributing area times adjusted runoff factor or greater. Unless demonstrated that the BMP surface area can be smaller than 3%.	Greater surface area to tributary area ratios: a) maximizes volume retention as required by the MS4 Permit and b) decrease loading rates per square foot and therefore increase longevity. Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance. Refer to Appendix B.5 for guidance to support use of smaller than 3% footprint..
□	Where receiving waters are impaired or have a TMDL for nutrients, the system is designed with nutrient sensitive media design (see fact sheet BF-2).	Potential for pollutant export is partly a function of media composition; media design must minimize potential for export of nutrients, particularly where receiving waters are impaired for nutrients.
Filter Course Layer		
□	A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade and can result in poor water quality performance for turbidity and suspended solids. Filter fabric is more likely to clog.
□	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
□	To reduce clogging potential, a two-layer filter course (aka choking stone system) is used consisting of one 3" layer of clean and washed ASTM 33 Fine Aggregate Sand overlying a 3" layer of ASTM No 8 Stone (Appendix F.4).	This specification has been developed to maintain permeability while limiting the migration of media material into the stone reservoir and underdrain system.

	Design Criteria	Intent/Rationale
Aggregate Storage Layer		
□	ASTM #57 open graded stone is used for the storage layer and a two layer filter course (detailed above) is used above this layer	This layer provides additional storage capacity. ASTM #8 stone provides an acceptable choking/bridging interface with the particles in ASTM #57 stone.
□	The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
Inflow, Underdrain, and Outflow Structures		
□	Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
□	Inflow velocities are limited to 3 ft./s or less or use energy dissipation methods. (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
□	Curb cut inlets are at least 18 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.
□	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
□	Minimum underdrain diameter is 8 inches.	Minimum diameter required for maintenance by City crews. For privately maintained BMPs, a minimum underdrain diameter of 6 inches is allowed.
□	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
□	An underdrain cleanout with a minimum 8-inch diameter and lockable cap is placed every 50 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance. For privately maintained BMPs, cleanout diameter of 6 inches is allowed.
□	Overflow is safely conveyed to a downstream storm drain system or discharge point Size overflow structure to pass 100-year peak flow for on-line infiltration basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.
Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only		

To design bioretention with underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Calculate the DCV per **Appendix B** based on expected site design runoff for tributary areas.
3. Use the sizing worksheet presented in **Appendix B.5** to size biofiltration BMPs.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in **Chapter 6** of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If biofiltration with underdrain cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with significant storage volume such as an underground vault can be used to provide remaining controls.
4. After biofiltration with underdrain has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

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ENGINEERED SOLUTIONS

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Detention & Infiltration

The experts you need to solve your stormwater challenges

Contech is the leader in stormwater solutions, helping engineers, contractors and owners with infrastructure and land development projects throughout North America.

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Your Contech Team

STORMWATER CONSULTANT

It's my job to recommend the best solution to meet permitting requirements.

STORMWATER DESIGN ENGINEER

I work with consultants to design the best approved solution to meet your project's needs.

REGULATORY MANAGER

I understand the local stormwater regulations and what solutions will be approved.

SALES ENGINEER

I make sure our solutions meet the needs of the contractor during construction.

Contech is your partner in stormwater management solutions

Detention and Infiltration Solutions by Contech

One of the essential functions of a stormwater management system is to control the quantity of runoff leaving a site. There are various ways to do this. Common methods are detention ponds and other land based solutions.

The problem with ponds is that they take up valuable land space. This is not a major issue in rural areas, but in urban environments where land space is limited and expensive, the use of ponds is simply not an option.

Where there are competing demands for land, underground storage can provide many of the benefits of landscape-based systems but without requiring dedicated land area, thus maximizing the land value for the owner. In addition, subsurface infiltration in urban environments meets the objectives of Low Impact Development by reducing runoff and recharging groundwater.

Contech helps engineers and owners maximize land value by providing solutions for storing stormwater underground. Our underground systems offer you flexibility and customization to accommodate a variety of site conditions and storage volume requirements.

CMP Detention and Infiltration Solutions

DuroMaxx® SRPE Pipe for Stormwater Detention

ChamberMaxx® Stormwater Chamber System

Concrete Detention & Infiltration Solutions with CON/SPAN®

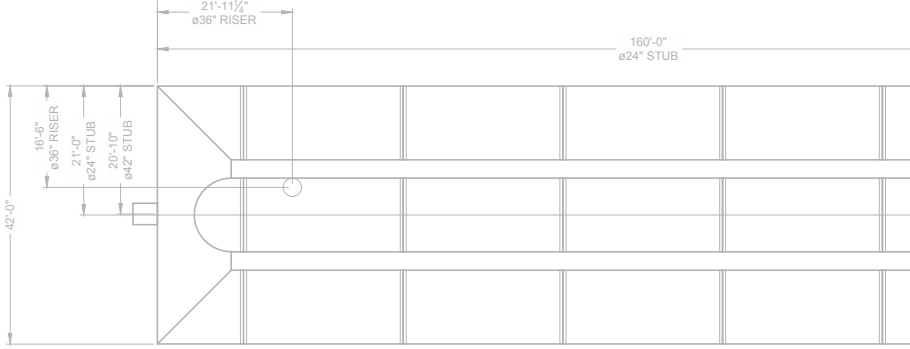
Corrugated Metal Pipe
The “Go To” Material for Stormwater Detention

For the majority of applications, corrugated metal pipe (CMP) is the “go to” material for stormwater detention and infiltration. With its low cost, a wide variety of diameters, layout configurations and coatings, no other material can match CMP’s flexibility and versatility.

- NCSPA service life guidance of 75+ years for certain materials in recommended environments. Please refer to the Corrugated Metal Pipe Detention Design Guide for additional information.
- Various pipe coatings and materials are available to accommodate site-specific needs: Aluminized Steel Type 2 (ALT2), Galvanized, CORLIX® Aluminum, and Polymeric.
- Wide range of gages, corrugations, and shapes, diameters 12”– 144”
- Pipe can be fully or partially perforated for infiltration or groundwater recharge applications
- Custom risers and manifolds provide direct access for maintenance
- Outlet control devices can be incorporated within the system, eliminating the need for a separate structure
- Customizable - a variety of fittings allow CMP to match most layout configurations
- May be designed for heavy loading and high maximum cover
- Contributes to LEED points
- Available locally; quick turnaround time
- The most economical installed solution

No other material can match the flexibility and versatility of CMP

System Sizing



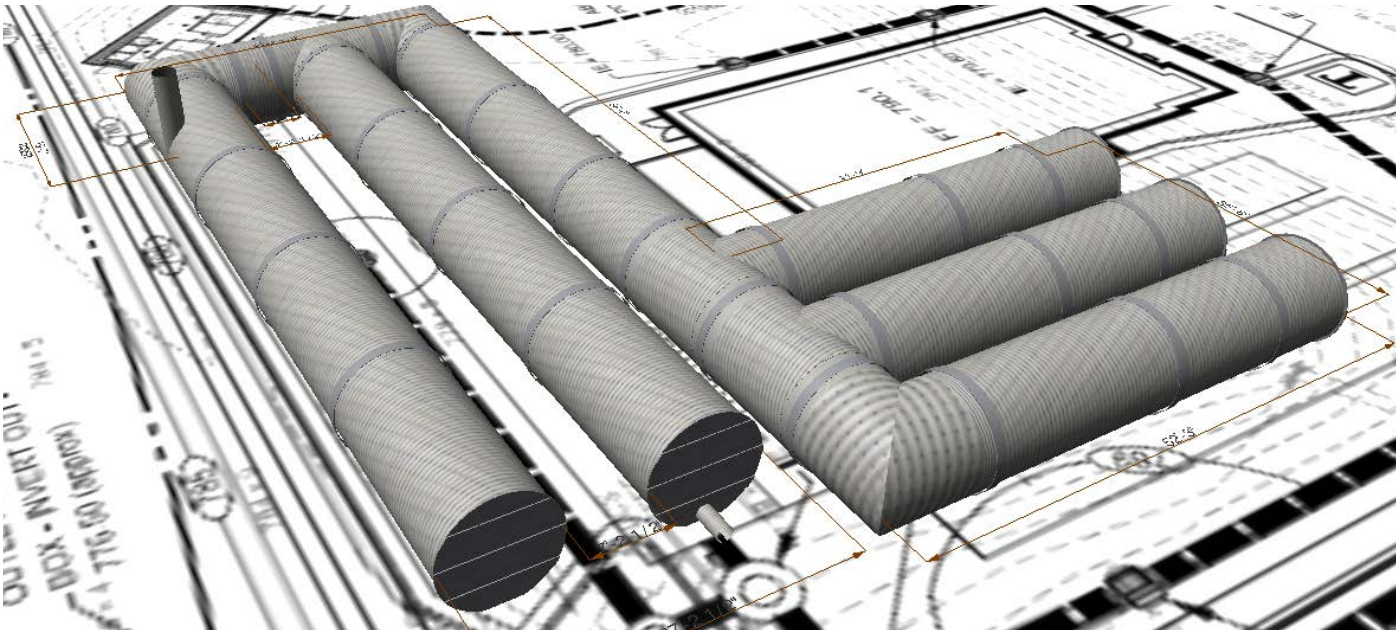
APPLICATION TIPS

- Use the largest diameter pipe possible to maximize vertical storage space and minimize the overall footprint. Doing so will reduce material, excavation, and backfill costs.
- Single manifold systems are most cost effective as they reduce the amount of fabrication needed.
- Incorporating flow controls into the CMP system can reduce costs by eliminating the need for additional concrete structures.
- The Contech MOBILE PIPE® mill can be delivered to remote locations and assembled on-site for fast and cost effective steel pipe manufacturing.

DIAMETER (IN)	VOLUME (FT^3/FT)	MIN. COVER HEIGHT
6	0.20	12″
8	0.35	12″
10	0.55	12″
12	0.78	12″
15	1.22	12″
18	1.76	12″
21	2.40	12″
24	3.14	12″
30	4.90	12″
36	7.10	12″
42	9.60	12″
48	12.60	12″
54	15.90	12″
60	19.60	12″
66	23.80	12″
72	28.30	12″
78	33.20	12″
84	38.50	12″
90	44.20	12″
96	50.30	12″
102	56.80	18″
108	63.60	18″
114	70.90	18″
120	78.50	18″
126	86.60	18″
132	95.00	18″
138	103.90	18″
144	113.10	18″

Because of its low cost and flexible configurations, CMP is the ‘go to’ material for stormwater detention and filtration.

Design Your Own Detention System (DYODS®)



Learn More:
www.ContechES.com/designcenter

Quickly prepare designs for estimates and project meetings ...

Engineers are always looking for new ways to quickly prepare designs for estimates and project meetings. We have a tool that does just that… the Design Your Own Detention System (DYODS®) tool.

Part of the Contech Design Center, this free, online tool fully automates the layout process for stormwater detention and infiltration systems. The tool allows you to design systems using corrugated metal pipe (CMP), ChamberMaxx® plastic chambers, or DuroMaxx® steel reinforced polyethylene (SRPE). You can also create multiple systems for each project while saving all project information for future use.

- "Drag and drop" feature allows users to customize layout
- A 2D/3D design environment with high-resolution graphics including BIM model output
- Optimize designs for the storage requirement or maximize storage for a given footprint
- Import a PDF site plan, scale and design a system over the plan and view the overlay in 2D
- Instant access to customized, project specific drawings, and CAD files
- Ability to co-workers or Contech design engineers to your project with the new Collaborator feature

CONTECH® DESIGNCENTER
DESIGN MADE EASY

A free, online tool that fully automates the layout process for stormwater detention systems.

Protecting Detention and Infiltration Systems

Pretreatment can mean a huge difference in maintenance ...

By their very nature, detention systems are difficult to inspect and maintain. The selection of a cost-effective and easy-to-access treatment system can mean a huge difference in maintenance expenses for years to come.

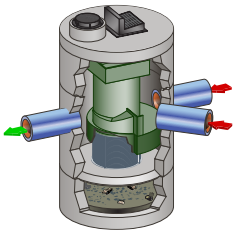
It is in the design engineer's best interest to provide an aggressive pretreatment practice prior to infiltrating the water quality flow or greater flow events. Unforeseen upstream construction, erosion, annual tree debris, and winter maintenance treatments can quickly occlude infiltration facilities, putting them at risk for hydraulic failure and reducing water quality benefits.

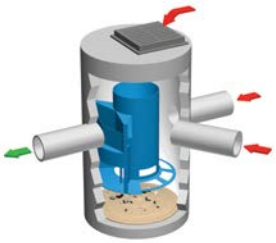
The CDS® hydrodynamic separator is the preferred pretreatment device. CDS uses swirl concentration and continuous deflective separation to screen, separate and trap trash, debris, sediment, and hydrocarbons from runoff. CDS provides unobstructed access to stored pollutants, making it easy to maintain. Maintaining a CDS is a simple process that can be easily accomplished using a vacuum truck, with no requirement to enter the unit.

CDS is the preferred pretreatment device

Pretreatment Options

Contech offers a number of pretreatment options, all of which will extend the life of subsurface infiltration systems and improve water quality. The type of system chosen will depend on a number of factors including footprint, soil conditions, local regulations, and the desired level of pretreatment.





Hydrodynamic Separation

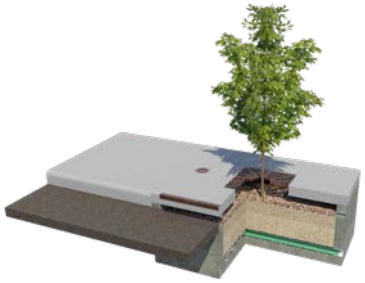
Hydrodynamic Separation (HDS) provides a basic level of pretreatment by capturing and retaining trash and debris, sediment, and oil from stormwater runoff.

CDS®

CDS provides superior trash and sediment removal, and is much easier to clean and maintain compared to the infiltration system itself.

Cascade Separator®

The Cascade Separator uses advanced sediment capture technology to provide the highest sediment removal efficiency to protect the stone backfill voids of infiltration systems, thus extending the life of the system.



Filtration

Filtration provides a higher level of pretreatment and improved water quality by removing trash and debris, oil, fine solids, and dissolved pollutants such as metals, hydrocarbons, and nutrients.

Filterra® Bioretention System

Filterra is an engineered bioretention system that has been optimized for high volume/flow treatment and high pollutant removal.

The Stormwater Management StormFilter®

The StormFilter system is comprised of a structure that houses rechargeable, media-filled cartridges. The media can be customized to target site-specific pollutants.

Jellyfish® Filter

The Jellyfish filter uses membrane filtration in a compact footprint to remove a high level and a wide variety of stormwater pollutants such as fine particulates, oil, trash and debris, metals, and nutrients.

A partner you can rely on

STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

Few companies offer the wide range of high-quality stormwater resources you can find with us — state-of-the-art products, decades of expertise, and all the maintenance support you need to operate your system cost-effectively.

THE CONTECH WAY

Contech® Engineered Solutions provides innovative, cost-effective site solutions to engineers, contractors, and developers on projects across North America. Our portfolio includes bridges, drainage, erosion control, retaining wall, sanitary sewer and stormwater management products.

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Revised PDF - 09/2021

Appendix 5 Calculations

The biofiltration planters were sized to hold the Design Control Volume (1.5 times the stormwater quality design volume) within the ponding and pore space (mulch, media, choking layer, and aggregate). Since the L.A. County LID Standards Manual did not have a porosity value for media and aggregate, the values from the City of San Diego's Storm Water Standards manual were used and the associated biofiltration planter sizing worksheet (Worksheet B.5-1) was adapted for the volume based biofiltration planter design.

Peak Flow Hydrologic Analysis

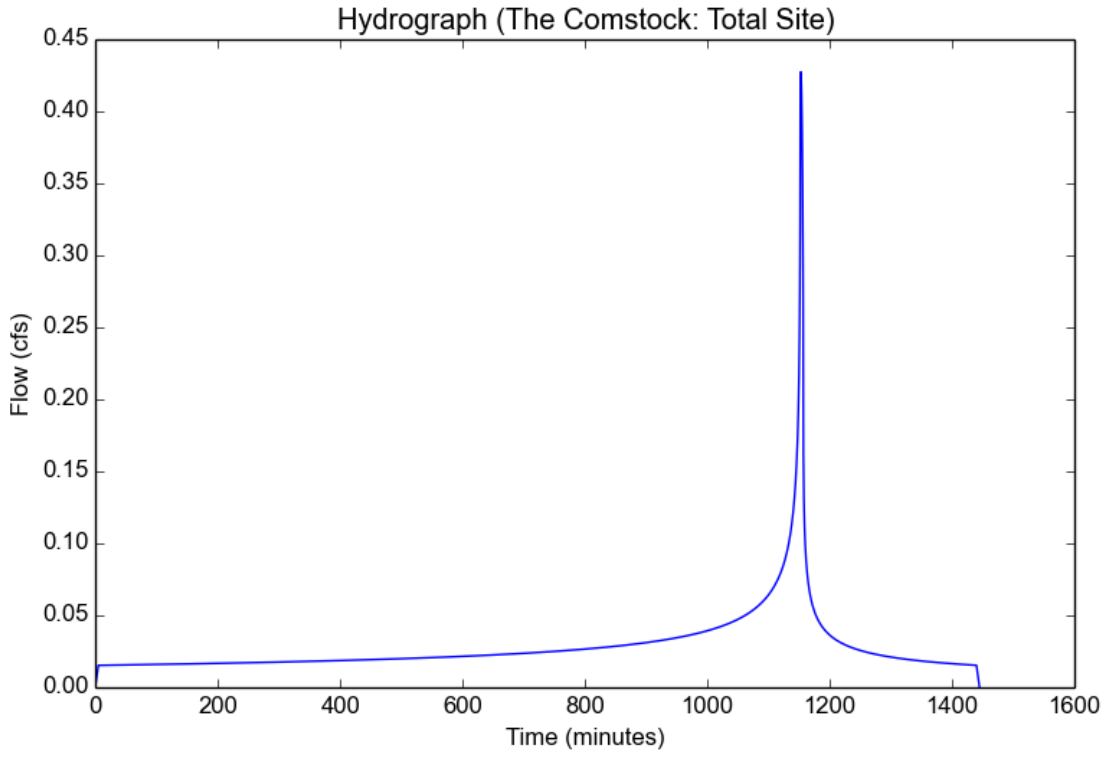
File location: C:/Users/Josh/KHR Associates Dropbox/R Drive/MW Investments/MW-Comstock-Whittier/Documents/LID/Appendix 5 Calculations/22-04-2
Version: HydroCalc 1.0.3

Input Parameters

Project Name	The Comstock
Subarea ID	Total Site
Area (ac)	0.82
Flow Path Length (ft)	30.0
Flow Path Slope (vft/hft)	0.025
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.93
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.5966
Undeveloped Runoff Coefficient (Cu)	0.5233
Developed Runoff Coefficient (Cd)	0.8736
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	0.4274
Burned Peak Flow Rate (cfs)	0.4274
24-Hr Clear Runoff Volume (ac-ft)	0.0573
24-Hr Clear Runoff Volume (cu-ft)	2495.328



BF-1: BIOFILTRATION SIZING WORKSHEET B.5-1		Drainage Management Area	DMA	Site
		BF-1 BMP ID		Site
This worksheet has been adapted from Worksheet B.5-1 from The City of San Diego's Storm Water Standards Manual in order to design the Biofiltration planter with adequate storage for the Biofiltration Volume within the system's pores and ponding area.				
Sizing Method				
1	Area Draining to the BMP		35,915	sq. ft.
2	Developed runoff coefficient (from HydroCalc)		0.8763	
3	$SWQD_V$ (from HydroCalc)		2,495	cu. ft.
4	Required Biofiltration Volume [1.5 x Line 3]		3,743	cu. ft.
BMP Parameters				
5	Surface Ponding [6 inch minimum, 18 inch maximum]		14	inches
6	Media thickness [24 inch minimum], also add mulch layer and and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations		30	inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical)		15	inches
8	Aggregate storage below underdrain invert (3 inches minimum)		3	inches
9	Freely drained pore storage of the media		0.2	in/in
10	Porosity of aggregate storage		0.4	in/in
11	Media filtration rate to be used for sizing (5 in/hr minimum, 12 in/hr maximum)		5	in/hr
Baseline Calculations				
12	Allowable routing time for sizing		6	hours
13	Depth filtered during storm [Line 11 x Line 12]		30	inches
14	Depth of detention storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]		27.2	inches
15	Total depth treated [Line 13 + Line 14]		57.2	inches
Store Biofiltration volume in pores and ponding				
16	Required footprint [Line 4/Line 14]x 12		1,651	sq. ft.
Footprint of the BMP				
20	Provided BMP footprint		1,664	sq. ft.
21	Provided BMP Volume [(Line 20 x Line 14)/ 12]]		3,772	cu. ft.
22	Is Line 21 ≥ Line 4?	**YES , Performance Standard is Met**		

