

Appendix

Appendix E LID Plan

Appendix

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**Preliminary
Low Impact Development Plan
(LID)**

**Starbucks Coffee
SWC Las Tunas Drive &
Del Mar Avenue
San Gabriel, CA
Los Angeles County**

Prepared for:



Prepared by:

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March 23, 2022

Starbucks Coffee
SWC Las Tunas Drive &
Del Mar Avenue
San Gabriel, CA
Los Angeles County
GreenbergFarrow Job # 202111300

TABLE OF CONTENTS

Project Narrative – Existing Conditions	1
Project Narrative – Proposed conditions.....	1
Pollutants of Concern	2
Inspection and Maintenance	4
Area and Volume Calculations Summary.....	6
Owner`s Certification.....	7
Mitigated Flow Rate Calculations and Worksheets	TAB A
LID Exhibit.....	TAB B
Educational material.....	TAB C
Master Covenant and Agreement.....	TAB D
LID Review Sheet (County of LA).....	TAB E
Operations and Maintenance (O&M) Plan	TAB F
Geotechnical Report (Including Percolation Test Report).....	TAB G

1. PROJECT NARRATIVE - EXISTING CONDITIONS

The subject property is located at southeast corner of W. Las Tunas Drive and S. Del Mar Avenue in San Gabriel, Los Angeles County, CA. The project is bound on the North by a multi-tenant shopping plaza, South by residential homes, West by a church, and East by a bank.

There used to be a building at this location, but the building and parking lot are previously demolished. The current condition of the site is a flat, vacant lot with exposed soil with chain link fence in perimeter. The existing site is approximately 100% pervious (Refer to table on Section 4).

The entire site slopes towards the south and sheet flows to the adjacent property. The onsite discharge exits the adjacent property through a parkway drain located at south west corner of the property to Del Mar Avenue. Stormwater discharges, from the site are not considered direct discharges, as defined by the State Water Board. Currently there are no existing stormwater Best Management Practices (BMP's) are in operation within the current site.

2. PROJECT NARRATIVE - PROPOSED CONDITION

The proposed property is located at southeast corner of W. Las Tunas Drive and S. Del Mar Avenue in San Gabriel, Los Angeles County, CA. The site is approximately 0.34 acre in area and is fully developed with a Starbucks building and associated site improvements including access drives, pavement, parking, landscaping, and site lighting. The new Starbucks building is approximately 999 square feet.

Under the proposed condition, generated runoff from the site sheet flows away from the building and is captured and treated by one BMP. This includes portion of proposed Starbucks building, parking lot, walkways, and landscape areas.

The generated runoff from the site is mainly runoff from roof and parking lot drainage, runoff will sheet flow on the asphalt paved parking lot and is being routed to the proposed Permeable Pavement without an Underdrain (RET-05). Storm water will be treated while infiltrating through the bedding and base layers of permeable pavement and will then infiltrate into local soils. Any excess water that does not percolate will exit the site via an overflow catch basin. The approximate location for proposed LID is (34.10237 and -118.10025). The site is approximately 73% impervious. (Refer to table on Section 4).

The proposed project contains an outdoor trash enclosure area. The trash enclosure is located east of the proposed building. The trash enclosure area is enclosed by a wall in three sides and swing doors on the other. The walls will minimize the transport of trash and litter by wind or water inside the trash enclosure area. Any runoff water from adjoining pavement will be directed around the trash enclosure to avoid flow through, the trash enclosure drainage will sheet flow on the ground and enters the proposed BMP. Also, the proposed project includes equipment –cleaning area that are located indoors, there will be no equipment cleaning operations outside of the building. All food processing operations including storage of waste materials will be performed at designated areas and indoors. In addition to performing regularly scheduled maintenance, the owner will sweep and remove any excessive oil, grease from the food processing operations to prevent discharge fats, oil and grease in concentrations that will cause an obstruction to the flow in a sewer. The inspection and maintenance should be performed on a regularly basis.

The Pollutants of Concern for the proposed development are shown on the following page:

Pollutants of Concern		
Pollutant	Circle One: E=Expected to be of concern N=Not Expected to be of concern	Additional Information and Comments
Suspended-Solid/ Sediment	☒ E ☐ N	Soils or other surface materials eroded and then transported or deposited by the action of wind. Small rocks or stones, sand, remains of plants or animals, and dust
Nutrients	☒ E ☐ N	Landscape products, inorganic substances, such as nitrogen and phosphorus
Heavy Metals	☒ E ☐ N	Heavy Metal includes: Lead: leaded gasoline, tire wear, lubricating oil and grease, bearing wear Zinc: tire wear, motor oil, grease, brake emissions, corrosion of galvanized parts Iron: auto body rust Copper: brake emissions Cadmium: tire wear, fuel burning, batteries Chromium: air conditioning coolants, engine parts, brake emissions Nickel: diesel fuel and gasoline, lubricating oil, brake emissions Aluminum: auto body corrosion
Pathogens (Bacteria/Virus)	☒ E ☐ N	Bacteria and viruses include infectious agents and disease producing organisms normally associated with human wastes, leakage from sewers
Pesticides	☒ E ☐ N	chemical compounds commonly used to control nuisance growth or prevalence of organisms
Oil and Grease	☒ E ☐ N	petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids
Toxic Organic Compounds	☒ E ☐ N	Some common forms of contamination of stormwater from organics are direct dumping, spills and improper storage and disposal.
Trash and Debris	☒ E ☐ N	Sources are paper, plastic, polystyrene packing foam, aluminum materials and biodegradable organic matter (such as leaves, grass cuttings, and food waste)

Sediments – Sediments are soils or other surface 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.

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 – The primary source of metal pollution in stormwater is 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. Metals are also raw material components in non-metal products such as fuels, adhesives, paints, and other coatings. At low concentrations naturally occurring in soil, metals may not be 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.

Pathogens / Coliforms – Pathogens and coliforms 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. Also, the decomposition of excess organic waste causes increased growth of undesirable organisms in the water

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.

Oil and Grease – Oil and grease in water bodies decreases the aesthetic value of the water body, as well as the water quality. Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.

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.

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 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.

3. INSPECTION AND MAINTENANCE

The Owner will conduct visual inspections of the source control and LID BMPs in accordance with the schedules. Water quality monitoring is not locally required for the site. The Owner will document results and observations, and maintain inspection records. Inspection results shall be maintained on file for not less than three years following the date of the inspection.

The responsible party for long-term inspection and maintenance of the proposed structural source control BMP is:

Starbucks Coffee, Inc
Lessee

Recordkeeping

All inspection records must be maintained and kept on site indefinitely and must be made available for review upon request.

4. AREA AND VOLUME CALCULATIONS SUMMARY

The hydrology calculations will be performed by the Hydrocalc developed by the Los Angeles County Public Works department. The Hydrocalc uses the full modified rational runoff calculation process to determine peak runoff flow rates and volumes.

Pre and Post Area Calculations

	Impervious Area (acres)	Impervious %	Pervious Area (acres)	Pervious %	Total
Pre-Development	0	0	0.34	100%	0.34
Post-Development on-site	0.25	73%	0.09	27%	0.34

Pre Development Runoff Calculations

50 Years

Area	Acres	%imp	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (cu-ft)
EX-1	0.34	0%	190	0.0200	7.0	5.0	4.1764	0.9	0.9	1.278	1757.3308

REFER TO TAB A FOR SIZING CALCULATIONS

Post Development Runoff Calculations

50 Years

Area (acres)	Acres	%imp	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (cu-ft)
PROP-1	0.34	73%	181	0.0119	7.0	5.0	4.1764	0.9	0.9	1.278	6087.4193

85th Percentile

Area (acres)	Acres	%imp	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (cu-ft)
PROP-1	0.34	73%	181	0.0119	1.1	13	0.4188	0.1	0.684	0.0974	920.9396

REFER TO TAB A FOR SIZING CALCULATIONS

OWNER'S CERTIFICATION

"The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan. 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 gathered the 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. Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the responsibility to implement and amend the stormwater plans."