Peak Flow Hydrologic Analysis

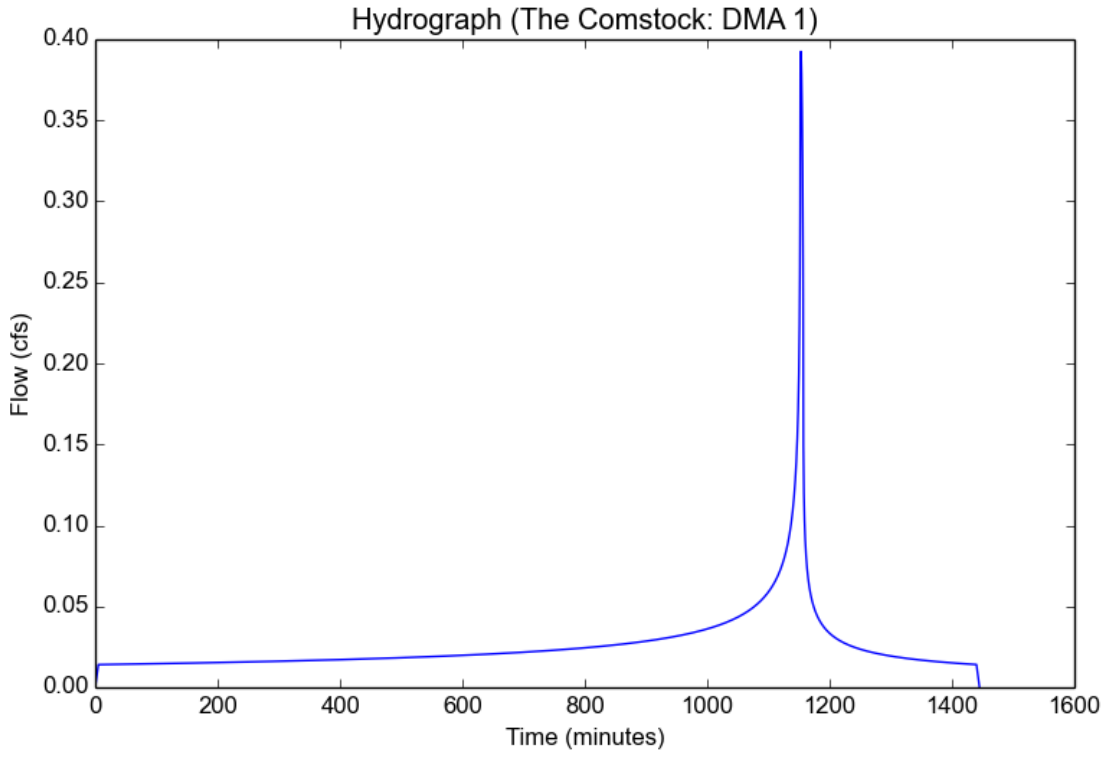
File location: C:/Users/Josh/KHR Associates Dropbox/R Drive/MW Investments/MW-Comstock-Whittier/Documents/LID/Appendix 5 Calculations/22-06-2
Version: HydroCalc 1.0.3

Input Parameters

Project Name	The Comstock
Subarea ID	DMA 1
Area (ac)	0.753
Flow Path Length (ft)	30.0
Flow Path Slope (vft/hft)	0.01
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.93
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.5966
Undeveloped Runoff Coefficient (Cu)	0.5233
Developed Runoff Coefficient (Cd)	0.8736
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	0.3925
Burned Peak Flow Rate (cfs)	0.3925
24-Hr Clear Runoff Volume (ac-ft)	0.0526
24-Hr Clear Runoff Volume (cu-ft)	2291.4414



BF-1: BIOFILTRATION SIZING WORKSHEET B.5-1		Drainage Management Area	DMA	1
		BF-1 BMP ID		A
This worksheet has been adapted from Worksheet B.5-1 from The City of San Diego's Storm Water Standards Manual in order to design the Biofiltration planter with adequate storage for the Biofiltration Volume within the system's pores and ponding area.				
Sizing Method				
1	Area Draining to the BMP		32,804	sq. ft.
2	Developed runoff coefficient (from HydroCalc)		0.8736	
3	$SWQD_V$ (from HydroCalc)		2,291	cu. ft.
4	Required Biofiltration Volume [1.5 x Line 3]		3,437	cu. ft.
BMP Parameters				
5	Surface Ponding [6 inch minimum, 18 inch maximum]		15	inches
6	Media thickness [24 inch minimum], also add mulch layer and and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations		30	inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical)		15	inches
8	Aggregate storage below underdrain invert (3 inches minimum)		3	inches
9	Freely drained pore storage of the media		0.2	in/in
10	Porosity of aggregate storage		0.4	in/in
11	Media filtration rate to be used for sizing (5 in/hr minimum, 12 in/hr maximum)		5	in/hr
Baseline Calculations				
12	Allowable routing time for sizing		6	hours
13	Depth filtered during storm [Line 11 x Line 12]		30	inches
14	Depth of detention storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]		28.2	inches
15	Total depth treated [Line 13 + Line 14]		58.2	inches
Store Biofiltration volume in pores and ponding				
16	Required footprint [Line 4/Line 14]x 12		1,462	sq. ft.
Footprint of the BMP				
20	Provided BMP footprint		1,506	sq. ft.
21	Provided BMP Volume [(Line 20 x Line 14)/ 12]]		3,539	cu. ft.
22	Is Line 21 ≥ Line 4?	**YES , Performance Standard is Met**		

Peak Flow Hydrologic Analysis

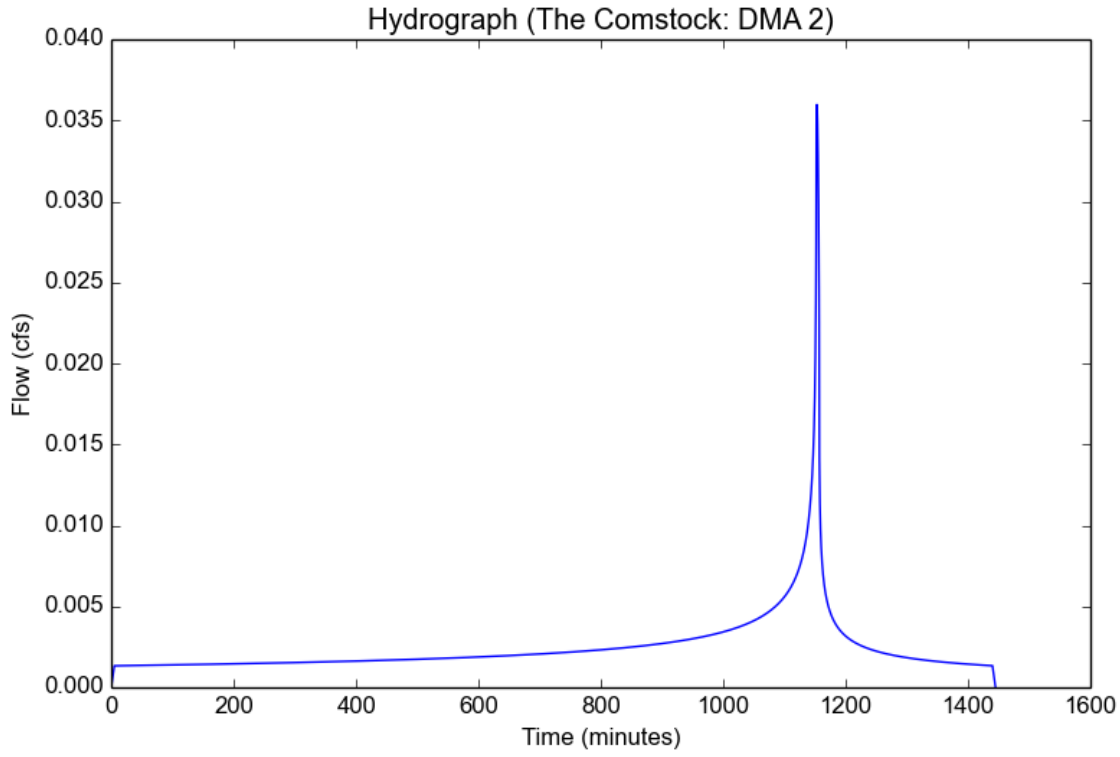
File location: C:/Users/Josh/KHR Associates Dropbox/R Drive/MW Investments/MW-Comstock-Whittier/Documents/LID/Appendix 5 Calculations/22-06-0
Version: HydroCalc 1.0.3

Input Parameters

Project Name	The Comstock
Subarea ID	DMA 2
Area (ac)	0.067
Flow Path Length (ft)	30.0
Flow Path Slope (vft/hft)	0.01
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	17
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.5966
Undeveloped Runoff Coefficient (Cu)	0.5233
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	0.036
Burned Peak Flow Rate (cfs)	0.036
24-Hr Clear Runoff Volume (ac-ft)	0.005
24-Hr Clear Runoff Volume (cu-ft)	217.0801



BF-1: BIOFILTRATION SIZING WORKSHEET B.5-1		Drainage Management Area	DMA	2
		BF-1 BMP ID		B
This worksheet has been adapted from Worksheet B.5-1 from The City of San Diego's Storm Water Standards Manual in order to design the Biofiltration planter with adequate storage for the Biofiltration Volume within the system's pores and ponding area.				
Sizing Method				
1	Area Draining to the BMP		3,111	sq. ft.
2	Developed runoff coefficient (from HydroCalc)		0.9000	
3	$SWQD_V$ (from HydroCalc)		217	cu. ft.
4	Required Biofiltration Volume [1.5 x Line 3]		326	cu. ft.
BMP Parameters				
5	Surface Ponding [6 inch minimum, 18 inch maximum]		12	inches
6	Media thickness [24 inch minimum], also add mulch layer and and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations		30	inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical)		15	inches
8	Aggregate storage below underdrain invert (3 inches minimum)		3	inches
9	Freely drained pore storage of the media		0.2	in/in
10	Porosity of aggregate storage		0.4	in/in
11	Media filtration rate to be used for sizing (5 in/hr minimum, 12 in/hr maximum)		5	in/hr
Baseline Calculations				
12	Allowable routing time for sizing		6	hours
13	Depth filtered during storm [Line 11 x Line 12]		30	inches
14	Depth of detention storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]		25.2	inches
15	Total depth treated [Line 13 + Line 14]		55.2	inches
Store Biofiltration volume in pores and ponding				
16	Required footprint [Line 4/Line 14]x 12		155	sq. ft.
Footprint of the BMP				
20	Provided BMP footprint		158	sq. ft.
21	Provided BMP Volume [(Line 20 x Line 14)/ 12]]		332	cu. ft.
22	Is Line 21 ≥ Line 4?	**YES , Performance Standard is Met**		

Appendix 6 Soils Report

May 17, 2021 Project No. 21051-01

Mr. Matthew J. Waken
MW Investment Group, LLC
27702 Crown Valley Parkway, Suite D-4-197
Ladera Ranch, CA 92694

Subject: ***Preliminary Geotechnical Evaluation and Recommendations, Proposed Multi-Family Residential Development Located at the Intersection of Philadelphia Street and Comstock Avenue, Whittier, California***

In accordance with your request and authorization, LGC Geotechnical, Inc. has performed a preliminary geotechnical evaluation for the proposed multi-family residential development located at the intersection of Philadelphia Street and Comstock Avenue in the City of Whittier, California. The purpose of our study was to evaluate the existing onsite geotechnical conditions and to provide geotechnical recommendations, including infiltration testing, relative to the proposed residential development.

Should you have any questions regarding this report, please do not hesitate to contact our office. We appreciate this opportunity to be of service.

Respectfully Submitted,

LGC Geotechnical, Inc.

Ryan Douglas, PE, GE 3147
Project Engineer

RLD/BPP/amm

Distribution: (1) Addressee (electronic copy)
(1) KHR Associates (electronic version)
Attn: Mr. James Kawamura

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Appendices

1.0 INTRODUCTION

1.1 Purpose and Scope of Services

This report presents the results of our preliminary geotechnical evaluation for the proposed approximately 0.8-acre residential development located at the intersection of Philadelphia Street and Comstock Avenue in the City of Whittier, California. Refer to the Site Location Map (Figure 1).

The purpose of our study was to provide a geotechnical evaluation relative to the proposed residential development. As part of our scope of work, we have: 1) reviewed available geotechnical information and in-house geologic maps pertinent to the site (Appendix A); 2) performed a subsurface geotechnical evaluation of the site consisting of the excavation and sampling of four small-diameter borings ranging from approximately 15 to 46.5 feet below existing ground surface, 3) performed two falling head infiltration tests within borings; 4) performed laboratory testing of select soil samples obtained during our subsurface evaluation; and 5) prepared this preliminary geotechnical summary report presenting our findings and preliminary conclusions and recommendations for the development of the proposed project.

It should be noted that our evaluation and this report only address geotechnical issues associated with the site and do not address any environmental issues.

1.2 Background

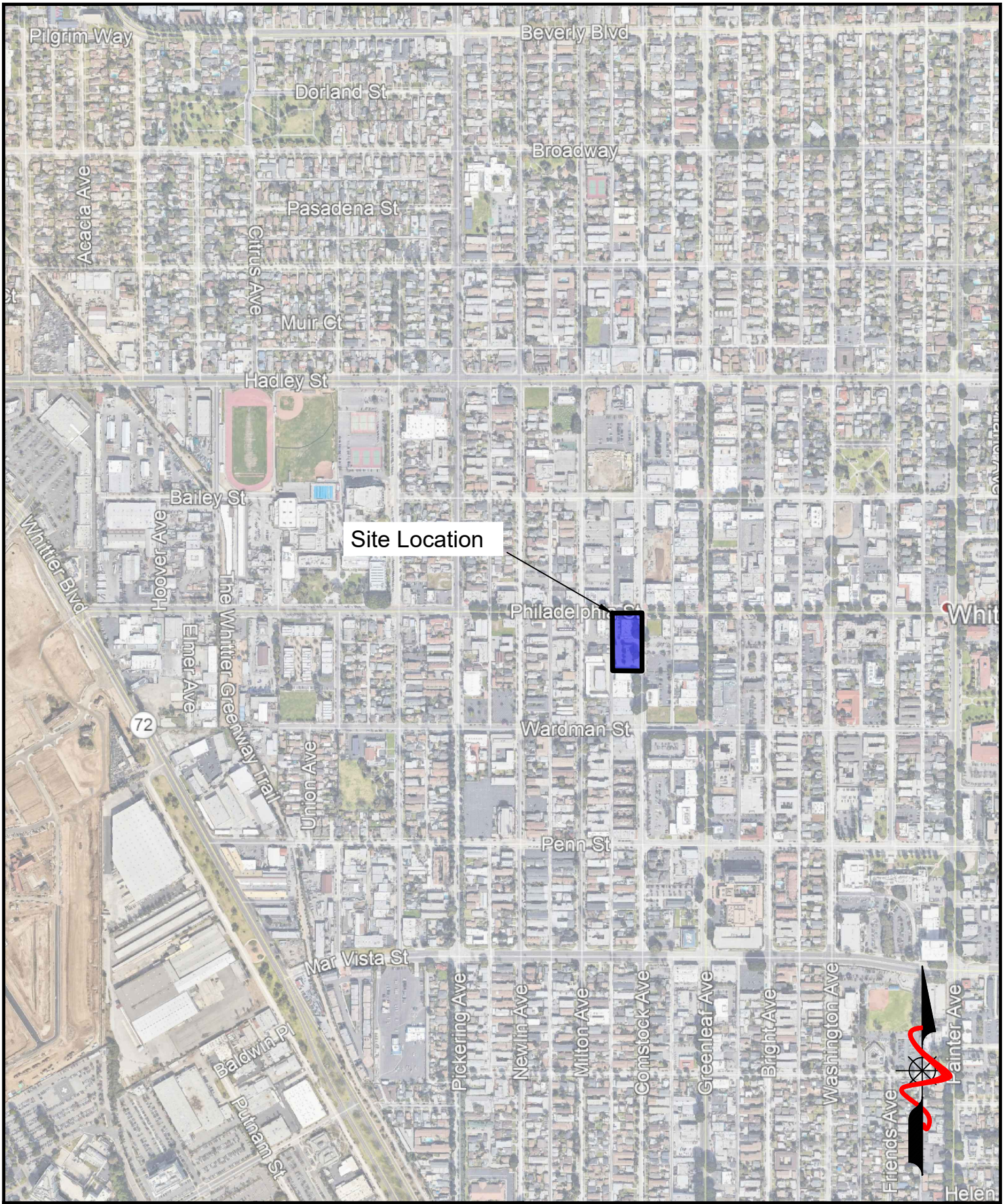
Review of historical aerials indicates the site had been undeveloped in 1954. It appears between the years of 1954 and 1963 the current building and parking lot were constructed (Historic Aerials, 2021).

1.3 Project Description

The approximately 0.8-acre site is bound to the north by Philadelphia Street, to the east by Comstock Avenue, to the south by an existing commercial development, and to the west by an alley. The site is currently occupied by an existing commercial structure and on-grade asphalt concrete parking lot.

Proposed development will consist of one 4-level residential structure with 51 multi-family dwelling units, on-grade parking, amenity deck, and a water quality system. The proposed residential development is anticipated to consist of relatively light building loads (column and wall loads maximum of 40 kips and 2 kips per linear foot, respectively).

The recommendations given in this report are based upon at-grade structures with estimated structural loads and grading information indicated above. LGC Geotechnical should be provided with any updated project information, plans and/or any structural loads when they become available, in order to either confirm or modify the recommendations provided herein.



PROJECT NAME	MWIG- Whittier
PROJECT NO.	21051-01
ENG. / GEOL.	RLD
SCALE	Not to Scale
DATE	May 2021

LGC Geotechnical, Inc.

FIGURE 1
Site Location Map

1.4 Subsurface Geotechnical Evaluation

A limited subsurface geotechnical evaluation of the site was performed by LGC Geotechnical. Our exploration program consisted of drilling and sampling four small-diameter exploratory hollow-stem borings (HS-1, HS-2, I-1 & I-2) for the purpose of obtaining samples for evaluation and laboratory testing of site soils, with two of the borings (I-1 and I-2) utilized for percolation testing. The borings were drilled by Cal Pac Drilling, Inc., under subcontract to LGC Geotechnical. The depths of the borings ranged from approximately 15 to 46.5 feet below existing grade. An LGC Geotechnical representative observed the drilling operations, logged the borings, and collected soil samples for laboratory testing. The borings were performed using a truck-mounted drill rig equipped with 8-inch-diameter hollow-stem augers. Bulk samples of the near-surface soils were logged and collected for laboratory testing from select borings. Driven soil samples were collected by means of the Standard Penetration Test (SPT) and Modified California Drive (MCD) sampler generally obtained at 2.5 and 5-foot vertical increments. The MCD is a split-barrel sampler with a tapered cutting tip and lined with a series of 1-inch-tall brass rings. The SPT sampler (1.4-inch ID) and MCD sampler (2.4-inch ID, 3.0-inch OD) were driven using a 140-pound automatic hammer falling 30 inches to advance the sampler a total depth of 18 inches or until refusal. The raw blow counts for each 6-inch increment of penetration were recorded on the boring logs. The borings were subsequently backfilled with cuttings, tamped and capped with asphalt coldpatch, where necessary.

Infiltration testing was performed within two of the borings, I-1 and I-2, to depths of approximately 15 feet below existing grade. An LGC Geotechnical geologist installed standpipes, backfilled the borings with crushed rock and pre-soaked the infiltration holes prior to testing. Infiltration testing was performed per the County of Los Angeles testing guidelines. Standpipes were removed and the locations were subsequently backfilled with native soils at the completion of testing. Some settlement of the backfill soils may occur over time.

The approximate locations of our subsurface explorations are provided on the Boring Map, Figure 2. The boring and infiltration testing logs are provided in Appendix B and Appendix D, respectively.

1.5 Field Infiltration Testing

Two shallow infiltration test wells were installed in Borings I-1 and I-2 to approximate depths of 15 feet below existing grade. The approximate infiltration test boring locations are shown on the Boring Map (Figure 2).

Estimation of infiltration rates was performed in general accordance with the "Boring Percolation Test Procedure" guidelines set forth by the County of Los Angeles (2017). The borings for the infiltration tests were excavated using a drill rig equipped with 8-inch diameter hollow-stem augers. A 3-inch diameter perforated PVC pipe was placed in the borehole above a thin layer of gravel and the annulus was backfilled with gravel. Infiltration tests were performed using relatively clean water free of particulates, silt, etc. The infiltration wells were pre-soaked approximately 1 hour prior to testing. During the pre-test, water was added to the boring and was observed after 10 minutes and 30 minutes to determine test methodology. In infiltration test holes I-1 and I-2 water remained in the borings after 30 minutes. Therefore, the test procedure utilizing a thirty-minute reading interval was performed on both infiltration test

holes (I-1 & I-2). Readings were taken a minimum of 8 times or until a "stabilized rate" was established. A "stabilized rate" is when the highest and lowest readings are within 10 percent of each other over three consecutive readings. At the completion of infiltration testing, the pipe was removed and backfilled with cuttings and tamped. Some settlement of the backfill should be expected.

Based on the County of Los Angeles testing guidelines (2017), the infiltration rate is calculated by dividing the volume of water discharged by the surface area of the test section (including the sidewalls and bottom of the boring) over a specific time period. The measured infiltration rate is taken as the average of the last three readings during which a "stabilized rate" is achieved. The measured infiltration rates are provided in Table 1 below.

TABLE 1

Summary of Field Infiltration Testing

Infiltration Test Location	Approximate Infiltration Test Depth (ft)	Measured Infiltration Rate* (inch/hr.)
I-1	15	0.2
I-2	15	0.1

*Does Not Include Required Reduction Factors for Design.

Please note that the values provided in Table 1 do not include reduction factors associated with the test procedure, site variability, and long-term siltation plugging that are used to calculate the design infiltration rate. Infiltration test data is presented in Appendix D. Refer to Section 4.6 for recommendations regarding infiltration of stormwater.

1.6 Laboratory Testing

Representative bulk, grab, and driven (relatively undisturbed) samples were retained for laboratory testing during our field evaluation. Laboratory testing included in-situ moisture content and in-situ dry density, sieve analysis, Atterberg limits, consolidation, direct shear, expansion index, laboratory compaction, and corrosion (sulfate, chloride, pH and minimum resistivity).