Property Owner:

Signed: _____

Name: _____

Title: _____

Company: _____

Address: _____

Telephone Number: _____

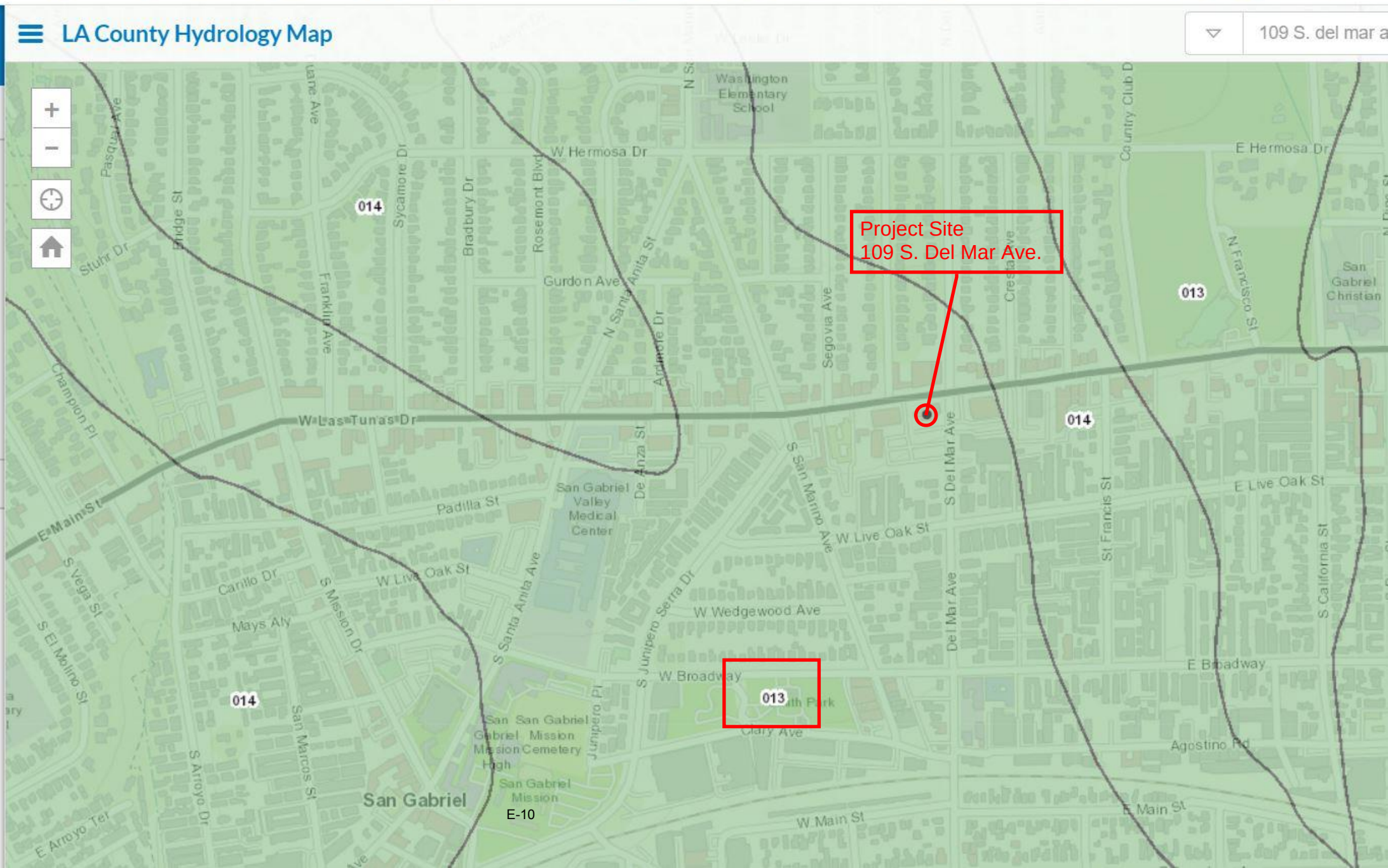
Date: _____

Mitigated Flow Calculations and Worksheets

About Legend Layers

Layers

- ☒ Hydrology GIS
 - ☐ 50yr Two Tenths (Rainfall)
 - ☐ DPA Zones
 - ☒ Soils 2004
 - ☐ Final 85th Percentile, 24-hr Rainfall
 - ☐ 1-year, 1-hour Rainfall Intensity
 - ☐ Final 95th Percentile, 24-hr Rainfall
- ☐ LA County Parcels



Layers

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 - ☒ 50yr Two Tenths (Rainfall)
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 - ☐ Final 85th Percentile, 24-hr Rainfall
 - ☐ 1-year, 1-hour Rainfall Intensity
 - ☐ Final 95th Percentile, 24-hr Rainfall