The following is a summary of the laboratory test results:

- Dry density of the samples collected ranged from approximately 104.9 pounds per cubic foot (pcf) to 119.6 pcf, with an average of 114.1 pcf. Field moisture contents ranged from approximately 1.4 to 17.0 percent, with an average of approximately 12.4 percent.
- Two sieve particle size analysis tests were performed and indicated a fines content (passing No. 200 sieve) of approximately 60 to 82 percent. Based on the Unified Soils Classification System (USCS), the tested samples would be classified as "fine-grained."
- One Atterberg Limit (liquid limit and plastic limit) test was performed. Results indicated a Plasticity Index (PI) value of 19.

- One consolidation test was performed. The load versus deformation plot is provided in Appendix C.
- One direct shear test was performed. The plot is provided in Appendix C.
- Expansion potential testing indicated an expansion index of 47, corresponding to "Low" expansion potential.
- Laboratory compaction of a near-surface bulk sample resulted in a maximum dry density of 120.5 pcf at an optimum moisture content of 10.2 percent.
- Corrosion testing indicated soluble sulfate content of less than 0.02 percent, a chloride content of 60 parts per million (ppm), pH of 6.50 and a minimum resistivity of 1,860 ohm-centimeters.

A summary of the laboratory test results is presented in Appendix C. The moisture and dry density results are presented on the boring logs in Appendix B.

2.0 GEOTECHNICAL CONDITIONS

2.1 Regional Geology

The subject site is generally located within the Peninsular Ranges Geomorphic Province of California, more specifically just north of the Downey Plains region and south of the Puente Hills. The site is located on a younger alluvial fan deposit generated from the nearby canyons in the Puente Hills. Regional topography is mostly flat lying to the south of the site, with the hills to the north of the site defined by the steeper and overturned stratigraphy of the Whittier fault zone (approximately one mile northeast of the site). The trace of the Workman Hill fault is also located further northwest on the northern edge of the Puente Hills. The San Gabriel River is located about 2.4 miles west of the site where it flows in a southwestern direction (CDMG, 1998 and Dibblee, 2001).

2.2 Site-Specific Geology

Based on review of available geologic maps (Dibblee, 2001), the primary geologic unit underlying the site is Holocene age, young alluvial fan deposits. The site is specifically on the Northeastern extent of young alluvial fan deposits emanating from Puente Hills. The fan is largely described as alluvial gravel, sand and silt (Dibblee, 2001). As encountered at the subject site, the alluvial fan deposits generally consist of brown to reddish brown silt, clay and sand with variable amounts of gravel.

2.3 Generalized Subsurface Conditions

The field explorations (borings) indicate minor amounts of undocumented artificial fill soils overlying native alluvial soils. The undocumented artificial fill soils consisted of variable amounts of sand, silt, clay, and gravel, that is brown to grayish brown, slightly moist to moist, and loose to very stiff up to approximately 5 feet below existing grade. The native alluvial soils consisted of primarily silt with varying amounts of sand and clay, that is brown to dark brown, dry to moist, and very stiff to hard for fine-grained soils and medium dense for coarse-grained soils (see Appendix B for Boring Logs).

It should be noted that borings are only representative of the location and time where/when they are performed, and varying subsurface conditions may exist outside of the performed location. In addition, subsurface conditions can change over time. The soil descriptions provided above should not be construed to mean that the subsurface profile is uniform, and that soil is homogeneous within the project area. For details on the stratigraphy at the exploration locations, refer to Appendix B.

2.4 Groundwater

Groundwater was not encountered to the maximum depth of approximately 46.5 feet below existing ground surface during our subsurface evaluation. Historic high groundwater is

approximately 100 feet below current grade per the Seismic Hazard Zone Report for the Whittier 7.5-Minute Quadrangle (CDMG, 1998).

Seasonal fluctuations of groundwater elevations should be expected over time. In general, groundwater levels fluctuate with the seasons and local zones of perched groundwater may be present due to local seepage caused by irrigation and/or recent precipitation. Local perched groundwater conditions or surface seepage may develop once site development is completed.

2.5 Seismic Design Criteria

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2019 California Building Code (CBC) and applicable portions of ASCE 7-16 which has been adopted by the CBC. **Please note that the following seismic parameters are only applicable for code-based acceleration response spectra and are not applicable for where site-specific ground motion procedures are required by ASCE 7-16.** Representative site coordinates of latitude 33.9786 degrees north and longitude -118.0389 degrees west were utilized in our analyses. The maximum considered earthquake (MCE) spectral response accelerations (S_{MS} and S_{M1}) and adjusted design spectral response acceleration parameters (S_{DS} and S_{D1}) for Site Class D are provided in Table 2 on the following page. The structural designer should contact the geotechnical consultant if structural conditions (e.g., number of stories, seismically isolated structures, etc.) require site-specific ground motions.

A deaggregation of the PGA based on a 2,475-year average return period (MCE) indicates that an earthquake magnitude of 6.85 at a distance of approximately 8.9 km from the site would contribute the most to this ground motion. A deaggregation of the PGA based on a 475-year average return period (Design Earthquake) indicates that an earthquake magnitude of 6.74 at a distance of approximately 13.9 km from the site would contribute the most to this ground motion (USGS, 2014).

Section 1803.5.12 of the 2019 CBC (per Section 11.8.3 of ASCE 7) states that the maximum considered earthquake geometric mean (MCE_G) Peak Ground Acceleration (PGA) should be used for liquefaction potential. The PGA_M for the site is equal to 0.884g (SEAOC, 2021).

TABLE 2

Seismic Design Parameters

Selected Parameters from 2019 CBC, Section 1613 - Earthquake Loads	Seismic Design Values	Notes/Exceptions
Distance to applicable faults classifies the site as a "Near-Fault" site.		Section 11.4.1 of ASCE 7
Site Class	D*	Chapter 20 of ASCE 7
Ss (Risk-Targeted Spectral Acceleration for Short Periods)	1.852g	From SEAOC, 2021
S_1 (Risk-Targeted Spectral Accelerations for 1-Second Periods)	0.66g	From SEAOC, 2021
F_a (per Table 1613.2.3(1))	1.000	For Simplified Design Procedure of Section 12.14 of ASCE 7, F_a shall be taken as 1.4 (Section 12.14.8.1)
F_v (per Table 1613.2.3(2))	1.700	Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7
S_{MS} for Site Class D [Note: $S_{MS} = F_aS_S$]	1.852g	-
S_{M1} for Site Class D [Note: $S_{M1} = F_vS_1$]	1.122g	Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7
S_{DS} for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$]	1.235g	-
S_{D1} for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$]	0.748g	Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7
C_{RS} (Mapped Risk Coefficient at 0.2 sec)	0.897	ASCE 7 Chapter 22
C_{R1} (Mapped Risk Coefficient at 1 sec)	0.899	ASCE 7 Chapter 22
*Since site soils are Site Class D and S_1 is greater than or equal to 0.2, the seismic response coefficient Cs is determined by Eq. 12.8-2 for values of $T \leq 1.5T_s$ and taken equal to 1.5 times the value calculated in accordance with either Eq. 12.8-3 for $T_L \geq T > T_s$, or Eq. 12.8-4 for $T > T_L$. Refer to ASCE 7-16.		

2.6 Faulting

Prompted by damaging earthquakes in California, State legislation and policies concerning the classification and land-use criteria associated with faults have been developed. Their purpose was to prevent the construction of urban developments across the trace of active faults, resulting in the Alquist-Priolo Earthquake Fault Zoning Act. Earthquake Fault Zones have been delineated along the traces of active faults within California. Where developments for human occupation are proposed within these zones, the State requires detailed fault evaluations be performed so that

engineering geologists can mitigate the hazards associated with active faulting by identifying the location of active faults and allowing for a setback from zones of previous ground rupture.

The subject site is not located within an Alquist-Priolo Earthquake Fault Zone and no faults were identified on the site during our site evaluation. The possibility of damage due to ground rupture is considered low since no active faults are known to cross the site.

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching, shallow ground rupture, soil liquefaction and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependant on the distance between the site and causative fault and the onsite geology. Some of the major active nearby faults that could produce these secondary effects include the Whittier, Puente Hills, Compton, Elysian Park, and Anaheim Fault Zones, among others (CGS, 2018). A discussion of these secondary effects is provided in the following sections.

2.6.1 Liquefaction and Dynamic Settlement

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subject to high-intensity ground shaking. Liquefaction occurs when three general conditions coexist: 1) shallow groundwater; 2) low density non-cohesive (granular) soils; and 3) high-intensity ground motion. Studies indicate that saturated, loose to medium dense, near-surface cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. In general, cohesive soils are not considered susceptible to liquefaction, depending on their plasticity and moisture content. Effects of liquefaction on level ground include settlement, sand boils, and bearing capacity failures below structures. Dynamic settlement of dry loose sands can occur as the sand particles tend to settle and densify as a result of a seismic event.

Based on our review of the State of California Seismic Hazard Zone for liquefaction potential (CDMG, 1999), the site is not located within a liquefaction hazard zone. Due to the absence of groundwater and the presence of very stiff fine-grained soils in the upper 50 feet, the potential for liquefaction is considered very low to remote.

2.6.2 Lateral Spreading

Lateral spreading is a type of liquefaction-induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake inertial forces may cause the mass to move downslope towards a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements and such movement typically damages pipelines, utilities, bridges, and structures.

Due to depth to groundwater, very low potential for liquefaction and lack of nearby "free face" conditions, the potential for lateral spreading is also considered very low to remote.

2.7 Oversized Material

Oversized material (material larger than 8 inches in maximum dimension) is not anticipated during site grading. However, if encountered, recommendations are provided for appropriate handling of oversized materials in Appendix E. If feasible, crushing oversized materials onsite or exporting oversized materials may be considered. Special handling recommendations should be provided on a case-by case basis, if encountered.

2.8 Expansion Potential

Based on the results of our recent laboratory testing and our experience with similar soils in the area, site soils are anticipated to have a "Low" to "Medium" expansion potential. Final expansion potential of site soils should be determined at the completion of grading. Results of expansion testing at finish grades will be utilized to confirm final foundation design.

3.0 CONCLUSIONS

Based on the results of our geotechnical evaluation, it is our opinion that the proposed development is feasible from a geotechnical standpoint, provided the following conclusions and recommendations are implemented.

The following is a summary of the primary geotechnical factors that may affect future development of the site:

- In general, field explorations (borings) indicate minor amounts of undocumented artificial fill soils overlying native alluvial soils. The undocumented artificial fill soils consisted of variable amounts of sand, silt, clay, and gravel, that is brown to grayish brown, slightly moist to moist, and loose to very stiff up to approximately 5 feet below existing grade. The native alluvial soils consisted of primarily silt with varying amounts of sand and clay, that is brown to dark brown, dry to moist, and very stiff too hard for fine-grained soils and medium dense for coarse-grained soils (see Appendix B for Boring Logs). The near-surface loose and compressible soils are not suitable for the planned improvements in their present condition (refer to Section 4.1).
- Groundwater was not encountered during our subsurface evaluation to the maximum explored depth of approximately 46.5 feet below current grade. Historic high groundwater is estimated to be approximately 100 feet below current grade (CDMG, 1998).
- The subject site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo). The main seismic hazard that may affect the site is ground shaking from one of the active regional faults. The subject site will likely experience strong seismic ground shaking during its design life.
- The site is not located within a State of California Seismic Hazard Zone for liquefaction potential (CDMG, 1999). The potential for liquefaction is considered very low to remote due to the presence of very dense fine-grained soils and the lack of a groundwater in the upper 50 feet.
- Based on the results of preliminary laboratory testing and our experience with similar soils in the area, site soils are anticipated to have "Low" to "Medium" expansion potential. Final design expansion potential must be determined at the completion of grading.
- Pre-soaking of the subgrade for building slabs will be required due to site expansive soils. The duration of this process varies greatly based on the chosen method and is also dependent on factors such as soil type and weather conditions. Time duration for presoaking from completion of rough grading to trenching of foundations should be accounted for in the construction schedule (typically 1 to 2 weeks).
- Based on the corrosion test results, soils are not considered corrosive per the Caltrans criteria (Caltrans, 2018).
- Excavations into the existing site soils should be feasible with heavy construction equipment in good working order. From a geotechnical perspective, the existing onsite soils are suitable material for use as fill, provided that they are relatively free from rocks (larger than 8 inches in maximum dimension), construction debris, and significant organic material.
- Oversize particles (larger than 8 inches in maximum dimension) are not anticipated; however, if encountered, it will require reduction in size or export from the site.

4.0 PRELIMINARY RECOMMENDATIONS

The following recommendations are to be considered preliminary and should be confirmed upon completion of grading and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner.

It should be noted that the following geotechnical recommendations are intended to provide sufficient information to develop the site in general accordance with the 2019 CBC requirements. With regard to the potential occurrence of potentially catastrophic geotechnical hazards such as fault rupture, earthquake-induced landslides, liquefaction, etc. the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level." The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed improvements may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development, the recommendations contained herein are intended as a reasonable protection against the potential damaging effects of geotechnical phenomena such as expansive soils, fill settlement, groundwater seepage, etc. It should be understood, however, that although our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions, they cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

The geotechnical recommendations contained herein must be confirmed to be suitable or modified based on the actual as-graded conditions.

4.1 Site Earthwork

We anticipate that earthwork at the site will consist of the removal of existing improvements associated with the former land use followed by the required earthwork removals, precise grading and construction of the proposed new improvements, including the residential structures, subsurface utilities, interior streets, etc.

We recommend that earthwork onsite be performed in accordance with the following recommendations, future grading plan review report(s), the 2019 CBC/City of Whittier grading requirements, and the General Earthwork and Grading Specifications included in Appendix E. In case of conflict, the following recommendations shall supersede those included in Appendix E. The following recommendations should be considered preliminary and may be revised within the future grading plan review report or based on the actual conditions encountered during site grading.

4.1.1 Site Preparation

Prior to grading of areas to receive structural fill or engineered improvements, the areas should be cleared of existing asphalt, surface obstructions, structures, foundations and

demolition debris. Vegetation and debris should be removed and properly disposed of off-site. Holes resulting from the removal of buried obstructions, which extend below proposed finish grades, should be replaced with suitable compacted fill material. Any abandoned sewer or storm drain lines should be completely removed and replaced with properly placed compacted fill. Deeper demolition may be required in order to remove existing foundations. We recommend the trenches associated with demolition which extend below the remedial grading depth be backfilled and properly compacted prior to the demolition contractor leaving the site.

If cesspools or septic systems are encountered, they should be removed in their entirety. The resulting excavation should be backfilled with properly compacted fill soils. As an alternative, cesspools can be backfilled with lean sand-cement slurry. Any encountered wells should be properly abandoned in accordance with regulatory requirements. At the conclusion of the clearing operations, a representative of LGC Geotechnical should observe and accept the site prior to further grading.

4.1.2 Removal and Recompaction Depths and Limits

In order to provide a relatively uniform bearing condition for the planned building structures, upper loose/compressible soils are to be temporarily removed and recompacted as properly compacted fills. Existing undocumented artificial fill within the influence of the proposed structural improvements should be removed to suitable, competent native materials prior to placement of artificial fill to design grades. For preliminary planning purposes, the depth of required removals and recompaction may be estimated as indicated below. It should be noted that updated recommendations may be required based on changes to building layouts and/or grading plan.

Building Structures: We recommend that soils within building pads be removed and recompacted to a minimum depth of 5 feet below existing grade or 3 feet below the base of the foundations, whichever is deeper. Where space is available, the envelope for removal and recompaction should extend laterally a minimum distance equal to the depth of removal and recompaction below finish grade or 5 feet beyond the edges of the proposed building improvements, whichever is larger.

Minor Site Structures: For minor site structures such as free-standing walls, retaining walls, etc., removal and recompaction should extend a minimum of 3 feet below existing grade or 2 feet below proposed footings, whichever is greater. Where space is available, the envelope for removal and recompaction should extend laterally a minimum distance of 3 feet beyond the edges of the proposed minor site structure improvements.

Pavement and Hardscape Areas: Within pavement and hardscape areas, removal and recompaction should extend to a depth of at least 2 feet below existing grade. Removal and recompaction in any design cut areas of the pavement may be reduced by the depth of the design cut but should not be less than 1-foot below the finished subgrade (i.e., below planned aggregate base/asphalt concrete). In general, the envelope for removal and recompaction should extend laterally a minimum lateral distance of 2 feet beyond the edges of the proposed pavement or hardscape improvements.

Local conditions may be encountered during excavation that could require additional over-excavation beyond the above noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of grading will be determined by the geotechnical consultant, based on subsurface conditions encountered during grading. Removal areas and areas to be over-excavated should be accurately staked in the field by the Project Surveyor.

4.1.3 Temporary Excavations

Temporary excavations should be performed in accordance with project plans, specifications, and all Occupational Safety and Health Administration (OSHA) requirements. Excavations should be laid back or shored in accordance with OSHA requirements before personnel or equipment are allowed to enter.

Based on our field evaluation, the majority of the site soils within the upper 5 to 10 feet are anticipated to be OSHA Type "B" soils (refer to the attached boring logs). Sandy soils are present and should be considered susceptible to caving. Soil conditions should be regularly evaluated during construction to verify conditions are as anticipated. The contractor shall be responsible for providing the "competent person", required by OSHA standards, to evaluate soil conditions. Close coordination with the geotechnical consultant should be maintained to facilitate construction while providing safe excavations. Excavation safety is the sole responsibility of the contractor.

Where proposed improvements will be adjacent to property lines, the potential for impacting existing offsite improvements may be reduced by performing "ABC" slot cuts while performing earthwork removal and recompaction. "ABC" slot cuts are defined as excavations perpendicular to sensitive property boundaries that are divided into multiple "slots" of equal width. If slots are labeled A, B, C, A, B, C, etc., then all "A" slots can be excavated at the same time but must be backfilled before all "B" slots can be excavated, etc. Any given slot should be backfilled immediately with properly compacted fill to finish grade prior to excavation of the adjacent two slots. Please note sands susceptible to caving are present at the site. Recommendations for slot cut dimensions should be evaluated during grading. Protection of the existing offsite improvements during grading is the responsibility of the contractor.

Vehicular traffic, stockpiles, and equipment storage should be set back from the perimeter of excavations a distance equivalent to a 1:1 projection from the bottom of the excavation. Once an excavation has been initiated, it should be backfilled as soon as practical. Prolonged exposure of temporary excavations may result in some localized instability. Excavations should be planned so that they are not initiated without sufficient time to shore/fill them prior to weekends, holidays, or forecasted rain.

It should be noted that any excavation that extends below a 1:1 (horizontal to vertical) projection of an existing foundation will remove existing support of the structure foundation. If requested, temporary shoring parameters will be provided.

4.1.4 Removal Bottoms and Subgrade Preparation

In general, removal bottom areas and any areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content), and re-compacted per project recommendations.

Removal bottoms, over-excavation bottoms and areas to receive fill should be observed and accepted by the geotechnical consultant prior to subsequent fill placement. Soil subgrade for planned footings and improvements (e.g., slabs, etc.) should be firm and competent.

4.1.5 Material for Fill

From a geotechnical perspective, the onsite soils are generally considered suitable for use as general compacted fill, provided they are screened of organic materials, construction debris and oversized material (8 inches in greatest dimension).

From a geotechnical viewpoint, any required import soils for general fill (i.e., non-retaining wall backfill) should consist of clean, granular soils of "Low" expansion potential (expansion index 50 or less based on ASTM D 4829), and generally free of organic materials, construction debris and material greater than 3 inches in maximum dimension. Import for required retaining wall backfill should meet the criteria outlined in the following paragraph. Source samples should be provided to the geotechnical consultant for laboratory testing a minimum of four working days prior to planned importation.

Retaining wall backfill should consist of sandy soils with a maximum of 35 percent fines (passing the No. 200 sieve) per American Society for Testing and Materials (ASTM) Test Method D1140 (or ASTM D6913/D422) and a "Very Low" expansion potential (EI of 20 or less per ASTM D4829). Soils should also be screened of organic materials, construction debris, and any material greater than 3 inches in maximum dimension. Onsite soils are not suitable for retaining wall backfill due to their fines content and expansion index; therefore, import of soils meeting the criteria outlined above will be required by the contractor for obtaining suitable retaining wall backfill soil. These preliminary findings should be confirmed during grading.

Aggregate base (crushed aggregate base or crushed miscellaneous base) should conform to the requirements of Section 200-2 of the Standard Specifications for Public Works Construction ("Greenbook") for untreated base materials (except processed miscellaneous base) or Caltrans Class 2 aggregate base.

The placement of demolition materials in compacted fill is acceptable from a geotechnical viewpoint provided the demolition material is broken up into pieces not larger than typically used for aggregate base (approximately 1-inch in maximum dimension) and well blended into fill soils with essentially no resulting voids. Demolition material placed in fills must be free of construction debris (wood, brick, etc.) and reinforcing steel. If asphalt concrete fragments will be incorporated into the demolition materials, approval from an environmental viewpoint may be required and is not the purview of the geotechnical

consultant. From our previous experience, we recommend that asphalt concrete fragments be limited to fill areas within planned streets, alleys or non-structural areas (i.e., not within building pad areas).

4.1.6 Placement and Compaction of Fills

Material to be placed as fill should be brought to near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content) and recompacted to at least 90 percent relative compaction (per ASTM D1557). Moisture conditioning of site soils will be required in order to achieve adequate compaction. Soils are present that will require additional moisture in order to achieve the required compaction. Drying and/or mixing the very moist soils may also be required prior to reusing the materials in compacted fills.