☐ LA County Parcels

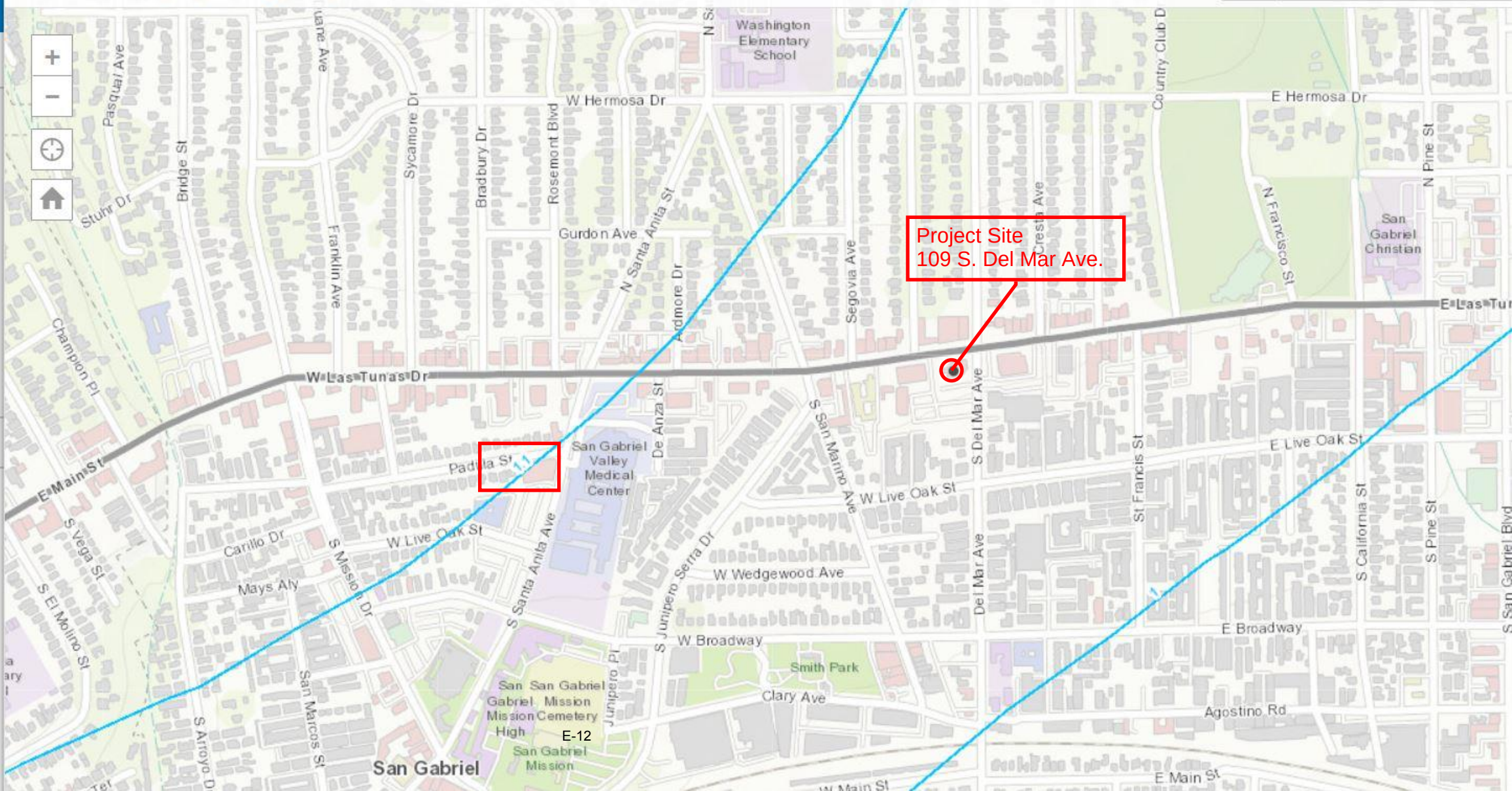


Layers

- ☒ Hydrology GIS
 - ☐ 50yr Two Tenths (Rainfall)
 - ☐ DPA Zones
 - ☐ Soils 2004
 - ☒ Final 85th Percentile, 24-hr Rainfall
 - ☐ 1-year, 1-hour Rainfall Intensity
 - ☐ Final 95th Percentile, 24-hr Rainfall
- ☐ LA County Parcels

LA County Hydrology Map

109 S. del mar ave. san



Peak Flow Hydrologic Analysis

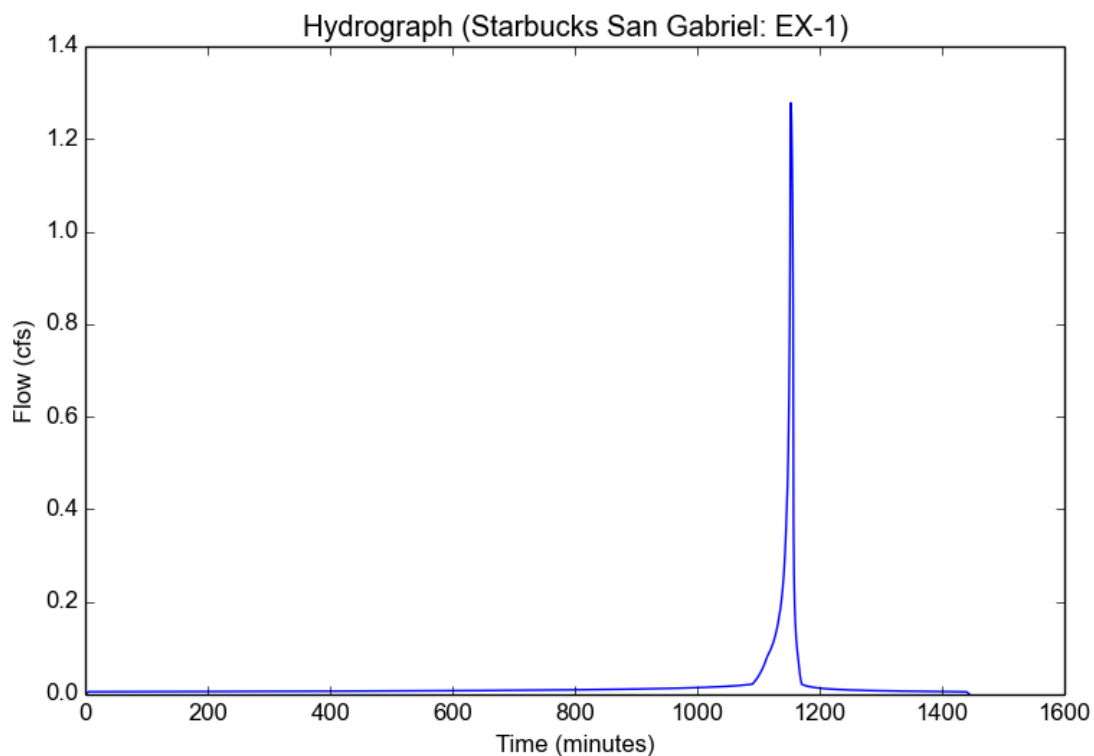
File location: P:/2021/202111300/800 Civil/LID/Tab A - Calculations/Starbucks San Gabriel - EX-1.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Starbucks San Gabriel
Subarea ID	EX-1
Area (ac)	0.34
Flow Path Length (ft)	190.0
Flow Path Slope (vft/hft)	0.02
50-yr Rainfall Depth (in)	7.0
Percent Impervious	0.01
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	7.0
Peak Intensity (in/hr)	4.1764
Undeveloped Runoff Coefficient (Cu)	0.9
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	1.278
Burned Peak Flow Rate (cfs)	1.278
24-Hr Clear Runoff Volume (ac-ft)	0.0403
24-Hr Clear Runoff Volume (cu-ft)	1757.3308



Peak Flow Hydrologic Analysis

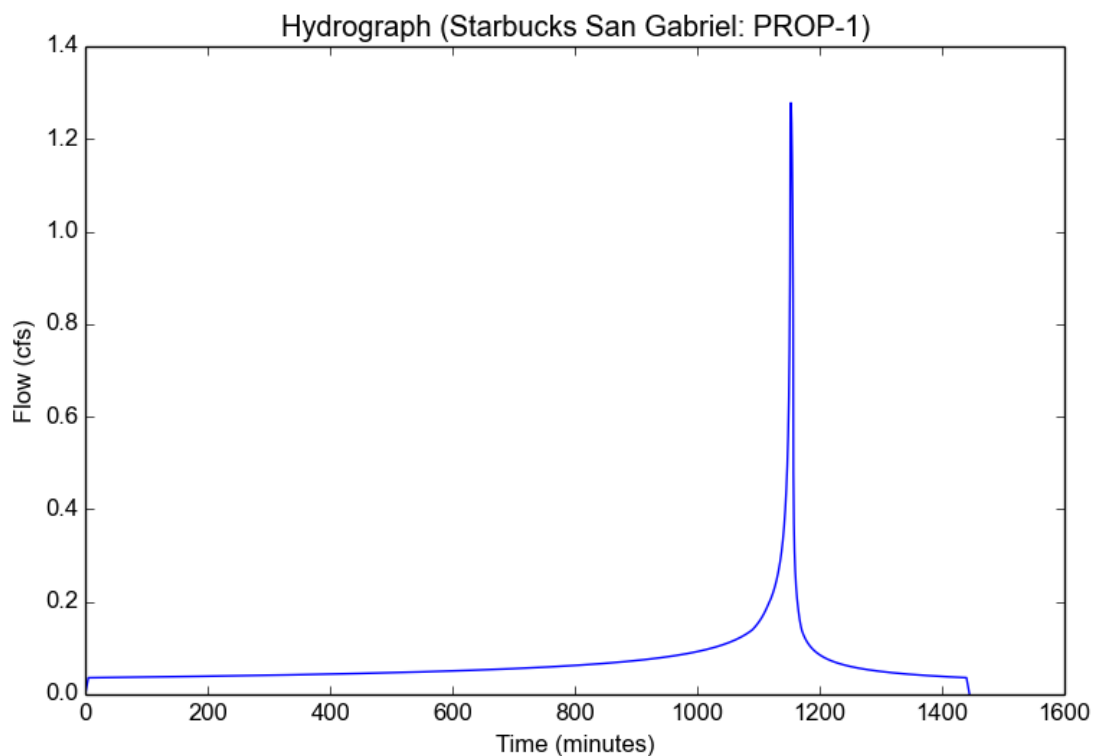
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Version: HydroCalc 1.0.3