The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in compacted thickness. Each lift should be thoroughly compacted and accepted prior to subsequent lifts. Generally, placement and compaction of fill should be performed in accordance with local grading ordinances and with observation and testing performed by the geotechnical consultant. Oversized material as previously defined should be removed from site fills. During backfill of excavations, the fill should be properly benched into firm and competent soils of temporary backcut slopes as it is placed in lifts.

Aggregate base material should be compacted to at least 95 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Subgrade below aggregate base should be compacted to at least 90 percent relative compaction per ASTM D1557 at or slightly above optimum moisture content (generally within optimum and 2 percent above optimum moisture content).

If gap-graded ¾-inch rock is used for backfill (around storm drain storage chambers, retaining wall backfill, etc.) it will require compaction. Rock shall be placed in thin lifts (typically not exceeding 6 inches) and mechanically compacted with observation by geotechnical consultant. Backfill rock shall meet the requirements of ASTM D2321. Gap-graded rock is required to be wrapped in filter fabric (Mirafi 140N or approved alternative) or at the very minimum to be vertically separated from the trench backfill to prevent the migration of fines into the rock backfill.

4.1.7 Trench and Retaining Wall Backfill and Compaction

The onsite soils may generally be suitable as trench backfill, provided the soils are screened of rocks and other material greater than 6 inches in diameter and organic matter. If trenches are shallow or the use of conventional equipment may result in damage to the utilities, sand having a sand equivalent (SE) of 30 or greater may be used to bed and shade the pipes. Sand backfill within the pipe bedding zone may be densified by jetting or flooding and then tamping to ensure adequate compaction. Subsequent trench

backfill should be compacted in uniform thin lifts by mechanical means to at least the recommended minimum relative compaction (per ASTM D1557).

Retaining wall backfill should consist of sandy soils as outlined in preceding Section 4.1.5. The limits of select sandy backfill should extend at minimum ½ the height of the retaining wall or the width of the heel (if applicable), whichever is greater (Figure 3). Retaining wall backfill soils should be compacted in relatively uniform thin lifts to at least 90 percent relative compaction (per ASTM D1557). Jetting or flooding of retaining wall backfill materials should not be permitted.

In backfill areas where mechanical compaction of soil backfill is impractical due to space constraints, typically sand-cement slurry may be substituted for compacted backfill. The slurry should contain about one sack of cement per cubic yard. When set, such a mix typically has the consistency of compacted soil. Sand cement slurry placed near the surface within landscape areas should be evaluated for potential impacts on planned improvements.

A representative from LGC Geotechnical should observe, probe, and test the backfill to verify compliance with the project recommendations.

4.1.8 Shrinkage and Subsidence

Allowance in the earthwork volumes budget should be made for an estimated 5 to 15 percent reduction (shrink) in volume of near-surface (upper approximate 5 feet) soils. It should be stressed that these values are only estimates and that an actual shrinkage factor would be extremely difficult to predetermine. Subsidence, due to earthwork operations, is expected to be on the order of 0.1 feet. These values are estimates only and exclude losses due to removal of vegetation or debris. The effective shrinkage of onsite soils will depend primarily on the type of compaction equipment and method of compaction used onsite by the contractor and accuracy of the topographic survey.

4.2 Preliminary Foundation Recommendations

The site may be considered suitable for the support of the proposed structures using a rigid slab-on-grade conventionally reinforced or post-tensioned slab foundation designed in accordance with Chapter 18 of the 2019 CBC. It should be noted that, as with many structures in Southern California, risk does remain that the proposed structures could suffer some damage as a result of an earthquake. Repair and remedial work may be required after a seismic event.

The following sections summarize our preliminary recommendations. Please note that the following foundation recommendations are preliminary and must be confirmed by LGC Geotechnical at the completion of grading. The proposed foundations should be designed by the foundation engineer in accordance with the following recommendations. The following recommendations may be superseded by the requirements of the foundation engineer, structural engineer and/or local jurisdictions. Proposed foundations should be designed to accommodate estimated site static settlements.

4.2.1 Provisional Conventional Foundation Design Parameters

Given that the expansion index exceeds 20, the foundation systems shall be designed for effects of expansive soil. Conventional foundations may be designed in accordance with Wire Reinforcement Institute (WRI) procedure for slab-on-ground foundations per Section 1808 of the 2019 CBC to resist expansive soils. The following preliminary soil parameters may be used:

- Effective Plasticity Index: 25
- Climatic Rating: Cw = 15
- Reinforcement: Per structural designer.
- Moisture condition slab subgrade soils to 120 % of optimum moisture content to a depth of 18 inches prior to trenching for footings.

Other types of stiff slabs may be used in place of the WRI design procedure provided that, in the opinion of the foundation structural designer, the alternative of slab is at least as stiff and strong as that designed by the WRI to resist expansive soils.

4.2.2 Post-Tensioned Foundation Design Parameters

The geotechnical parameters provided herein may be used for post-tensioned slab foundations with a deepened perimeter footing or a post-tensioned mat slab. These parameters have been determined in general accordance with the Post-Tensioning Institute (PTI) Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils, referenced in Chapter 18 of the 2019 CBC. In utilizing these parameters, the foundation engineer should design the foundation system in accordance with the allowable deflection criteria of applicable codes and the requirements of the structural designer/architect. Other types of stiff slabs may be used in place of the CBC post-tensioned slab design provided that, in the opinion of the foundation structural designer, the alternative type of slab is at least as stiff and strong as that designed by the CBC/PTI method.

Our design parameters are based on our experience with similar projects and the anticipated nature of the soil (with respect to expansion potential). Please note that implementation of our recommendations will not eliminate foundation movement (and related distress) should the moisture content of the subgrade soils fluctuate. It is the intent of these recommendations to help maintain the integrity of the proposed structures and reduce (not eliminate) movement, based upon the anticipated site soil conditions. Should future owners and/or property maintenance personnel not properly maintain the areas surrounding the foundation, for example by overwatering, then we anticipate for highly expansive soils the maximum differential movement of the perimeter of the foundation to the center of the foundation to be on the order of a couple of inches. Soils of lower expansion potential are anticipated to show less movement.

TABLE 3

Provisional Geotechnical Parameters for Post-Tensioned Foundation Slab Design with "Medium" Expansion Potential Subgrade Soils

Parameter	PT Slab with Perimeter Footing	PT Mat with Thickened Edge
Expansion Index	Medium	Medium
Thornthwaite Moisture Index	-20	-20
Constant Soil Suction	PF 3.9	PF 3.9
Center Lift Edge moisture variation distance, e_m Center lift, y_m	 9.0 feet 0.5 inch	 9.0 feet 0.6 inch
Edge Lift Edge moisture variation distance, e_m Edge lift, y_m	 4.7 feet 1.1 inch	 4.7 feet 1.3 inch
Modulus of Subgrade Reaction, k (assuming presoaking as indicated below)	150 pci	150 pci
Minimum perimeter footing/thickened edge embedment below finish grade	18 inches	6 inches

1. Recommendations for foundation reinforcement and slab thickness are ultimately the purview of the foundation engineer/structural engineer based upon geotechnical criteria and structural engineering considerations.
2. The sand layer requirements are the purview of the foundation engineer/structural engineer and should be provided in accordance with ACI Publication 302 "Guide for Concrete Floor and Slab Construction".
3. Recommendations for vapor retarders below slabs are also the purview of the foundation engineer/structural engineer and should be provided in accordance with applicable code requirements.
4. Moisture condition to 120% of optimum moisture content to a depth of 18 inches prior to trenching.

4.2.3 Foundation Subgrade Preparation and Maintenance

Moisture conditioning of the subgrade for building slabs will be required due to site expansive soils. The duration of this process varies greatly based on the chosen method and is also dependent on factors such as soil type and weather conditions. Time duration for presoaking from completion of rough grading to trenching of foundations should be accounted for in the construction schedule (typically 1 to 2 weeks). The subgrade moisture condition of the building pad soils should be maintained at the recommended moisture content up to the time of concrete placement. This moisture content should be maintained around the immediate perimeter of the slab during construction and up to occupancy of the building structures. As an alternative to presoaking, the upper 18 inches of subgrade soils may be placed at a higher moisture content and maintained up until the time of concrete placement. The upper 18 inches of subgrade would have to be placed at 120% of optimum moisture content, compacted to

90 percent relative compaction per the project specifications and maintained up until the time of concrete placement.

The geotechnical parameters provided in the section above assume that if the areas adjacent to the foundation are planted and irrigated, these areas will be designed with proper drainage and adequately maintained so that ponding, which causes significant moisture changes below the foundation, does not occur. Our recommendations do not account for excessive irrigation and/or incorrect landscape design. Plants should only be provided with sufficient irrigation for life and not overwatered to saturate subgrade soils. Sunken planters placed adjacent to the foundation should either be designed with an efficient drainage system or liners to prevent moisture infiltration below the foundation. Some lifting of the perimeter foundation beam should be expected even with properly constructed planters.

In addition to the factors mentioned above, future owners/property management personnel should be made aware of the potential negative influences of trees and/or other large vegetation. Roots that extend near the vicinity of foundations can cause distress to foundations. Future owners (and the owner's landscape architect) should not plant trees/large shrubs closer to the foundations than a distance equal to half the mature height of the tree or 20 feet, whichever is more conservative, unless specifically provided with root barriers to prevent root growth below the building foundation.

It is the owner's responsibility to perform periodic maintenance during hot and dry periods to ensure that adequate watering has been provided to keep soil from separating or pulling back from the foundation. Future owners and property management personnel should be informed and educated regarding the importance of maintaining a constant level of soil-moisture. The owners should be made aware of the potential negative consequences of both excessive watering, as well as allowing potentially expansive soils to become too dry. Expansive soils can undergo shrinkage during drying, and swelling during the rainy winter season, or when irrigation is resumed. This can result in distress to building structures and hardscape improvements. The developer should provide these recommendations to future owners and property management personnel.

4.2.4 Slab Underlayment Guidelines

The following is for informational purposes only since slab underlayment (e.g., moisture retarder, sand or gravel layers for concrete curing and/or capillary break) is unrelated to the geotechnical performance of the foundation and thereby not the purview of the geotechnical consultant. Post-construction moisture migration should be expected below the foundation. The foundation engineer/architect should determine whether the use of a capillary break (sand or gravel layer), in conjunction with the vapor retarder, is necessary or required by code. Sand layer thickness and location (above and/or below vapor retarder) should also be determined by the foundation engineer/architect.

4.3 Soil Bearing and Lateral Resistance

Provided our earthwork recommendations are implemented, an allowable soil bearing pressure of 1,500 pounds per square foot (psf) may be used for the design of footings having a minimum width of 12 inches and minimum embedment of 12 inches below lowest adjacent ground surface. This value may be increased by 300 psf for each additional foot of embedment of 150 psf for each additional foot of foundation width to a maximum value of 2,500 psf. A mat foundation a minimum of 6 inches below lowest adjacent grade may be designed for an allowable soil bearing pressure of 1,200 psf. These allowable bearing pressures are applicable for level (ground slope equal to or flatter than 5H:1V) conditions only. Bearing values indicated are for total dead loads and frequently applied live loads and may be increased by ⅓ for short duration loading (i.e., wind or seismic loads).

In utilizing the above-mentioned allowable bearing capacity, and provided our earthwork recommendations are implemented, foundation settlement due to structural loads is anticipated to be 1-inch or less. Differential settlement may be taken as half of the total settlement (i.e., ½-inch over a horizontal span of 40 feet).

Resistance to lateral loads can be provided by friction acting at the base of foundations and by passive earth pressure. For concrete/soil frictional resistance, an allowable coefficient of friction of 0.3 may be assumed with dead-load forces. An allowable passive lateral earth pressure of 225 psf per foot of depth (or pcf) to a maximum of 2,250 psf may be used for the sides of footings poured against properly compacted fill. Allowable passive pressure may be increased to 300 pcf (maximum of 3,000 psf) for short duration seismic loading. This passive pressure is applicable for level (ground slope equal to or flatter than 5H:1V) conditions. Frictional resistance and passive pressure may be used in combination without reduction. We recommend that the upper foot of passive resistance be neglected if finished grade will not be covered with concrete or asphalt. The provided allowable passive pressures are based on a factor of safety of 1.5 and 1.1 for static and seismic loading conditions, respectively.

4.4 Lateral Earth Pressures for Retaining Walls

Lateral earth pressures for approved native sandy or import soils meeting indicated project requirements are provided below. Lateral earth pressures are provided as equivalent fluid unit weights, in psf per foot of depth (or pcf). These values do not contain an appreciable factor of safety, so the retaining wall designer should apply the applicable factors of safety and/or load factors during design. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of soil over the wall footing.

The following lateral earth pressures are presented in Table 4 on the following page for approved granular soils with a maximum of 35 percent fines (passing the No. 200 sieve per ASTM D-421/422) and a “Very Low” expansion potential (EI of 20 or less per ASTM D4829). The site soils are not suitable for retaining wall backfill due to their fines content and expansion index; therefore, import of soils meeting the criteria outlined above will be required by the contractor for obtaining suitable retaining wall backfill soil. The wall designer should clearly indicate on the retaining wall plans the required imported select sandy soil backfill criteria.

TABLE 4

Lateral Earth Pressures – Approved Imported Sandy Soils

Conditions	Equivalent Fluid Unit Weight (pcf)	Equivalent Fluid Unit Weight (pcf)
	Level Backfill	2:1 Sloped Backfill
	Approved Sandy Soils	Approved Sandy Soils
Active	35	55
At-Rest	55	70

If the wall can yield enough to mobilize the full shear strength of the soil, it can be designed for "active" pressure. If the wall cannot yield under the applied load, the earth pressure will be higher. This would include 90-degree corners of retaining walls. Such walls should be designed for "at-rest." The equivalent fluid pressure values assume free-draining conditions. If conditions other than those assumed above are anticipated, the equivalent fluid pressure values should be provided on an individual-case basis by the geotechnical engineer.

Retaining wall structures should be provided with appropriate drainage and appropriately waterproofed. To reduce, but not eliminate, saturation of near-surface (upper approximate 1-foot) soils in front of the retaining walls, the perforated subdrain pipe should be located as low as possible behind the retaining wall. The outlet pipe should be sloped to drain to a suitable outlet. In general, we do not recommend retaining wall outlet pipes be connected to area drains. If subdrains are connected to area drains, special care and information should be provided to homeowners to maintain these drains. Typical retaining wall drainage is illustrated in Figure 3. It should be noted that the recommended subdrain does not provide protection against seepage through the face of the wall and/or efflorescence. Efflorescence is generally a white crystalline powder (discoloration) that results when water containing soluble salts migrates over a period of time through the face of a retaining wall and evaporates. If such seepage or efflorescence is undesirable, retaining walls should be waterproofed to reduce this potential. Please note that waterproofing and outlet systems are not the purview of the geotechnical consultant.

Surcharge loading effects from any adjacent structures should be evaluated by the retaining wall designer. In general, structural loads within a 1:1 (horizontal to vertical) upward projection from the bottom of the proposed retaining wall footing will surcharge the proposed retaining wall. In addition to the recommended earth pressure, retaining walls adjacent to streets should be designed to resist a uniform lateral pressure of 80 pounds per square foot (psf) due to normal street vehicle traffic if applicable. Uniform lateral surcharges may be estimated using the applicable coefficient of lateral earth pressure using a rectangular distribution. A factor of 0.45 and 0.3 may be used for at-rest and active conditions, respectively. The retaining wall designer should contact the geotechnical engineer for any required geotechnical input in estimating any applicable surcharge loads.

If required, the retaining wall designer may use seismic lateral earth pressure increment of 10 or 20 pcf for level backfill or 2:1 sloped backfill conditions, respectively. These increments should be

applied (in addition to the provided static lateral earth pressure) using a triangular distribution with the resultant acting at H/3 in relation to the base of the retaining structure (where H is the retained height). Per Section 1803.5.12 of the 2019 CBC, the seismic lateral earth pressure is applicable to structures assigned to Seismic Design Category D through F for retaining wall structures supporting more than 6 feet of backfill height. This seismic lateral earth pressure is estimated using the procedure outlined by the Structural Engineers Association of California (Lew, et al, 2010).

Soil bearing and lateral resistance (friction coefficient and passive resistance) are provided in Section 4.3. Earthwork considerations (temporary backcuts, backfill, compaction, etc.) for retaining walls are provided in Section 4.1 (Site Earthwork) and the subsequent earthwork related sub-sections.

4.5 Control of Surface Water and Drainage Control

From a geotechnical perspective, we recommend that compacted finished grade soils adjacent to proposed residences be sloped away from the proposed residence and towards an approved drainage device or unobstructed swale. Drainage swales, wherever feasible, should not be constructed within 5 feet of buildings. Where lot and building geometry necessitates that the side yard drainage swales be routed closer than 5 feet to structural foundations, we recommend the use of area drains together with drainage swales. Drainage swales used in conjunction with area drains should be designed by the project civil engineer so that a properly constructed and maintained system will prevent ponding within 5 feet of the foundation. Code compliance of grades is not the purview of the geotechnical consultant.

Planters with open bottoms adjacent to buildings should be avoided. Planters should not be designed adjacent to buildings unless provisions for drainage, such as catch basins, liners, and/or area drains, are made. Overwatering must be avoided.

4.6 Subsurface Water Infiltration

It should be noted that intentionally infiltrating storm water conflicts with the geotechnical engineering objective of directing surface water away from structures and improvements. The geotechnical stability and integrity of a site is reliant upon appropriately handling surface water.

In general, the vast majority of geotechnical distress issues are directly related to improper drainage. Distress in the form of movement of foundations and other improvements could occur as a result of soil saturation and loss of soil support of foundations and pavements, settlement, collapse, internal soil erosion, and/or expansion. Additionally, off-site properties and improvements may be subjected to seepage, springs, instability, movements of foundations or other impacts as a result of water infiltration and migration. Infiltrated water may enter underground utility pipe zones or other highly permeable layers and migrate laterally along these layers, potentially impacting other improvements located far away from the point of infiltration. Any proposed infiltration system should not be located near slopes or settlement sensitive existing/proposed improvements in order to reduce the potential for slope failures and geotechnical distress issues related to infiltration.

If water must be infiltrated due to regulatory requirements, we recommend the absolute minimum amount of water be infiltrated and that the infiltration areas not be located near settlement-sensitive existing/proposed improvements, basement/retaining walls, or any slopes. As with all systems that are designed to concentrate surface flow and direct the water into the subsurface soils, some minor settlement, nuisance type localized saturation and/or other water related issues should be expected. Due to variability in geologic and hydraulic conductivity characteristics, these effects may be experienced at the onsite location and/or potentially at other locations beyond the physical limits of the subject site. Infiltrated water may enter underground utility pipe zones or flow along heterogeneous soil layers or geologic structure and migrate laterally impacting other improvements which may be located far away or at an elevation much lower than the infiltration source. Recommendations for subsurface water infiltration are provided below.

The design infiltration rate is determined by dividing the measured infiltration rate by a series of reduction factors including; test procedure (RF_t), site variability (RF_v) and long-term siltation plugging and maintenance (RF_s). Based on the Los Angeles County testing guidelines (2017), the reduction factor for long-term siltation plugging and maintenance (RF_s) is the purview of the infiltration system designer. The test procedure reduction factor and recommended site variability reduction factor applied to the measured infiltration rate is provided in Table 5 below. The design infiltration rate is the measured infiltration rate divided by the total reduction factor (RF_t x RF_v x RF_s).

TABLE 5

Shallow Surface Infiltration - Reduction Factors Applied to Measured Infiltration Rate

Consideration	Reduction Factor
Test procedure, boring percolation, RF_t	2
Site variability, number of tests, etc., RF_v	1.5
Long-term siltation plugging and maintenance, RF_s	Per Infiltration Designer
Total Reduction Factor, RF = RF_t x RF_v x RF_s	**TBD**

Per the requirements of the Los Angeles County testing guidelines (2017), subsurface materials shall have a design infiltration rate equal to or greater than 0.3 inches per hour. The test procedure and site variability considerations (RF_t and RF_v) result in a minimum reduction factor of 3 (not including long-term siltation plugging and maintenance). When total reduction factor is applied to the measured infiltration rates presented in Table 1, the resulting design infiltration rate is anticipated to be less than the minimum required by the County of Los Angeles for infiltration.

Based on the results of field infiltration testing indication of extremely low infiltration rates (less than the minimum County design infiltration rate) and the presence of low permeability silts and clays to maximum explored depth of approximately 46.5 feet below existing grade, we strongly recommend against the intentional infiltration of stormwater into the subsurface soils.

4.7 Preliminary Asphalt Pavement Sections

For the purpose of these preliminary recommendations, we have selected a preliminary design R-value of 25 (assumed) and calculated pavement sections for Traffic Index (TI) of 5.0 (or less) and 5.5. The California Department of Transportation Highway Design Manual (Caltrans, 2017) allows for a maximum R-Value of 50 to be used in pavement design. These recommendations must be confirmed with R-Value testing of representative near-surface soils at the completion of grading and after underground utilities have been installed and backfilled. Final street sections should be confirmed by the project civil engineer based upon the final design Traffic Index. Determination of the TI is not the purview of the geotechnical consultant. If requested, LGC Geotechnical will provide sections for alternate TI values.

TABLE 6

Preliminary Pavement Sections

Assumed Traffic Index	5.0 or less	5.5
R -Value Subgrade	25	25
AC Thickness	4.0 inches	4.0 inches
Base Thickness	5.0 inches	6.0 inches

The thicknesses shown are for minimum thicknesses. Increasing the thickness of any or all of the above layers will reduce the likelihood of the pavement experiencing distress during its service life. The above recommendations are based on the assumption that proper maintenance and irrigation of the areas adjacent to the roadway will occur through the design life of the pavement. Failure to maintain a proper maintenance and/or irrigation program may jeopardize the integrity of the pavement.