Input Parameters

Project Name	Starbucks San Gabriel
Subarea ID	PROP-1
Area (ac)	0.34
Flow Path Length (ft)	181.0
Flow Path Slope (vft/hft)	0.0119
50-yr Rainfall Depth (in)	7.0
Percent Impervious	0.73
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	7.0
Peak Intensity (in/hr)	4.1764
Undeveloped Runoff Coefficient (Cu)	0.9
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	5.0
Clear Peak Flow Rate (cfs)	1.278
Burned Peak Flow Rate (cfs)	1.278
24-Hr Clear Runoff Volume (ac-ft)	0.1397
24-Hr Clear Runoff Volume (cu-ft)	6087.4193



Peak Flow Hydrologic Analysis

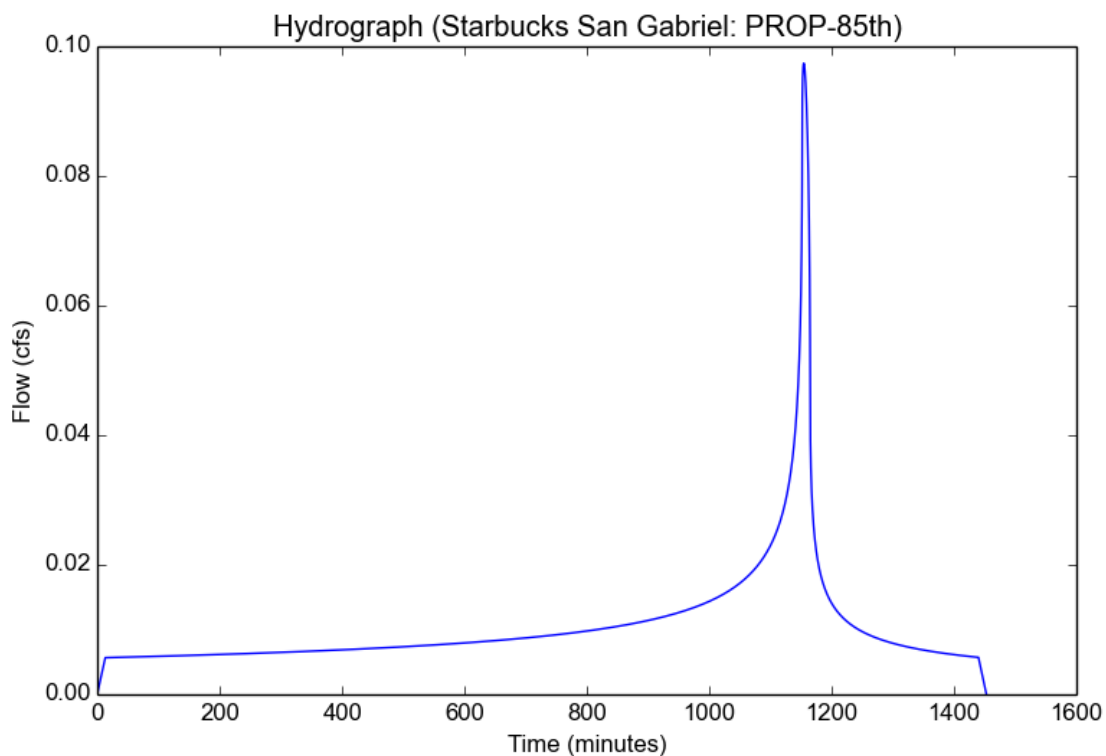
File location: P:/2021/202111300/800 Civil/LID/Tab A - Calculations/Starbucks San Gabriel - PROP-85th.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Starbucks San Gabriel
Subarea ID	PROP-85th
Area (ac)	0.34
Flow Path Length (ft)	181.0
Flow Path Slope (vft/hft)	0.0119
85th Percentile Rainfall Depth (in)	1.1
Percent Impervious	0.73
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.1
Peak Intensity (in/hr)	0.4188
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.684
Time of Concentration (min)	13.0
Clear Peak Flow Rate (cfs)	0.0974
Burned Peak Flow Rate (cfs)	0.0974
24-Hr Clear Runoff Volume (ac-ft)	0.0211
24-Hr Clear Runoff Volume (cu-ft)	920.9396



BMP No. 1

(Use RET-05 Permeable Pavement with No Underdrain)

Step 1 Determine the SWQDv (From Hydrocalc)

$$V_{\text{Design}} \text{ (cuft)} = 920.94 \text{ cuft}$$

Step 2 Determine the Design Infiltration Rate (From Geotech Report)

$$f_{\text{measure}} \text{ (in/hr)} = 0.30 \text{ in/hr} \quad \text{Factor of Safety: 2}$$

$$f_{\text{design}} \text{ (in/hr)} = 5.00 \text{ in/hr}$$

Step 3 Calculate the Surface Area

$$d_{\text{max}} = \frac{f_{\text{design}}}{12} \times t$$

Where:

d_{max} = Maximum depth of sub-base reservoir layer [ft];
 f_{design} = Design infiltration rate [in/hr];
 t = Maximum retention time (max 96 hrs) [hr]; and

Select the permeable pavement sub-base reservoir layer depth (d_t) such that:

$$d_t \leq \frac{d_{\text{max}}}{n_t}$$

Where:

d_t = Depth of permeable pavement sub-base reservoir layer [ft];
 d_{max} = Maximum depth of water that can be infiltrated within the maximum retention time [ft]; and
 n_t = permeable pavement sub-base reservoir layer porosity.

The required permeable pavement surface area is calculated using the following equation:

$$A_s = \frac{SWQDv}{d_t \times n_t}$$

Where:

A_s = Permeable pavement surface area [ft²];
 $SWQDv$ = Stormwater quality design volume [ft³]; and
 d_t = Depth of permeable pavement sub-base reservoir layer [ft]; and
 n_t = Infiltration trench porosity.

$$d_{\text{max}} \text{ (ft)} = (5.00) / 12 \times 96$$

$$d_{\text{max}} \text{ (ft)} = 40 \text{ ft} \quad \text{Use} \rightarrow d_t = 3 \text{ ft}$$