Earthwork recommendations regarding aggregate base and subgrade are provided in Section 4.1 "Site Earthwork" and the related sub-sections of this report.

4.8 Soil Corrosivity

Although not corrosion engineers (LGC Geotechnical is not a corrosion consultant), several governing agencies in Southern California require the geotechnical consultant to determine the corrosion potential of soils to buried concrete and metal facilities. We therefore present the results of our testing with regard to corrosion for the use of the client and other consultants, as they determine necessary.

Corrosion testing of near-surface bulk samples indicated soluble sulfate contents less than 0.02 percent, a chloride content of 60 parts per million (ppm), pH of 6.50 and minimum resistivity of 1,860 ohm-centimeters. Based on Caltrans Corrosion Guidelines (Caltrans, 2018), soils are considered corrosive to structural elements if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 1,500 ppm (0.15 percent) or greater. Based on the test results, soils are not considered corrosive using Caltrans criteria.

Based on laboratory sulfate test results, the near surface soils are designated to a class "S0" per ACI 318, Table 19.3.1.1 with respect to sulfates. Concrete in direct contact with the onsite soils can be designed according to ACI 318, Table 19.3.2.1 using the "S0" sulfate classification.

Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project and formulate an appropriate course of action.

4.9 Nonstructural Concrete Flatwork

Nonstructural concrete flatwork (such as walkways, bicycle trails, patio slabs, etc.) has a potential for cracking due to changes in soil volume related to soil-moisture fluctuations. To reduce the potential for excessive cracking and lifting, concrete may be designed in accordance with the minimum guidelines outlined in Table 7. These guidelines will reduce the potential for irregular cracking and promote cracking along construction joints but will not eliminate all cracking or lifting. Thickening the concrete and/or adding additional reinforcement will further reduce cosmetic distress.

TABLE 7

Nonstructural Concrete Flatwork for Medium Expansion Potential

	Private Drives	**Patios/Entryways**	**City Sidewalk Curb and Gutters**
Minimum Thickness (in.)	5 (full)	5 (full)	City/Agency Standard
Presoaking	Presoak to 12 inches	Presoak to 12 inches	City/Agency Standard
Reinforcement	No. 3 at 24 inches on centers	No. 3 at 24 inches on centers	City/Agency Standard
Thickened Edge (in.)	8 x 8	—	City/Agency Standard
Crack Control Joints	Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness	Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness	City/Agency Standard
Maximum Joint Spacing	10 feet or quarter cut whichever is closer	6 feet	City/Agency Standard

Aggregate Base Thickness (in.)	—	—	City/Agency Standard

4.10 Geotechnical Plan Review

When available, project plans (grading, foundation, retaining wall etc.) should be reviewed by LGC Geotechnical in order to verify our geotechnical recommendations are implemented. Updated recommendations and/or additional field work may be necessary.

4.11 Geotechnical Observation and Testing During Construction

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. The interpolated subsurface conditions should be checked in the field during construction by a representative of LGC Geotechnical. Geotechnical observation and testing is required per Section 1705 of the 2019 CBC.

Geotechnical observation and/or testing should be performed by LGC Geotechnical at the following stages:

- During grading (removal bottoms, fill placement, etc.);
- During retaining wall backfill and compaction;
- During utility trench backfill and compaction;
- After presoaking building pads and other concrete-flatwork subgrades, and prior to placement of aggregate base or concrete;
- Preparation of pavement subgrade and placement of aggregate base and asphalt concrete pavement;
- After building and wall footing excavation and prior to placing reinforcement and/or concrete; and
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

5.0 LIMITATIONS

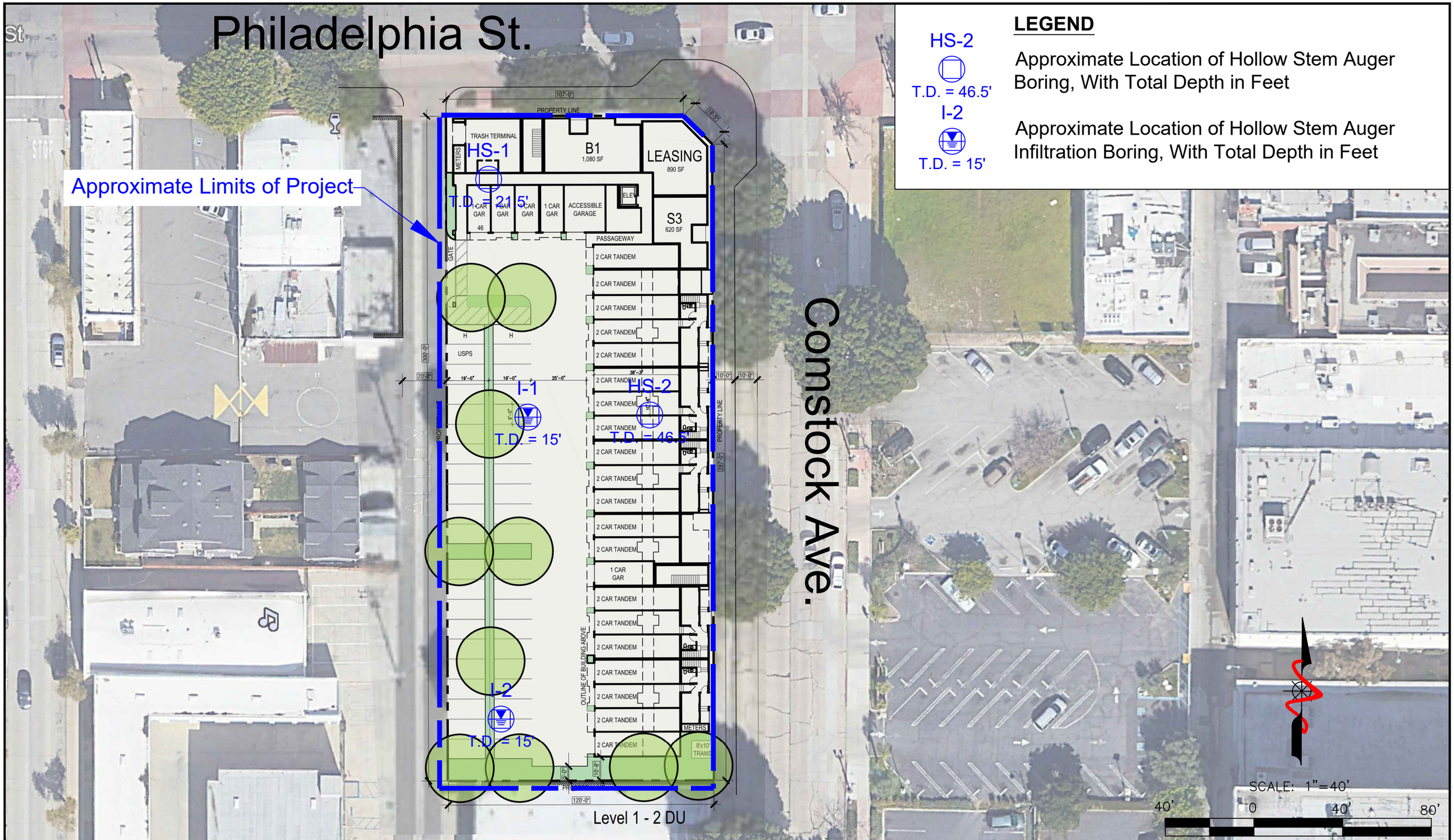
Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

This report is based on data obtained from limited observations of the site, which have been extrapolated to characterize the site. While the scope of services performed is considered suitable to adequately characterize the site geotechnical conditions relative to the proposed development, no practical evaluation can completely eliminate uncertainty regarding the anticipated geotechnical conditions in connection with a subject site. Variations may exist and conditions not observed or described in this report may be encountered during grading and construction.

This report is issued with the understanding that it is the responsibility of the owner, or of his/her representative, to ensure that the information and recommendations contained herein are brought to the attention of the other consultants (at a minimum the civil engineer, structural engineer, landscape architect) and incorporated into their plans. The contractor should properly implement the recommendations during construction and notify the owner if they consider any of the recommendations presented herein to be unsafe, or unsuitable.

The findings of this report are valid as of the present date. However, changes in the conditions of a site can and do occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. The findings, conclusions, and recommendations presented in this report can be relied upon only if LGC Geotechnical has the opportunity to observe the subsurface conditions during grading and construction of the project, in order to confirm that our preliminary findings are representative for the site. This report is intended exclusively for use by the client, any use of or reliance on this report by a third party shall be at such party's sole risk.

In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and modification.



LEGEND

HS-2
T.D. = 46.5'

Approximate Location of Hollow Stem Auger Boring, With Total Depth in Feet

I-2
T.D. = 15'

Approximate Location of Hollow Stem Auger Infiltration Boring, With Total Depth in Feet

LGC Geotechnical, Inc.

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131 Calle Iglesia, Ste. 200
San Clemente, CA 92672
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Figure 2
Boring Location Map

PROJECT NAME	MWIG - Whittier
PROJECT NO.	21051-01
ENG. / GEOL.	RLD
SCALE	1:40
DATE	May 2021

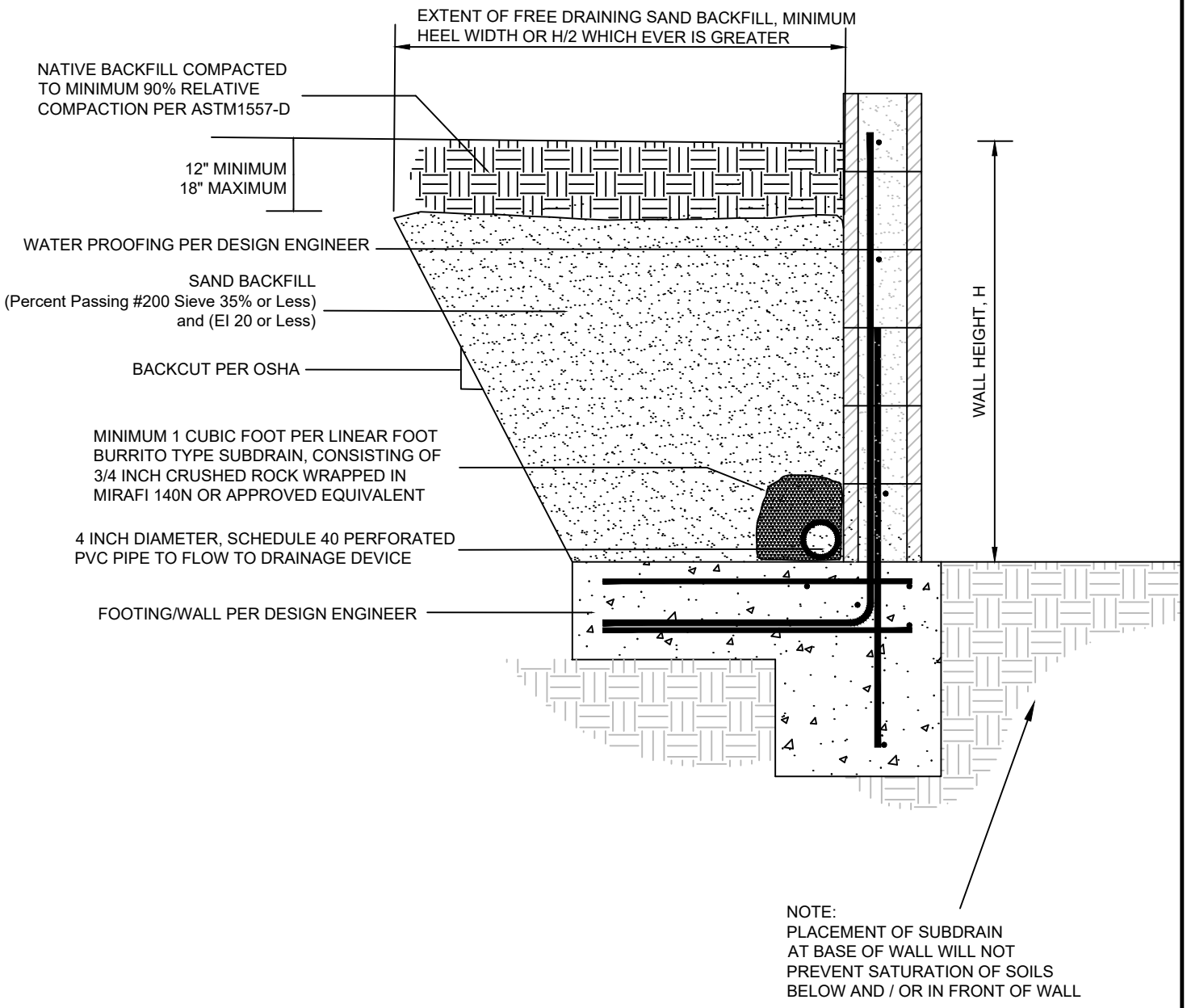

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FIGURE 3
Retaining Wall Backfill Detail

PROJECT NAME	*MWIG - Whittier*
PROJECT NO.	*21051-01*
ENG. / GEOL.	*RLD*
SCALE	*Not to Scale*
DATE	*May 2021*

Appendix A
References

APPENDIX A

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Appendix B
Field Exploration Logs

Geotechnical Boring Log Borehole HS-1

Date: 4/6/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Whittier | **Type of Rig:** CME 75

Project Number: 21051-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~319' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By MJG
Sampled By MJG
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to 5'- Undocumented Artificial Fill (afu):**	MD
								@0'- 3 inches of Asphalt over 9 inches of Base	EI
315			R-1	6 10 12	111.4	11.0	ML	@2.5'- Sandy SILT: brown, moist, very stiff	CR DS
	5		R-2	8 17 31	116.6	15.5	CL	**@5' to T.D.- Quaternary Alluvium (Qa):** @5'- CLAY with Sand: brown, moist, hard	
310			R-3	7 14 11	111.2	12.9		@7.5'- CLAY: dark yellowish brown, moist, very stiff	CO AL
	10		SPT-1	3 3 5		3.5	SM	@10'- Silty SAND: dusky brown, dry, medium dense	
305									
	15		R-1	17 40 50/3"	119.6	14.7	CL	@15'- CLAY with Gravel: brown, moist, hard	
300									
	20		SPT-2	8 10 10		8.5	ML	@20'- Sandy SILT: dusky brown, slightly moist, very stiff	
295								Total Depth = 21.5' Groundwater Not Encountered Backfilled with Cuttings on 4/6/2021	
	25								
290									
	30								

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THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 5/3/2021

Geotechnical Boring Log Borehole HS-2

Date: 4/6/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Whittier | **Type of Rig:** CME 75

Project Number: 21051-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~319' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By MJG
Sampled By MJG
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to 5'- Undocumented Artificial Fill (afu):** @0'- 2 inches of Asphalt over 3 inches of Base	
			R-1	6 8 4	104.9	5.8	SP	@2.5'- SAND with Gravel: gray/brown, slightly moist, loose	
315	5		R-2	3 7 11	110.8	1.4	SP	**@5' to T.D.- Quaternary Alluvium (Qa):** @5'- SAND with Gravel: dusky gray/brown, dry, medium dense	
			R-3	11 16 23	117.4	14.0	ML	@7.5'- Sandy SILT: brown, moist, hard	
310	10		R-4	10 20 26	118.5	14.4		@10'- Sandy SILT: brown, moist, hard	
305	15		SPT-1	5 7 12		17.0		@15'- Sandy SILT: brown, very moist, very stiff	-#200
300	20		R-5	26 50/5"	115.8	14.9		@20'- Sandy SILT: brown, moist, hard	
295	25		SPT-2	8 13 16		14.4		@25'- Sandy SILT: dusky brown, moist, hard	
290	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
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▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 5/3/2021

Geotechnical Boring Log Borehole HS-2

Date: 4/6/2021	**Drilling Company:** Cal Pac Drilling
Project Name: MWIG - Whittier	**Type of Rig:** CME 75
Project Number: 21051-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~319' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 2 of 2

Logged By MJG
Sampled By MJG
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	30		R-6	16 39 50/4"	118.0	15.0	CL	@30'- CLAY with Sand: brown, moist, hard	
285									
	35		SPT-3	8 12 10		11.8	ML	@35'- Sandy SILT: brown, moist, very stiff	-#200
280									
	40		R-7	9 23 50/6"	111.1	9.8		@40'- Sandy SILT: pinkish brown, slightly moist, hard	
275									
	45		SPT-4	10 21 41		15.1	CL	@45'- CLAY: reddish brown, moist, hard @46.5'- Refusal	
270								Total Depth = 46.5' Groundwater Not Encountered Backfilled with Cuttings on 4/6/2021	
	50								
265									
	55								
260									
	60								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Geotechnical Boring Log Borehole I-1

Date: 4/6/2021	**Drilling Company:** Cal Pac Drilling
Project Name: MWIG - Whittier	**Type of Rig:** CME 75
Project Number: 21051-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~316' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By MJG
Sampled By MJG
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
315	0							**@0' to 5'- Undocumented Artificial Fill (afu):** @0'- 4 inches of Asphalt over 5 inches of Base	
310	5		SPT-1	7 11 14		14.0	CL	**@5' to T.D.- Quaternary Alluvium (Qa):** @5'- CLAY with Sand: dark brown, moist, hard	
305	10		R-1	6 22 34	112.3	12.4	ML	@10'- Sandy SILT: dusky brown, moist, hard	
			SPT-2	13 19 19		10.7	CL	@13'- Sandy CLAY: brown, slightly moist, hard	
300	15							Total Depth = 15' Groundwater Not Encountered Pipe Pulled and Backfilled with Cuttings on 4/7/2021	
295	20								
290	25								
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
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TEST TYPES:

DS	DIRECT SHEAR
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CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 5/3/2021

Geotechnical Boring Log Borehole I-2

Date: 4/6/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Whittier | **Type of Rig:** CME 75

Project Number: 21051-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~313' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map |

Logged By MJG
Sampled By MJG
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
310	0							**@0' to 5'- Undocumented Artificial Fill (afu):** @0'- 6 inches of Asphalt over 5 inches of base	
305	5		R-1	9 11 18	111.2	16.5	CL	**@5' to T.D.- Quaternary Alluvium (Qa):** @5'- Sandy CLAY: brown, moist, very stiff	
	10		SPT-1	5 8 8		12.0	ML	@10'- Sandy SILT: dusky brown, moist, very stiff	
300			R-2	13 23 30	119.0	10.1		@13'- Sandy SILT: dusky brown, moist, hard	
295	15							Total Depth = 15' Groundwater Not Encountered Pipe Pulled and Backfilled with Cuttings on 4/7/2021	
290	20								
285	25								
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
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EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 5/3/2021

Appendix C
Laboratory Test Results

APPENDIX C

Laboratory Testing Procedures and Test Results

The laboratory testing program was formulated towards providing data relating to the relevant engineering properties of the soils with respect to residential construction. Samples considered representative of site conditions were tested in general accordance with American Society for Testing and Materials (ASTM) procedure and/or California Test Methods (CTM), where applicable. The following summary is a brief outline of the test type and a table summarizing the test results.

Moisture and Density Determination Tests: Moisture content (ASTM D2216) and dry density determinations (ASTM D2937) were performed on relatively undisturbed samples obtained from the test borings and/or trenches. The results of these tests are presented in the boring logs. Where applicable, only moisture content was determined from undisturbed or disturbed samples.

Expansion Index: The expansion potential of a selected sample was evaluated by the Expansion Index Test, Standard ASTM D4829. Specimens are molded under a given compactive energy to approximately the optimum moisture content and approximately 50 percent saturation or approximately 90 percent relative compaction. The prepared 1-inch-thick by 4-inch-diameter specimens are loaded to an equivalent 144 psf surcharge and are inundated with tap water until volumetric equilibrium is reached. The results of these tests are presented in the table below.

Sample Location	Expansion Index	Expansion Potential*
HS-1 @ 1-5 feet	47	Low

* ASTM D4829

Grain Size Distibution/Fines Content: Representative samples were dried, weighed and soaked in water until individual soil particles were separated (per ASTM D421) and then washed on a No. 200 sieve (ASTM D1140). Where applicable, the portion retained on the No. 200 sieve and dried and then sieved on a U.S. Standard brass sieve set in accordance with ASTM D6913 (sieve).

Sample Location	Description	% Passing # 200 Sieve
HS-2 @ 15 feet	Sandy Silt	82
HS-2 @ 35 feet	Sandy Silt	60

Laboratory Testing Procedures and Test Results

Atterberg Limits: The liquid and plastic limits ("Atterberg Limits") were determined per ASTM D4318 for engineering classification of fine-grained material and presented in the table below. The USCS soil classification indicated in the table below is based on the portion of sample passing the No. 40 sieve and may not necessarily be representative of the entire sample. The plot is provided in this Appendix.

Sample Location	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	USCS Soil Classification
HS-1 @ 7.5 ft	35	16	19	CL

Consolidation: One consolidation test was performed per ASTM D2435. A sample (2.4 inches in diameter and 1 inch in height) was placed in a consolidometer and increasing loads were applied. The sample was allowed to consolidate under "double drainage" and total deformation for each loading step was recorded. The percent consolidation for each load step was recorded as the ratio of the amount of vertical compression to the original sample height. The consolidation pressure curve is provided in this Appendix.

Direct Shear: One direct shear test was performed on remolded samples, which was soaked for a minimum of 24 hours prior to testing. The samples were tested under various normal loads using a motor-driven, strain-controlled, direct shear testing apparatus (ASTM D3080). The plot is provided in this Appendix.