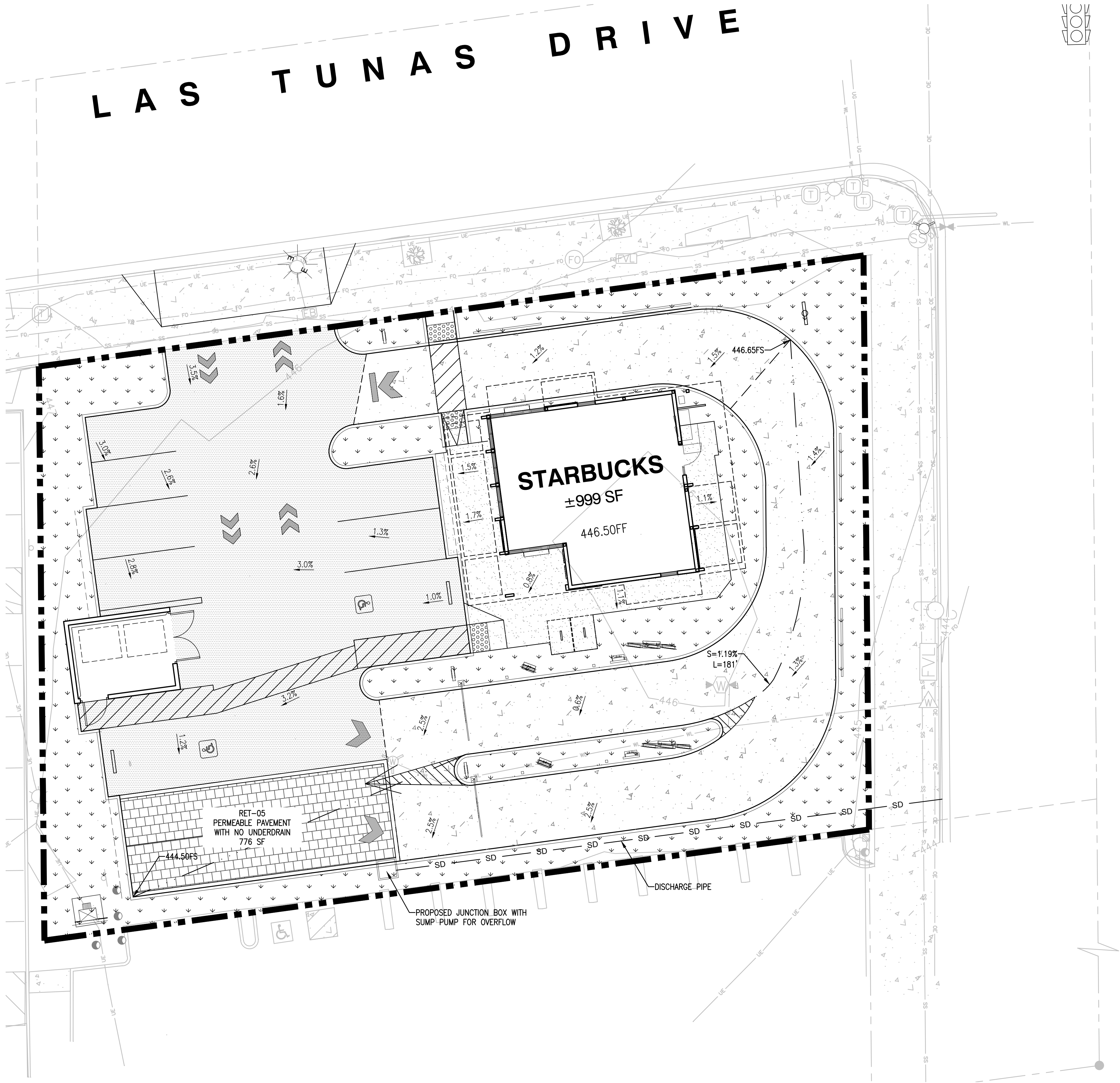
Check

$$\begin{aligned} d_t \text{ (ft)} &\leq 40 / 0.40 \\ 3 \text{ ft} &\leq 100 \text{ ft} \end{aligned}$$

$$A_{\text{min}} \text{ (sqft)} = 920.94 / (3 \times 0.4)$$

$$A_{\text{min}} \text{ (sqft)} = 767.45 \text{ sqft}$$

Provided 776.00 sqft O.K.



LEGEND:

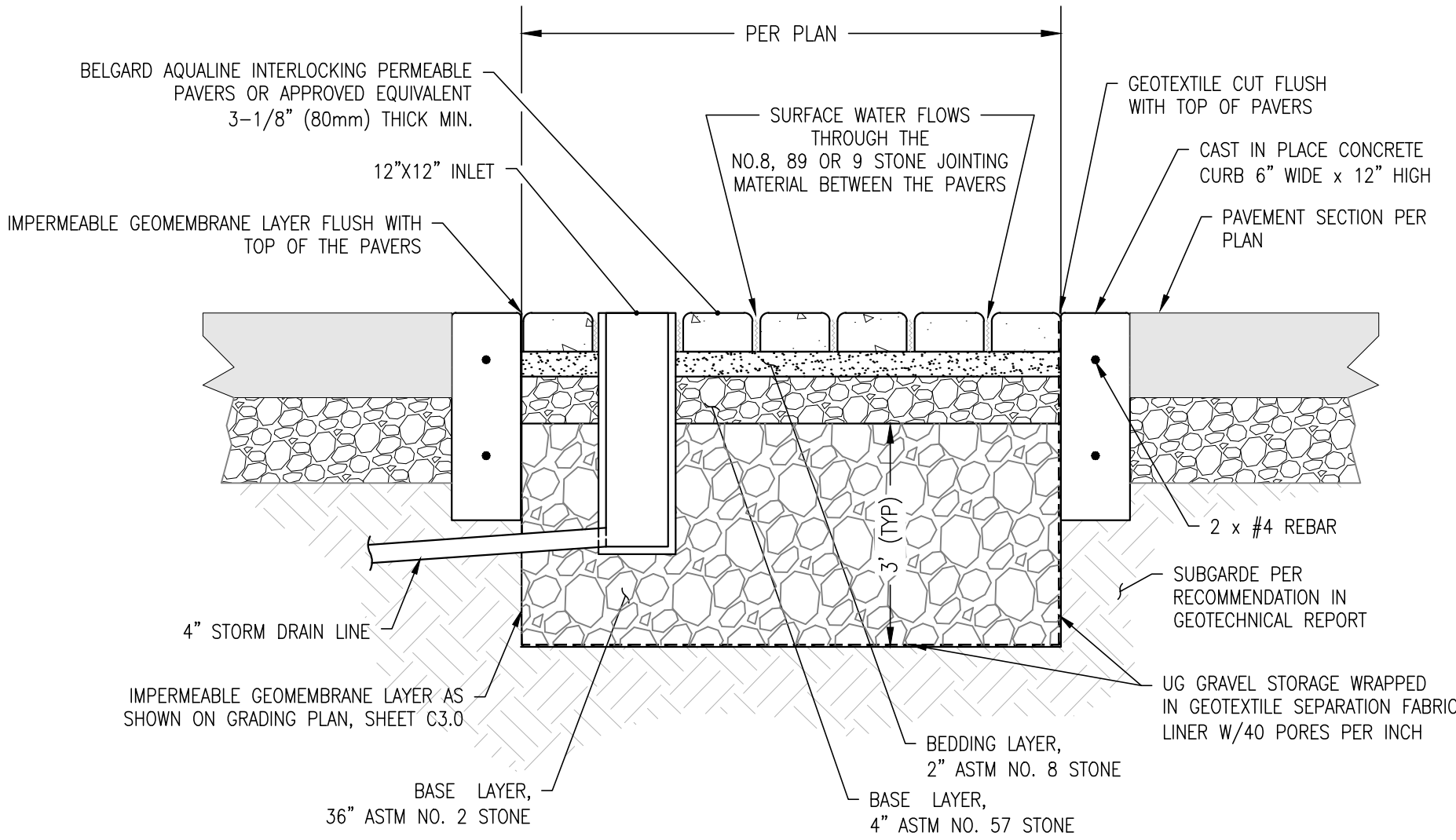
- PROPOSED FLOW LINE
- PROJECT BOUNDARY
- SURFACE FLOW DIRECTION

SUMMARY TABLE:

PERVIOUS: 3,898 SF (27%)
IMPERVIOUS: 10,702 SF (73%)
TOTAL: 14,600 SF (0.34 AC)

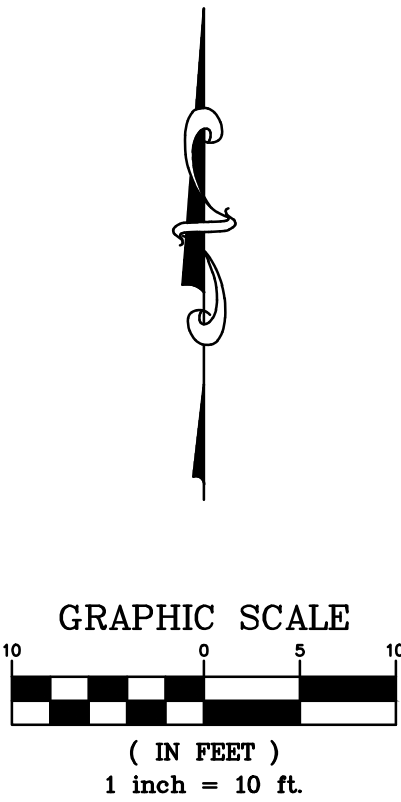
LEGEND

- PROPERTY LINE
- PROP. CURB
- AC PAVEMENT
- CONCRETE PAVEMENT
- TRUNCATED DOMES
- LANDSCAPE
- SIDEWALK



PERMEABLE PAVERS WITHOUT UNDERDRAIN

NOT TO SCALE



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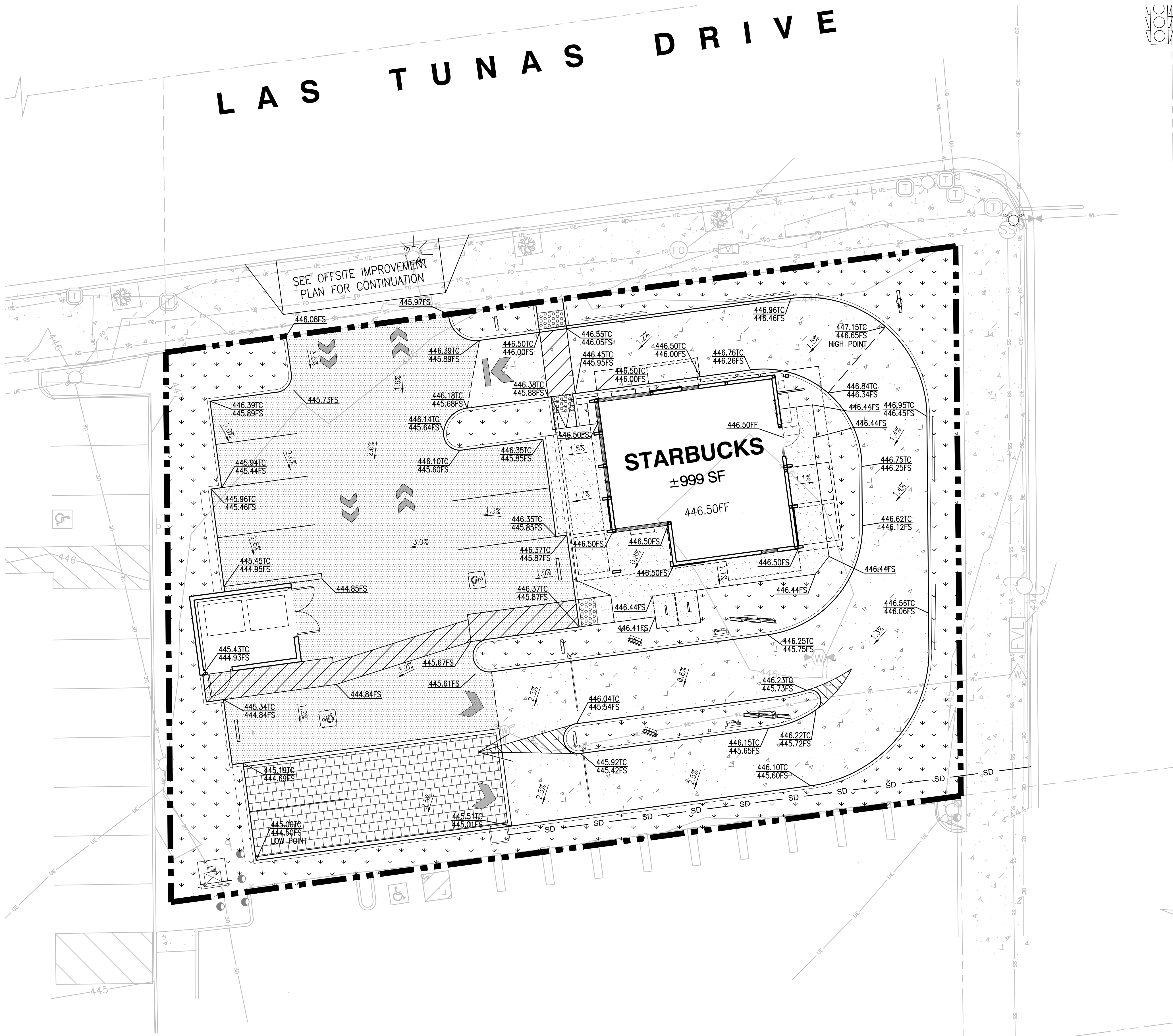
Revision Schedule			
Rev	Date	By	Description

PROJECT NAME: STARBUCKS
PROJECT ADDRESS: 109 S. DEL MAR AVENUE
SAN GABRIEL, CA 91776

PROFESSIONAL SEAL

STORE #:
PROJECT #:
CONCEPT:
PALETTE:
ISSUE DATE:
DESIGN MANAGER:
LEED® AP:
PRODUCTION DESIGNER: GREENBERGFARROW
CHECKED BY: BAHAREH SEHATZADEH

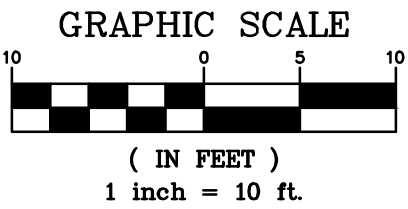
SHEET TITLE: LID/HYDROLOGY EXHIBIT
SCALE: NOTED
SHEET NUMBER: EX-1
2022-03-22



- GRADING NOTES**
1. CONTRACTOR MUST SECURE ALL NECESSARY PERMITS PRIOR TO STARTING WORK.
 2. IF THE CONTRACTOR, IN THE COURSE OF THE WORK, FINDS ANY DISCREPANCIES BETWEEN THE PLANS AND THE PHYSICAL CONDITIONS OF THE LOCALITY, OR ANY ERRORS OR OMISSIONS IN THE PLANS OR IN THE LAYOUT AS GIVEN BY THE ENGINEER, IT SHALL BE HIS DUTY TO IMMEDIATELY INFORM THE ENGINEER, IN WRITING, AND THE ENGINEER WILL PROMPTLY VERIFY THE SAME. ANY WORK DONE AFTER SUCH A DISCOVERY, UNTIL AUTHORIZED, WILL BE AT THE CONTRACTOR'S RISK.
 3. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF ALL SETBACKS, EASEMENTS, AND DIMENSIONS SHOWN HEREON BEFORE BEGINNING CONSTRUCTION.
 4. ALL CONSTRUCTION MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE TO THE STATE AND LOCAL GOVERNMENT AGENCY'S LATEST CONSTRUCTION SPECIFICATIONS AND DETAILS.
 5. ALL ADA SITE FEATURES SHALL BE CONSTRUCTED TO MEET ALL FEDERAL, STATE AND LOCAL CODES.
 6. NOTIFY THE CITY INSPECTOR TWENTY-FOUR (24) HOURS BEFORE BEGINNING EACH PHASE OF CONSTRUCTION.
 7. THE CONTRACTOR SHALL CAREFULLY PRESERVE BENCHMARKS, REFERENCE POINTS, AND STAKES. IF ANY OF THE AFOREMENTIONED ITEMS ARE DAMAGED AS A RESULT OF WORK, THE CONTRACTOR WILL REPLACE THE DAMAGED ITEM(S) AND PREPARE, SUBMIT APPROVED NEW RECORD DOCUMENTS AT THEIR OWN COST, AS REQUIRED BY THE ENGINEER.
 8. ARCHITECTURAL PLANS ARE TO BE USED FOR BUILDING STAKE OUT.
 9. ALL DIMENSIONS ARE FROM FACE OF BUILDING, CURB, AND WALL UNLESS OTHERWISE SPECIFIED ON PLANS.
 10. CONTRACTOR SHALL MAINTAIN THE SITE IN A MANNER SO THAT WORKMEN AND THE PUBLIC SHALL BE PROTECTED FROM INJURY, AND ADJOINING PROPERTY PROTECTED FROM DAMAGE.
 11. CONTRACTOR IS RESPONSIBLE FOR DAMAGE TO ANY EXISTING ITEM AND/OR MATERIAL INSIDE OR OUTSIDE CONTRACT LIMITS DUE TO CONSTRUCTION OPERATION.
 12. ALL STREET SURFACES, DRIVEWAYS, CULVERTS, CURB AND GUTTERS, ROADSIDE DRAINAGE DITCHES AND OTHER STRUCTURES THAT ARE DISTURBED OR DAMAGED IN ANY MANNER AS A RESULT OF CONSTRUCTION SHALL BE REPLACED OR REPAIRED IN ACCORDANCE WITH THE SPECIFICATIONS.
 13. ALL ROAD WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE STATE AND LOCAL GOVERNMENT AGENCY SPECIFICATIONS.
 14. SITE FULLY COMPLIES WITH T-24, ACCESSIBILITY STANDARDS; AND SUBJECT TO FIELD VERIFICATION.
 15. ADJUST ALL UTILITY LID, MANHOLE, PULLBOX ELEVATION TO FINAL FINISH GRADE, SEE GRADING PLAN HEREON