Maximum Density Tests: The maximum dry density and optimum moisture content of typical materials were determined in accordance with ASTM D1557. The results of this test are presented in the table below:

Sample Location	Sample Description	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
HS-1 @ 1-5 feet	Dark Yellowish Brown Clay with Sand	120.5	10.2

Chloride Content: Chloride content was tested in accordance with Caltrans Test Method (CTM) 422. The results are presented below.

Sample Location	Chloride Content, ppm
HS-1 @ 1-5 feet	60

Laboratory Testing Procedures and Test Results

Soluble Sulfates: The soluble sulfate contents of selected samples were determined by standard geochemical methods (CTM 417). The soluble sulfate content is used to determine the appropriate cement type and maximum water-cement ratios. The test results are presented in the table below.

Sample Location	Sulfate Content (ppm)	Sulfate Exposure Class *
HS-1 @ 1-5 feet	140	S0

*Based on ACI 318R-14, Table 19.3.1.1

Minimum Resistivity and pH Tests: Minimum resistivity and pH tests were performed in general accordance with CTM 643 and standard geochemical methods. The results are presented in the table below.

Sample Location	pH	Minimum Resistivity (ohms-cm)
HS-1 @ 1-5 feet	6.50	1860

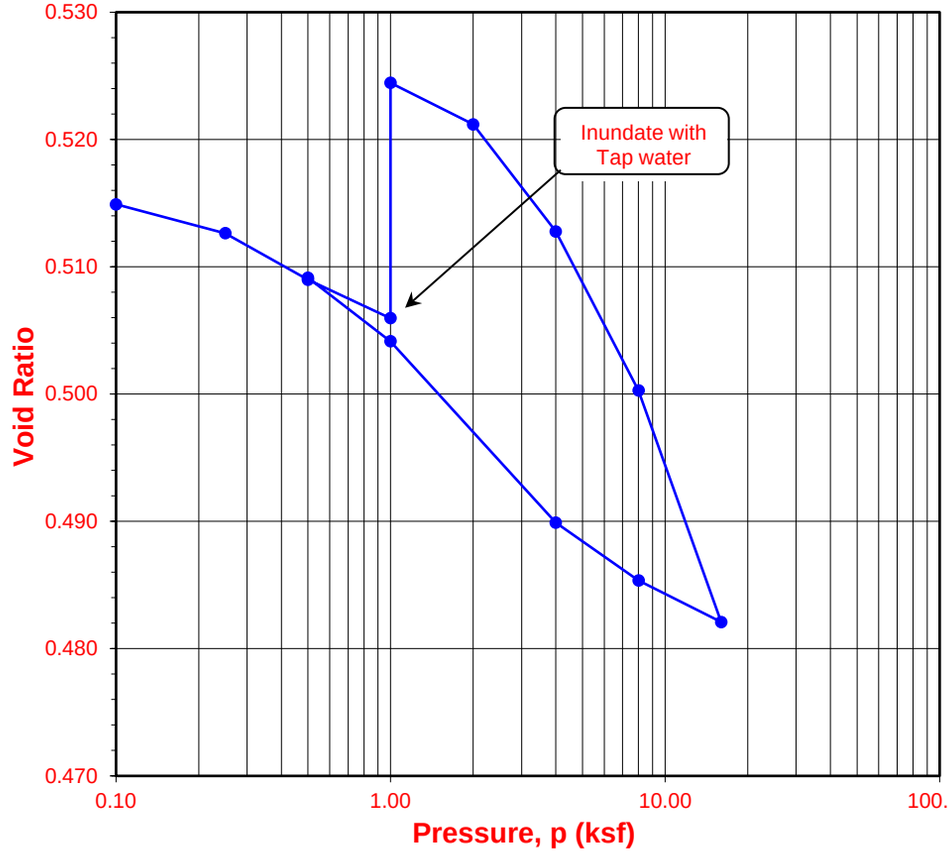
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name: Whittier
Project No.: 21051-01
Boring No.: HS-1
Sample No.: R-3
Soil Identification: Dark yellowish brown lean clay (CL)

Tested By: GB/YN Date: 04/13/21
Checked By: J. Ward Date: 05/04/21
Depth (ft.): 7.5
Sample Type: Ring

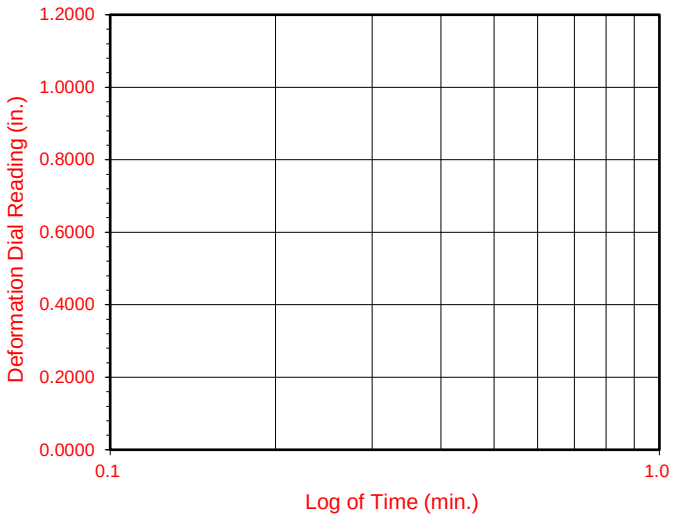
Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	194.04
Weight of Ring (g)	43.10
Height after consol. (in.)	0.9958
Before Test	
Wt.Wet Sample+Cont. (g)	297.31
Wt.of Dry Sample+Cont. (g)	272.29
Weight of Container (g)	77.78
Initial Moisture Content (%)	12.9
Initial Dry Density (pcf)	111.2
Initial Saturation (%)	67
Initial Vertical Reading (in.)	0.3014
After Test	
Wt.of Wet Sample+Cont. (g)	264.23
Wt. of Dry Sample+Cont. (g)	241.02
Weight of Container (g)	64.37
Final Moisture Content (%)	17.38
Final Dry Density (pcf)	111.5
Final Saturation (%)	92
Final Vertical Reading (in.)	0.2937
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

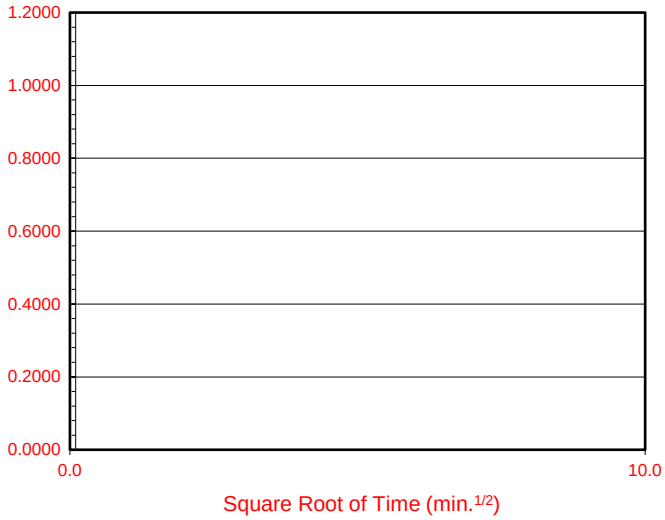


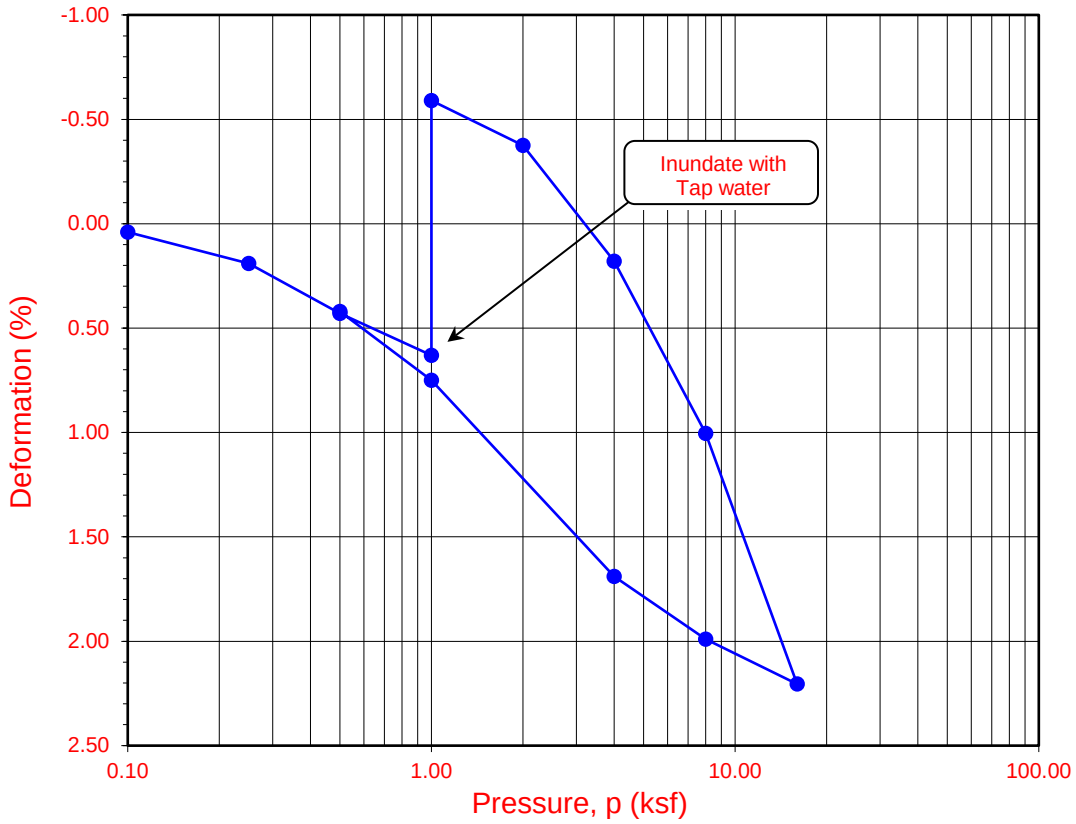
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3010	0.9996	0.00	0.04	0.515	0.04
0.25	0.2992	0.9978	0.03	0.22	0.513	0.19
0.50	0.2965	0.9951	0.06	0.49	0.509	0.43
1.00	0.2940	0.9926	0.11	0.74	0.506	0.63
1.00	0.3062	1.0048	0.11	-0.48	0.524	-0.59
2.00	0.3032	1.0018	0.20	-0.17	0.521	-0.37
4.00	0.2963	0.9949	0.33	0.51	0.513	0.18
8.00	0.2866	0.9852	0.48	1.49	0.500	1.01
16.00	0.2727	0.9713	0.67	2.88	0.482	2.21
8.00	0.2757	0.9743	0.58	2.57	0.485	1.99
4.00	0.2795	0.9781	0.50	2.19	0.490	1.69
1.00	0.2900	0.9886	0.39	1.14	0.504	0.75
0.50	0.2937	0.9923	0.35	0.77	0.509	0.42

Time Readings				
Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
HS-1	**R-3**	**7.5**	**12.9**	**17.4**	**111.2**	**111.5**	**0.516**	**0.509**	**67**	**92**

Soil Identification: Dark yellowish brown lean clay (CL)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 21051-01

Whittier

05-21

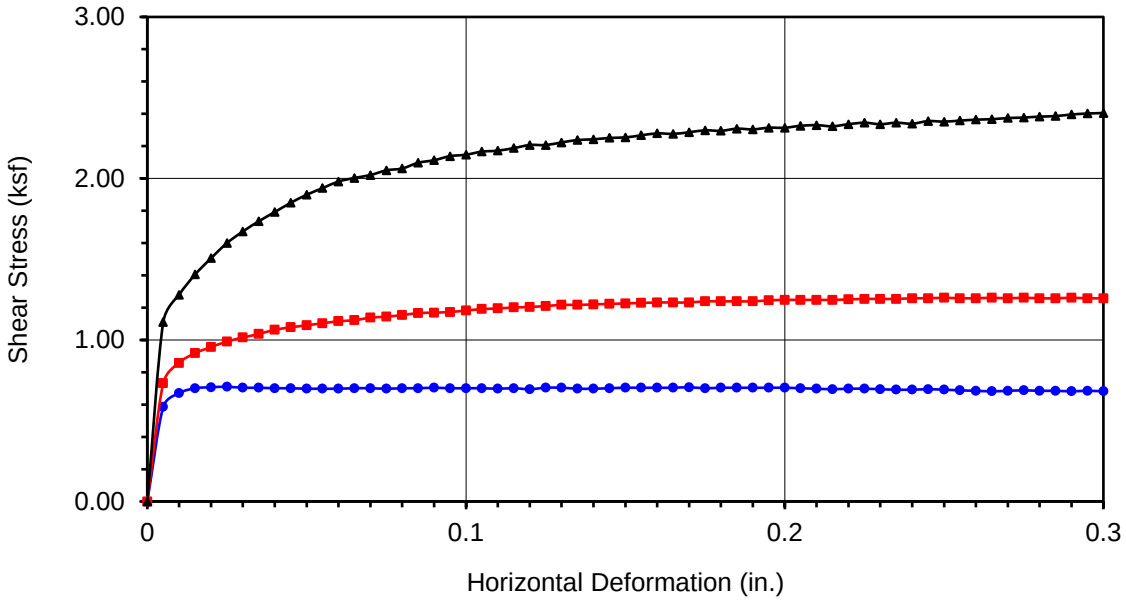
DIRECT SHEAR TEST

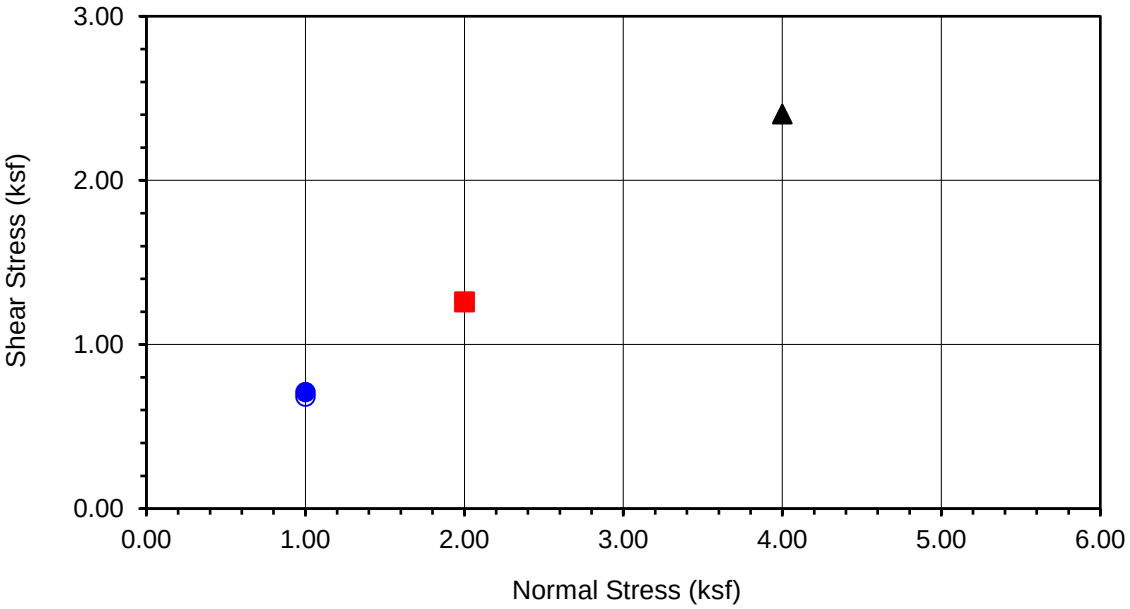
Consolidated Drained - ASTM D 3080

Project Name:	Whittier	Tested By:	G. Bathala	Date:	04/19/21
Project No.:	21051-01	Checked By:	J. Ward	Date:	05/04/21
Boring No.:	HS-1	Sample Type:	90% Remold		
Sample No.:	B-1	Depth (ft.):	1-5		

Soil Identification: Dark yellowish brown lean clay with sand (CL)s

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	186.81	187.77	188.30
Weight of Ring(gm):	44.44	45.35	45.45
Before Shearing			
Weight of Wet Sample+Cont.(gm):	157.30	157.30	157.30
Weight of Dry Sample+Cont.(gm):	148.05	148.05	148.05
Weight of Container(gm):	61.21	61.21	61.21
Vertical Rdg.(in): Initial	0.0000	0.2442	0.2661
Vertical Rdg.(in): Final	0.0153	0.2558	0.2892
After Shearing			
Weight of Wet Sample+Cont.(gm):	226.79	218.56	214.49
Weight of Dry Sample+Cont.(gm):	200.66	193.84	191.46
Weight of Container(gm):	72.43	65.76	63.41
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**HS-1**
Sample No.	**B-1**
Depth (ft)	**1-5**
Sample Type: 90% Remold	
Soil Identification: Dark yellowish brown lean clay with sand (CL)s	

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.710	■ 1.261	▲ 2.405
Shear Stress @ End of Test (ksf)	○ 0.682	□ 1.258	△ 2.405
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.65	10.65	10.65
Dry Density (pcf)	107.0	107.0	107.4
Saturation (%)	50.0	50.0	50.5
Soil Height Before Shearing (in.)	1.0153	0.9884	0.9769
Final Moisture Content (%)	20.4	19.3	18.0

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 21051-01

Whittier

04-21

Appendix D
Infiltration Test Results

Infiltration Test Data Sheet

LGC Geotechnical, Inc
131 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: MWIG - Whittier
Project Number: 21051-01
Date: 4/8/2021
Location: I-1

Test hole dimensions (if circular)	
Boring Depth (feet)*:	15
Boring Diameter (inches):	8
Pipe Diameter (inches):	3

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

Pre-Soak /Pre-Test

No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Comments
PS-1	8:23	8:33	10.0	12.93	13.00	0.07	
PS-2	8:33	8:43	10.0	13	13.05	0.05	
Pre-Test	8:43	8:53	10.0	13.05	13.09	0.04	

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Surface Area of Test Section (feet ^2)	Raw Percolation Rate (in/hr)
1	8:56	9:26	30.0	12.90	13.03	0.13	4.75	0.2
2	9:26	9:56	30.0	13.03	13.10	0.07	4.48	0.1
3	9:56	10:26	30.0	13.10	13.19	0.09	4.33	0.2
4	10:26	10:56	30.0	13.06	13.14	0.08	4.41	0.2
5	10:56	11:26	30.0	12.93	13.03	0.10	4.68	0.2
6	11:26	11:56	30.0	13.03	13.12	0.09	4.48	0.2
7	11:56	12:26	30.0	12.93	13.02	0.09	4.68	0.2
8	12:26	12:56	30.0	13.02	13.10	0.08	4.50	0.1
9								
10								
11								
12								

Measured Infiltration Rate	**0.2**
Feasibility Reduction Factor	See Report
Feasibility Infiltration Rate	**See Report**

Sketch:

Notes:

Based on Guidelines from: LA County dated 06/2017
Spreadsheet Revised on: 12/23/2019

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc
131 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: MWIG - Whittier
Project Number: 21051-01
Date: 4/8/2021
Location: I-2

Test hole dimensions (if circular)	
Boring Depth (feet)*:	15
Boring Diameter (inches):	8
Pipe Diameter (inches):	3

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

Pre-Soak /Pre-Test

No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Comments
PS-1	8:29	8:39	10.0	11.91	11.95	0.04	
PS-2	8:39	8:49	10.0	11.95	11.98	0.03	
Pre-Test	8:49	8:59	10.0	11.98	12.01	0.03	

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Surface Area of Test Section (feet ^2)	Raw Percolation Rate (in/hr)
1	9:00	9:30	30.0	12.01	12.11	0.10	6.61	0.1
2	9:30	10:00	30.0	12.11	12.20	0.09	6.40	0.1
3	10:00	10:30	30.0	12.20	12.27	0.07	6.21	0.1
4	10:30	11:00	30.0	12.10	12.19	0.09	6.42	0.1
5	11:00	11:30	30.0	11.96	12.05	0.09	6.72	0.1
6	11:30	12:00	30.0	12.05	12.13	0.08	6.53	0.1
7	12:00	12:30	30.0	12.13	12.22	0.09	6.36	0.1
8	12:30	13:00	30.0	12.09	12.17	0.08	6.44	0.1
9								
10								
11								
12								

Measured Infiltration Rate	**0.1**
Feasibility Reduction Factor	See Report
Feasibility Infiltration Rate	**See Report**

Sketch:

Notes:

Based on Guidelines from: LA County dated 06/2017
Spreadsheet Revised on: 12/23/2019

LGC Geotechnical, Inc.

Appendix E
General Earthwork & Grading Specifications for Rough Grading

General Earthwork and Grading Specifications for Rough Grading

1.0 General

1.1 Intent

These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 The Geotechnical Consultant of Record

Prior to commencement of work, the owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to confirm that the attained level of compaction is being accomplished as specified. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the project plans and specifications. The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of “equipment” of work and the estimated quantities of daily earthwork

contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the
Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified. It is the contractor's sole responsibility to provide proper fill compaction.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed. The contractor is responsible for all hazardous waste relating to his work. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Client should acquire the services of a qualified environmental assessor.

2.2 Processing

Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be over-excavated as specified in the following section. Scarification shall continue until soils are broken down and free of oversize material and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Over-excavation

In addition to removals and over-excavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be over-excavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise over-excavated to provide a flat subgrade for the fill.

2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical consultant. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557.

4.5 Compaction Testing

Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 Frequency of Compaction Testing

Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 Compaction Test Locations

The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than
5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

7.1 The Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

7.2 All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over

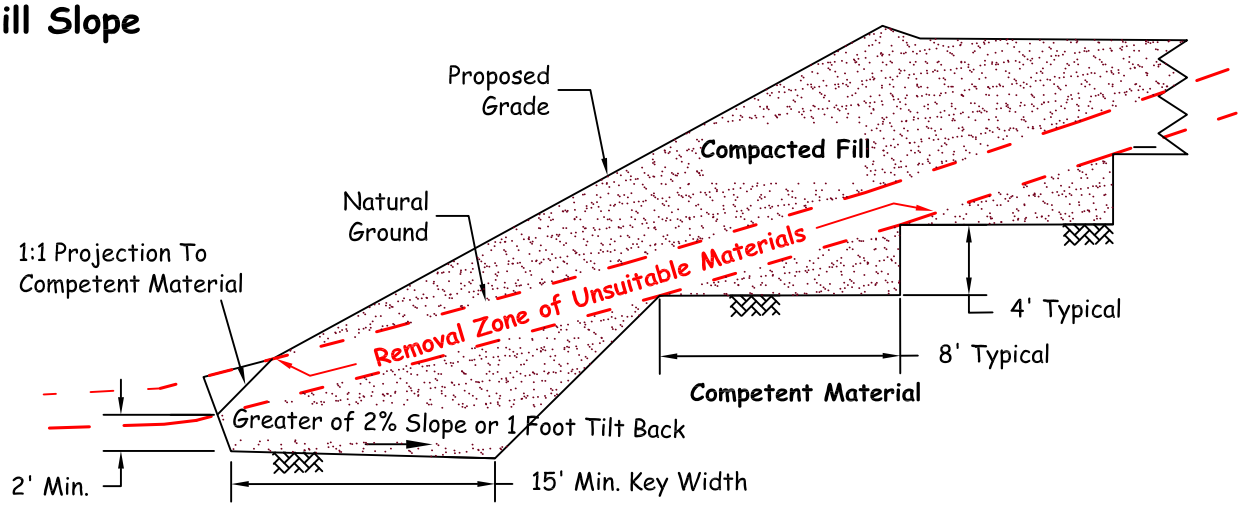
the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

7.3 The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

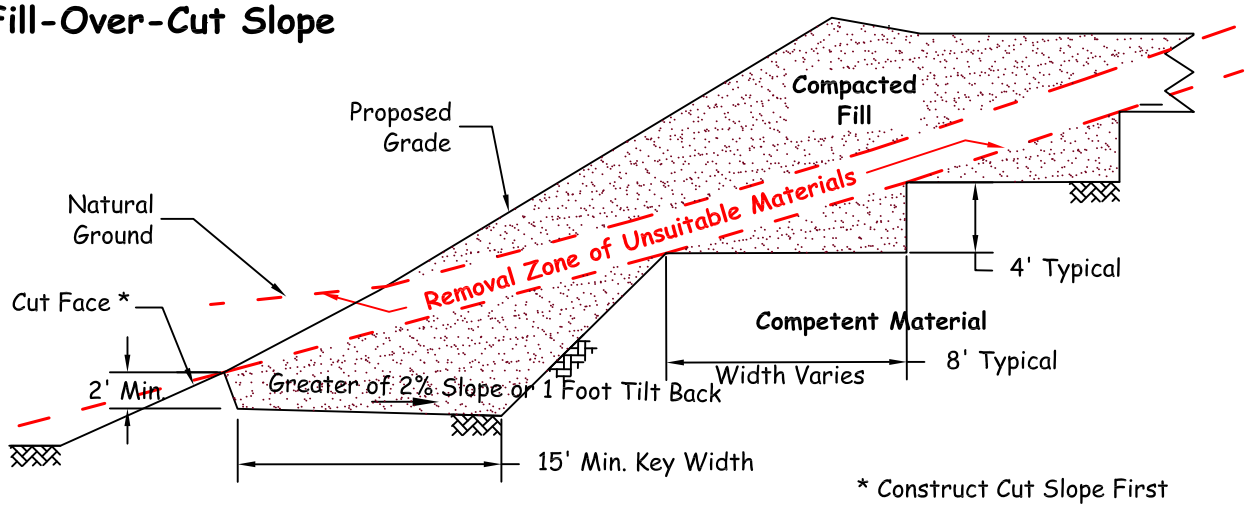
7.4 The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

7.5 Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

Fill Slope

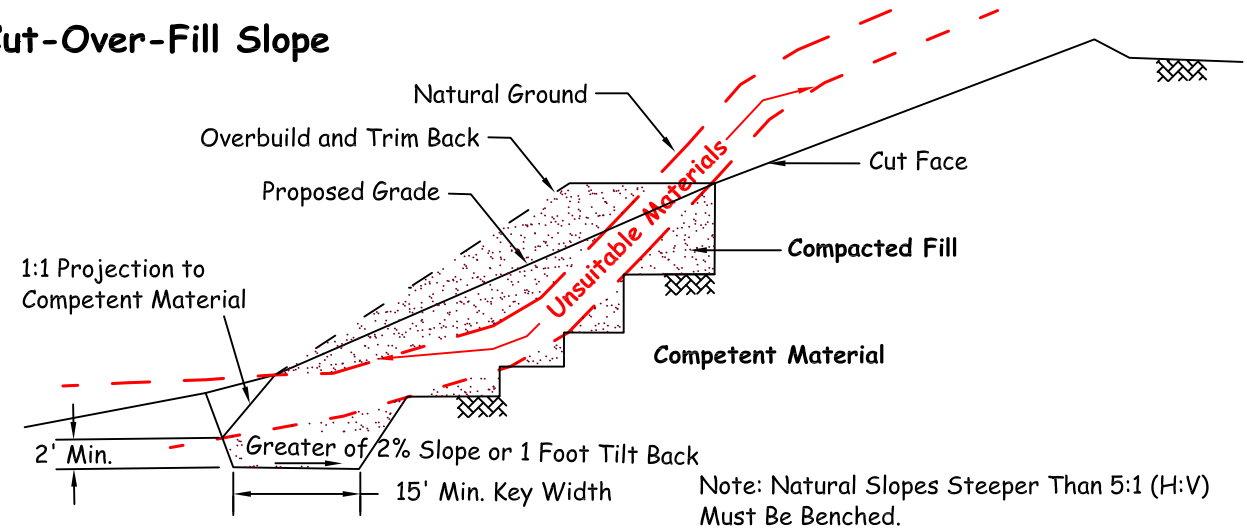


Fill-Over-Cut Slope



* Construct Cut Slope First

Cut-Over-Fill Slope



Note: Natural Slopes Steeper Than 5:1 (H:V) Must Be Benched.

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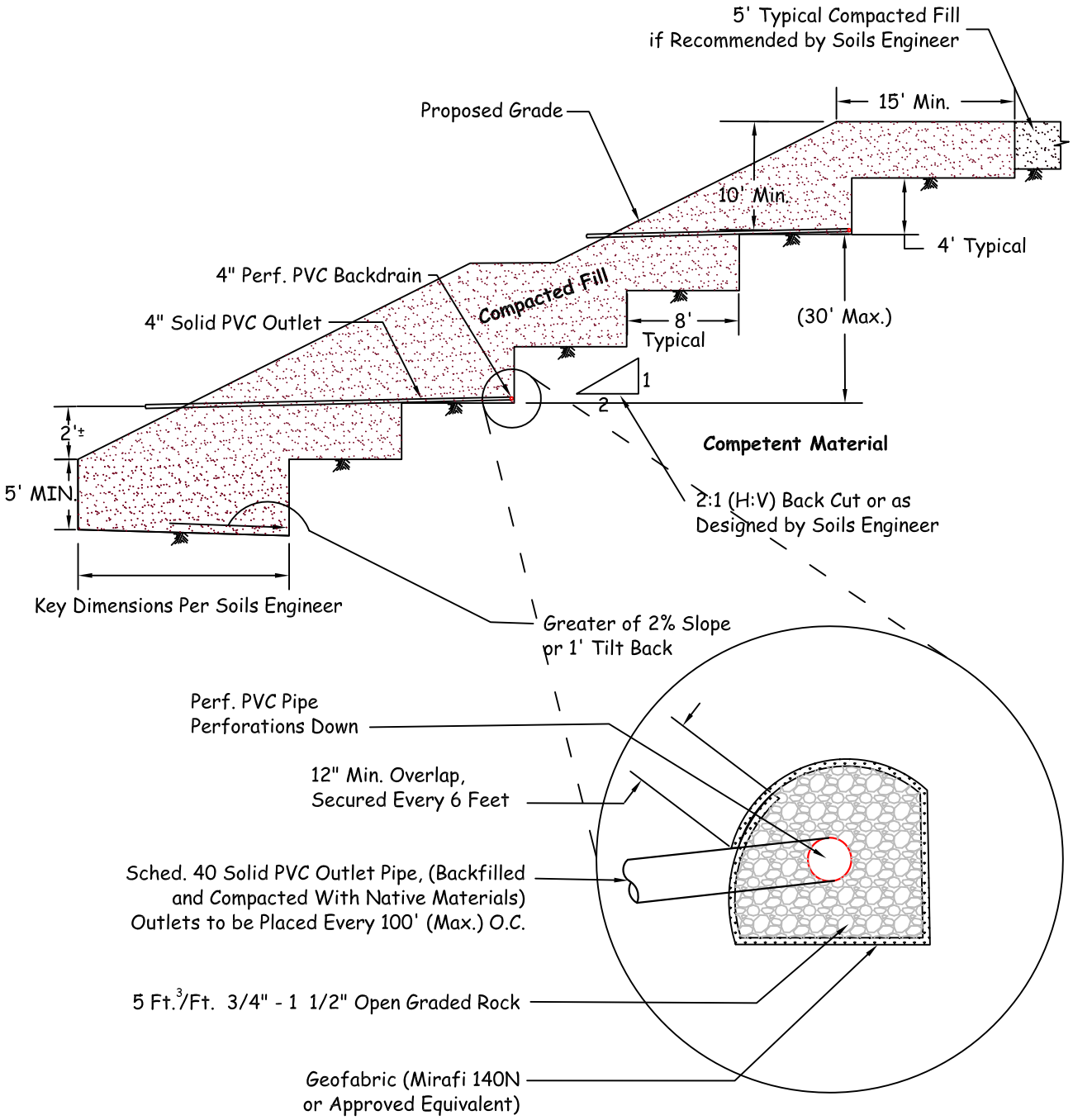
KEYING AND BENCHING



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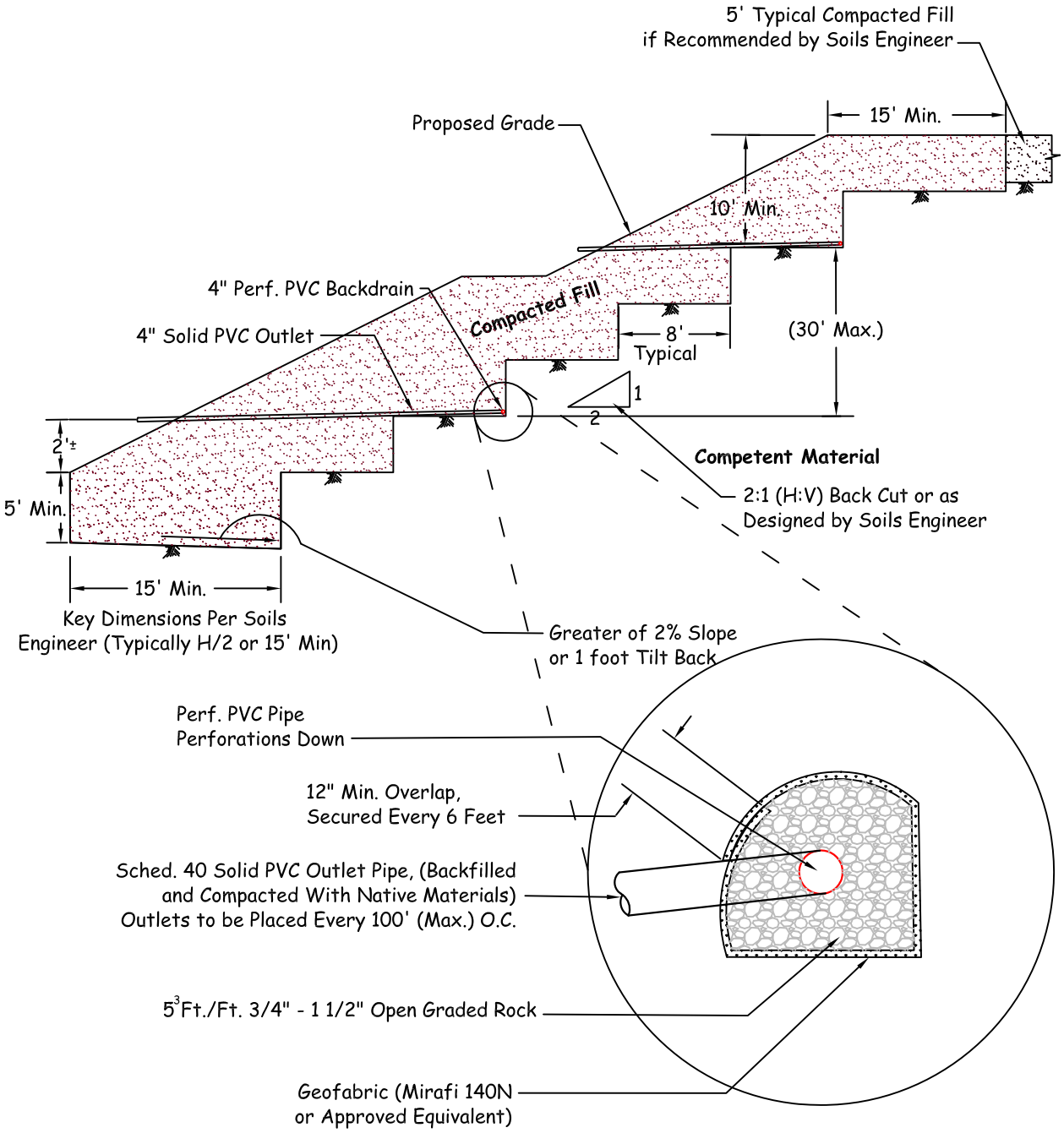
TYPICAL BUTTRESS DETAIL



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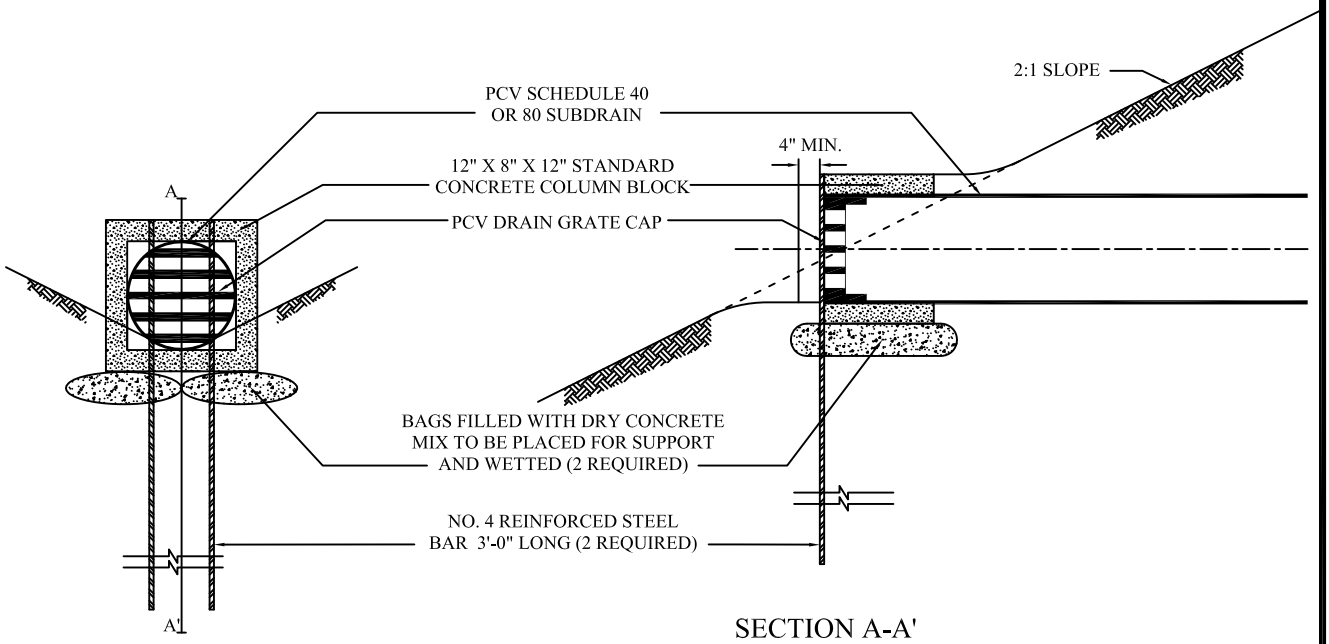
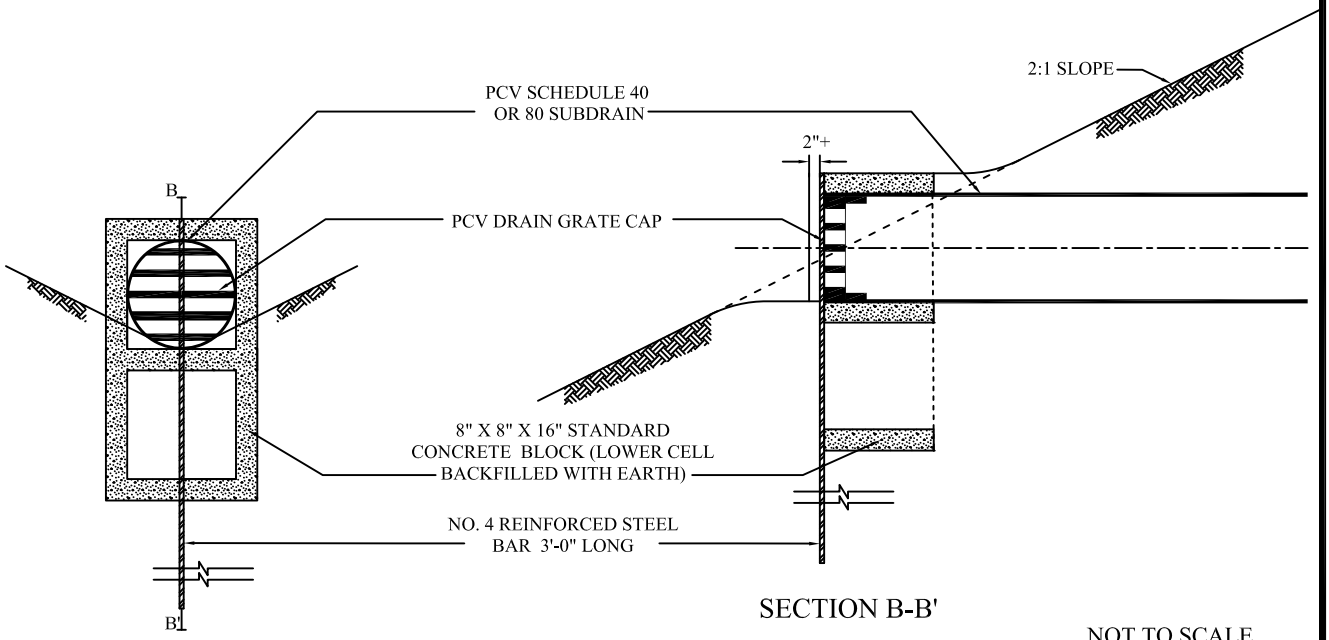
TYPICAL STABILIZATION FILL DETAIL

SUBDRAIN OUTLET MARKER -6" & 8" PIPE



SECTION A-A'

SUBDRAIN OUTLET MARKER -4" PIPE



SECTION B-B'

NOT TO SCALE

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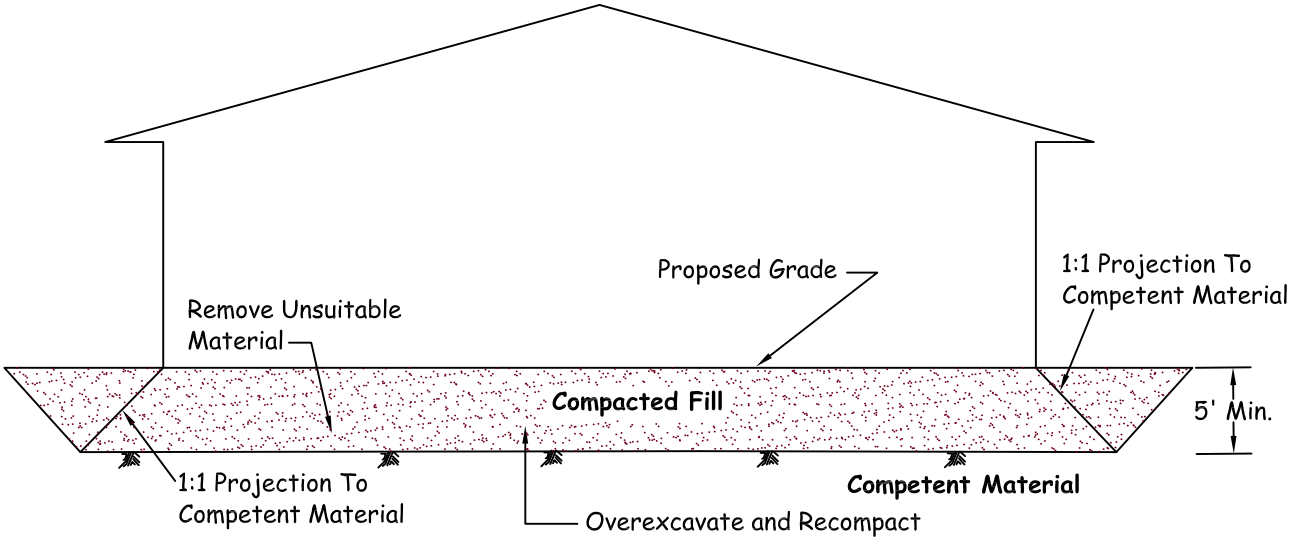
SUBDRAIN OUTLET MARKER DETAIL