- ACCESSIBILITY NOTES:**
1. THE ACCESSIBLE PATH OF TRAVEL SHALL BE 4' WIDE, MINIMUM, PER CBC SECTION 11B-402.
 2. THE LONGITUDINAL SLOPE OF THE PATH OF TRAVEL SHALL NOT EXCEED 5%. SLOPES GREATER THAN 5% SHALL BE DESIGNED AND COMPLY WITH CBC SECTION 11B-402.2.
 3. THE CROSS SLOPE ALONG ANY ACCESSIBLE PATH OF TRAVEL SHALL NOT EXCEED 2%.
 4. ACCESSIBLE PARKING STALLS AND THE LOADING-UNLOADING AISLES SHALL HAVE A SLOPE NO GREATER THAN 2% IN ANY DIRECTION PER CBC SECTION 11B-502.4.

- LEGEND**
- PROPERTY LINE
 - PROP. CURB
 - AC PAVEMENT TO MATCH EXISTING
 - CONCRETE PAVEMENT
 - TRUNCATED DOMES
 - LANDSCAPE
 - PERMEABLE PAVERS WITHOUT UNDERDRAIN



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Revision Schedule			
Rev	Date	By	Description

PROJECT NAME:
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PROJECT ADDRESS:
109 S. DEL MAR AVENUE
SAN GABRIEL, CA 91776

PROFESSIONAL SEAL

STORE #:
PROJECT #:
CONCEPT:
PALETTE:
ISSUE DATE:
DESIGN MANAGER:
LEED® AP:
PRODUCTION DESIGNER: GREENBERGFARROW
CHECKED BY: BAHAREH SEHATZADEH

SHEET TITLE:
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Protecting Our Investment



Contract Operation and Maintenance

The Answer for Your Town?



CONTRACT OPERATIONS: THE ISSUES

OPERATIONS AND MAINTENANCE: ARE YOU PROTECTING YOUR INVESTMENT?

Many people worked long and hard to plan, fund, design and build the facilities that treat your town's wastewater. How well is this system working today? Is your treatment plant:

- Meeting permit limits?
- Economically and efficiently operated?
- Conscientiously maintained?
- Properly and capably staffed?

In short, are these facilities being operated and maintained in a manner that protects the considerable investment taxpayers have made in environmental quality?

Over the years, the U.S. Environmental Protection Agency (EPA) has provided billions in federal construction grants. State and local taxpayers also contributed a sizable share of the construction costs. Even more important to local taxpayers are the day-to-day costs of operating and maintaining the wastewater facilities

built with these funds. Yet, in many communities across the country, our investment in water quality is being squandered due to inadequate operations and maintenance. Because operations and maintenance (O&M) are not being taken seriously enough, a host of interrelated problems has resulted: poor performance, staff turnover, violation of permits, public health problems, plant deterioration, costly operation, excessive equipment replacement rates and costs, and high user charges. In some localities, such problems have become severe.

The truth is that most people don't really want to think about wastewater or sewage treatment plants. And that's part of the problem. Isn't a department whose work gets limited attention and respect, even though that work is vital and often unpleasant, a department where morale and performance are likely to be low?

Of course, your plant may be exceptionally well run by a conscientious manager with excellent strategies for cost control and a firm dedication to quality O&M. Plants with this sort of supervision are star performers. Those that are not, could benefit from a closer look. How is your plant doing? Do you know?

IMPROVING OPERATION AND MAINTENANCE

If the concept of improving O&M at your town's wastewater plant intrigues you, you have two basic choices on how to proceed. Your municipality can undertake the challenge on its own. Or, you may want to acquire expert help from a contract operations firm. These companies contract with municipalities to manage and run their treatment plants. They offer to take the headaches of wastewater O&M off the municipality's shoulders, run the plant professionally and economically, and sometimes even save the town money.

EPA has surveyed the services offered by these contract operations firms and investigated some of their projects. This brochure summarizes the findings of that study. The information is designed to help you evaluate your unique situation and decide whether you should engage an O&M expert. While it may not be right for every city or town, contract operations may be the answer for you.

ALL ABOUT CONTRACT O&M

As part of EPA's study, staff at several contract operations firms were interviewed. Here is a synthesis of their answers to typical questions about their wastewater management, operations, and maintenance approaches:

What is Contract Operations?

When referring to contract O&M in this brochure we mean arranging with an outside organization (usually a private for profit firm) to perform all operation and maintenance functions at your wastewater treatment plant. Sometimes this is also referred to as full contract O&M (FCO). With this arrangement the municipality still owns the plant and equipment—so this is not privatization. However, the plant staff become employees of the contract firm and the firm generally assumes responsibility for all plant functions—therefore contract O&M is more than contract management. You should recognize that a range of other contract services is available—lab work, training, maintenance management, start-up and troubleshooting. You need to carefully decide which level of service is appropriate for your situation. This brochure will discuss only the full contract O&M level of service.

HOW CONTRACT O&M WAS EVALUATED

EPA evaluated contract O&M by talking to the firms and their references: the city officials and plant staff at several treatment plants (POTWs) where O&M is contracted. Four national contract O&M firms and one regional firm were included in the study. Interviews were held with each firm, and a list of plants under contract with three of the firms was compiled. From this list, eight plants were selected for detailed study.

These plants were chosen to reflect a variety of locations, design and operating flows, treatment type and level of treatment. Plants were also selected where sufficient information was available to compare treatment cost and performance both before and after contracting. From this group a number of plants were selected for on-site evaluation. An extensive interview guide was compiled and used as the basis for discussions with plant managers and city officials at each location.

We asked questions such as:

- What were O&M costs before and after contracting?
- What was the effluent quality before and after contracting?
- Were there changes in staffing?
- What changes did the contract firm make in management, operations, and maintenance?
- How was the need for a contractor determined?
- How were responsibilities split between the city and the contract firm?

Who Will These Firms Serve?