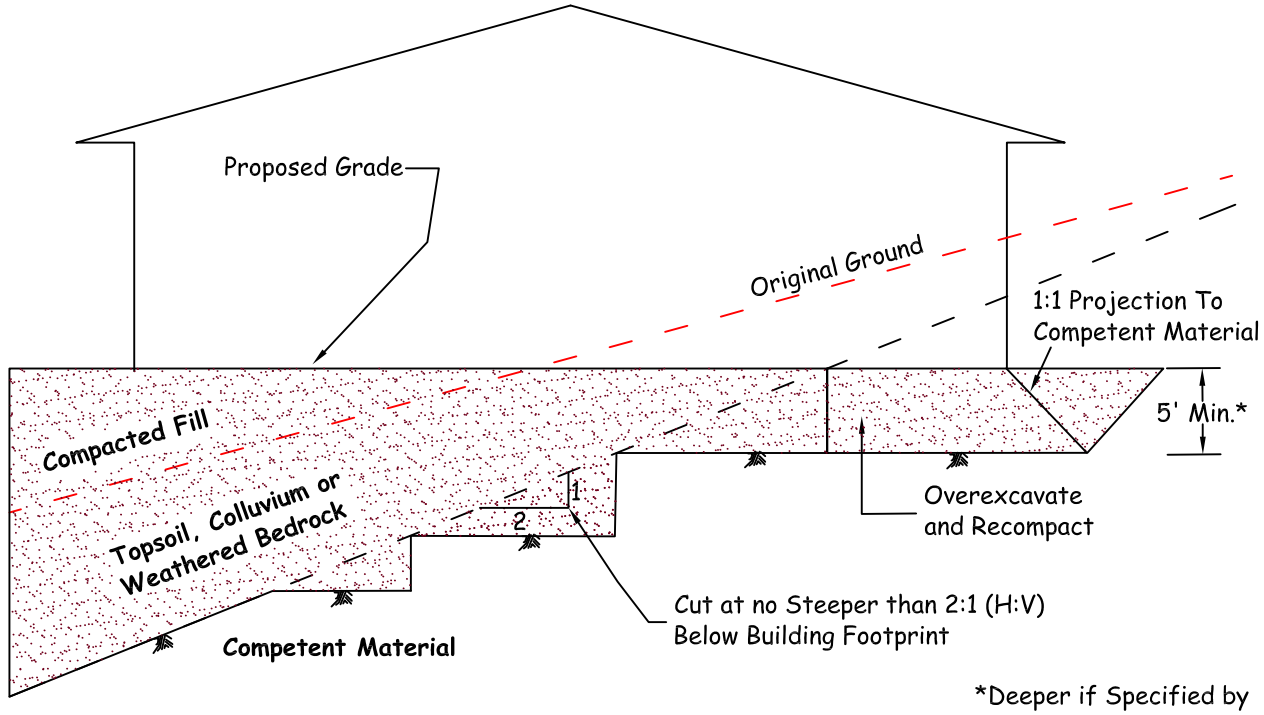
Cut Lot
(Exposing Unsuitable Soils at Design Grade)



Note 1: Removal Bottom Should be Graded With Minimum 2% Fall Towards Street or Other Suitable Area (as Determined by Soils Engineer) to Avoid Ponding Below Building

Note 2: Where Design Cut Lots are Excavated Entirely Into Competent Material, Overexcavation May Still be Required for Hard-Rock Conditions or for Materials With Variable Expansion Characteristics.

Cut/Fill Transition Lot



*Deeper if Specified by Soils Engineer

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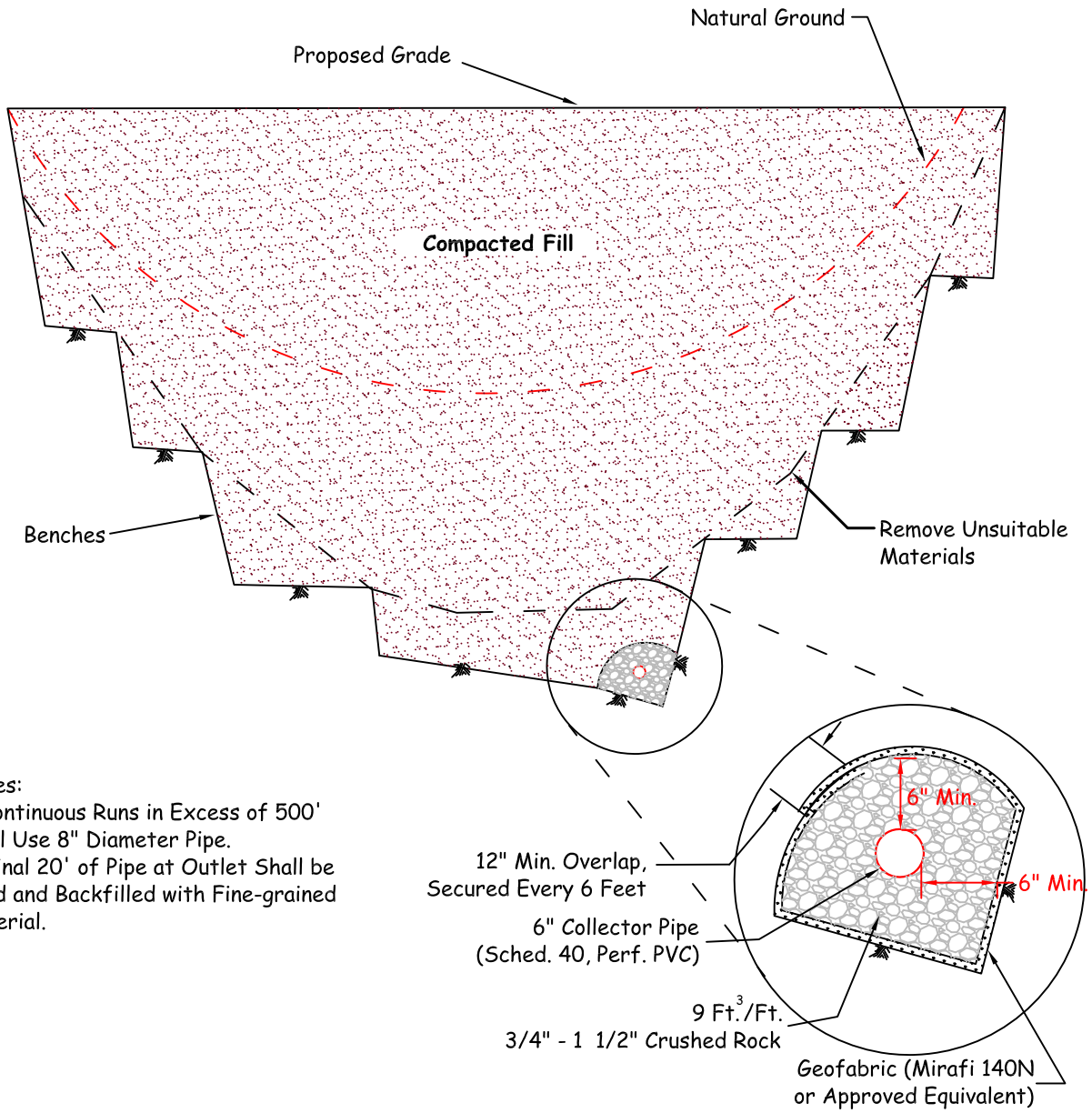
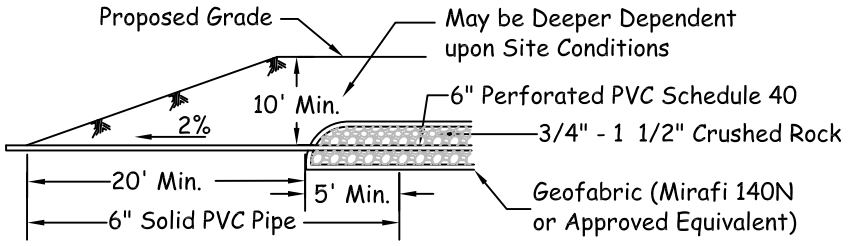
CUT AND TRANSITION LOT OVEREXCAVATION DETAIL



Notes:
1) Continuous Runs in Excess of 500' Shall Use 8" Diameter Pipe.
2) Final 20' of Pipe at Outlet Shall be Solid and Backfilled with Fine-grained Material.

Proposed Outlet Detail



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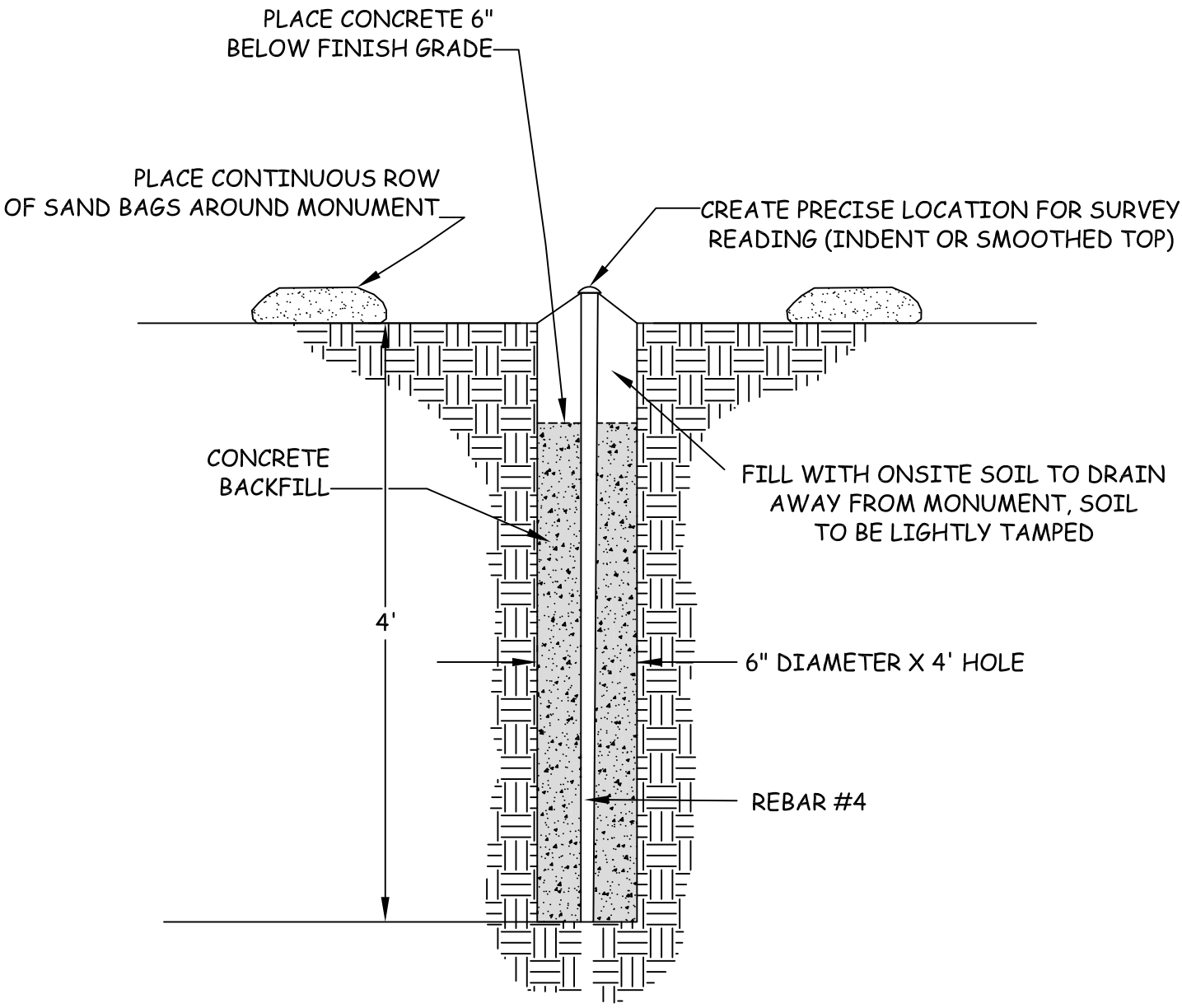
CANYON SUBDRAINS



NO CONSTRUCTION EQUIPMENT WITHIN 25 FEET
OF ANY INSTALLED SETTLEMENT MONUMENTS

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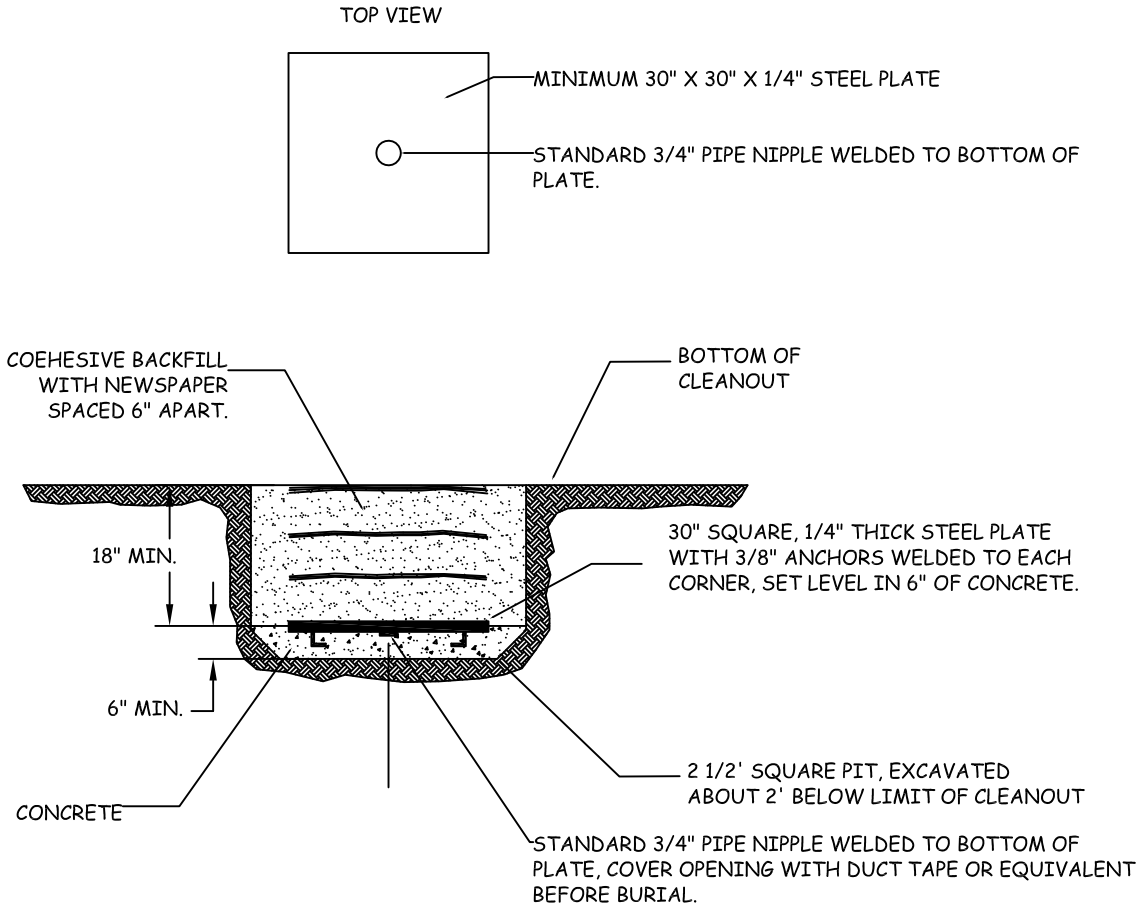
TYPICAL SURFACE SETTLEMENT MONUMENT



1. SURVEY FOR HORIZONTAL AND VERTICAL LOCATION TO NEAREST .01 INCH PRIOR TO BACKFILL USING KNOW LOCATIONS THAT WILL REMAIN INTACT DURING THE DURATION OF THE MONITORING PROGRAM. KNOW POINTS EXPLICITELY NOT ALLOWED ARE THOSE LOCATED ON FILL OR THAT WILL BE DESTROYED DURING GRADING.
2. IN THE EVENT OF DAMAGE TO SETTLEMENT PLATE DURING GRADING, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE GEOTECHNICAL ENGINEER AND SHALL BE RESPONSIBLE FOR RESTORING THE SETTLEMENT PLATES TO WORKING ORDER.
3. DRILL TO RECOVER AND ATTACH RISER PIPE.

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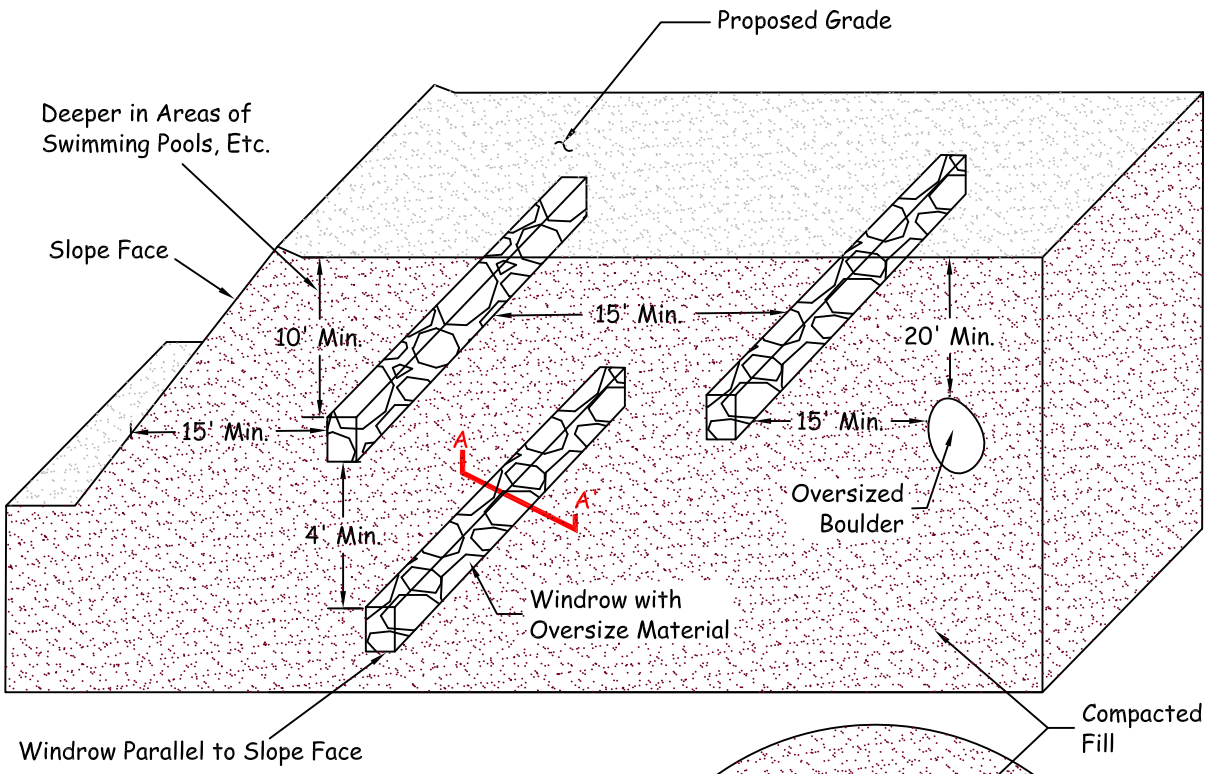
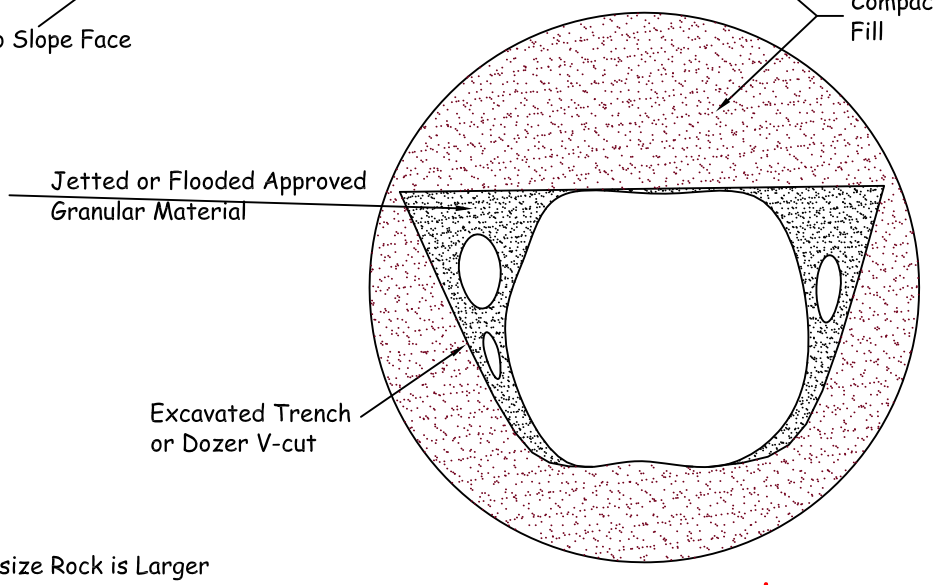
TYPICAL SETTLEMENT PLATE AND RISER





Note: Oversize Rock is Larger
than 8" in Maximum Dimension.

Section A-A'

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OVERSIZE ROCK DISPOSAL DETAIL

Appendix 7 Operation & Maintenance Documents

To be provided with Final LID Report