The large contract operations firms look nationwide for their clients, evaluating business opportunities against plant size and location. They will tackle any process type or treatment level. They look for plants from 1 (but usually 2) million gallons per day, on up. (Most plants range between 2 and 10 to 15 mgd.) To extend service to smaller plants a contract firm may look for towns where services can be shared among several small, neighboring plants.

Contract operations firms are generally reluctant, however, to take on problem-ridden plants in situations where the community is not willing to pay a realistic sum to turn the plant around. Strife over the wastewater budget is only one of several difficult political situations in which these firms prefer not to get involved. Dissension on the municipal council over whether or not to choose the contract operations option, labor disputes involving plant staff, a willingness to accept routine noncompliance levels in an attempt to keep or attract industry, are examples of circumstances where a contractor may choose to stay away.

Who Are These Specialists?

A handful of large firms exists—all highly experienced. At least one is operating in your area of the country. These specialists provide a wide range of expertise in plant management, process engineering, design engineering, automated systems, procurement, training, and budgeting.

On the other end of the spectrum are small, local firms with varying levels of experience and sophistication. Many are now moving into the business. Such local providers may offer the advantage of being intimately familiar with your plant's design and equipment or may understand your municipality's unique political climate very well.

What's the Deal?

Naturally, contract operations firms are in business to make money, but they can also offer distinctly attractive benefits to potential clients. They:

- Promise to improve performance and increase efficiency.
- Put great stock in good management and staff motivation and training.
- Install computerized management systems.
- Provide corrective and preventive maintenance.
- Offer the experience and specialized knowledge needed to implement these approaches skillfully; expertise gained from work on many different plants.

- Many contracts provide for full cost disclosure and end-of-year reckoning, with any budget under run returned to the city. Some categories of cost savings are split with the contractor.

- Keep "open books" and report regularly so the city can see what's being done and what it costs.

- Usually seek 5-year contracts so that they can establish a track record with the client, prove their effectiveness over time, and spread their front-end costs over several years.

- Undertake most of the management headaches, leaving fewer responsibilities for the city.

- May help the city pay for costly capital improvements.

- Pay fines if they violate effluent limits.

This last feature indicates the confidence these specialists have that they can turn around a poorly performing plant.

WHAT EVERY MUNICIPALITY WANTS TO KNOW

How Can A Firm Beat Our Performance And Still Save Money?

Contract operations firms are proud of the cases in which they improved plant O&M and handed the city a check for shared savings at year's end. But if you seek bottom-line savings only, you may end up disappointed. Contract operations companies hold improved performance as their primary goal, and focus on giving clients the most for the money they spend. In many instances, however, cost savings can also be achieved.

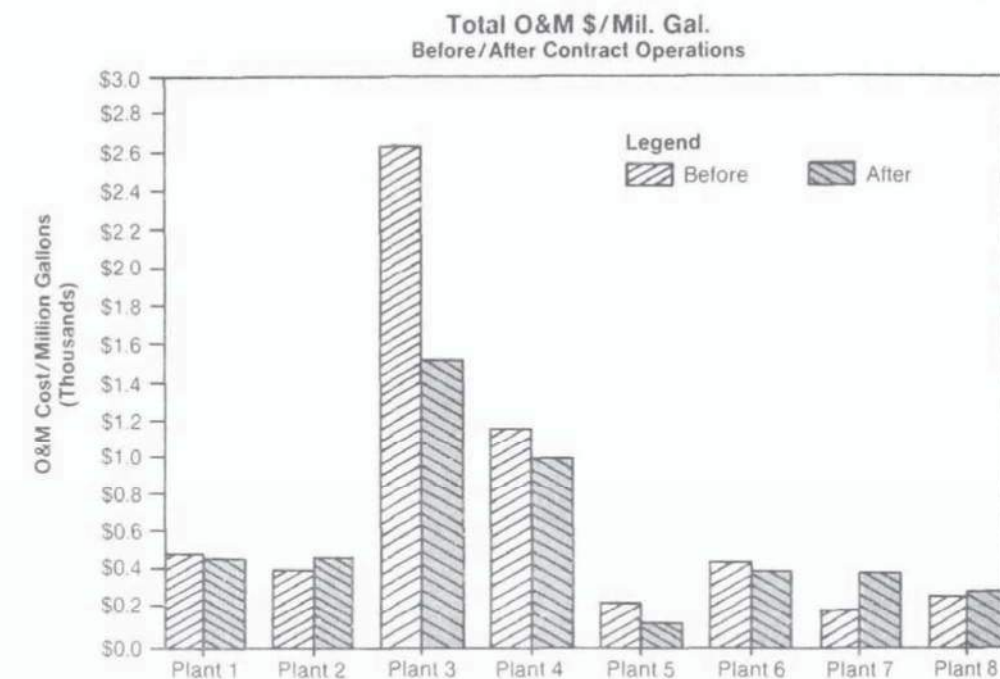
Savings depend on many things, particularly on the nature of your plant's problems. A history of severe physical problems or very poor management at your plant may mean that cost conservation by a contractor must be shifted to other deficient areas to improve performance. The overall plan for improving plant O&M is also a factor: savings may be dramatic the first year, but plateau as the plant approaches maximum efficiency.

In short, don't expect a miracle, even though some companies do have miracles on their books.

How Do They Do It?

Cost savings can be achieved in many ways:

Energy Efficiency—Analysis of design and operations often reveal ways to cut fuel and electrical consumption.



Management—Increases in pay and training improve morale and labor productivity. Management focused on bottom-line saving and using modern computer techniques can increase efficiency, and foster troubleshooting and conscientious O&M.

Purchasing Power—Large Contract operations firms have national contracts for parts and chemicals.

Staffing and Training—Better trained and more productive personnel mean better teamwork and make possible a leaner staffing plan.

Economies of Scale—Contractors often operate a number of smaller plants with one "circuit rider" superintendent or one lab.

Backup Expertise—Many firms have technical experts who can be brought in to solve problems before they become crises.

Process Control—Creative techniques put to work by knowledgeable, experienced managers can mean fewer chemicals and less energy used.

Automated Systems—Most firms feature computerized management, monitoring, and administrative systems that cut costs while increasing oversight power.

Capital Improvements—Contract firms identify long-term repair and replacement needs. Some will help municipalities finance major equipment that creates dramatic cost savings.

Is Contract Operations Right for My Plant?

The decision to bring on a contract O&M firm should not be made in haste. It is essential to perform a complete evaluation to determine whether the in-house route is feasible and if so, more cost-effective. The place to begin is by getting input from sources that are as knowledgeable and objective as possible. To find out more about the present problems and in-house solutions, talk to the plant staff and superintendent. If your community is large enough to have these departments, check with the public works director, community relations officer, and financial manager. To find out more about contract firms that may be able to help you, check with the state health and environmental agencies. It may be very helpful to contact a city manager or plant superintendent in another municipality who has experience with contracting. You could also invite representatives from various contract firms to give you a presentation of their services. Don't expect a full-blown audit of your plant, however. These are costly and few firms will carry out a thorough plant review without a definite job prospect.

To better evaluate the information from contractors it can be beneficial to develop a cost estimate for in-house improvements. What will it really cost you to improve plant management, revise staffing, implement necessary training, install a preventive maintenance program, and carry out the other changes that a contract firm

would put in place. EPA's brochure on cost-effective plant operations—*Six Cities Save Over A Million Dollars*—should be helpful in making this assessment.

Another tool that can be used in your decision-making process is the accompanying plant checklist. Review the list and attempt to answer the questions realistically. If you answer "yes" to several of the questions, it may reflect major underlying problems with plant management and budgeting. In this case it may be hard to bring the plant around on your own. On the other hand, major changes in management, staffing, and financing can work wonders. It takes a major commitment, however.

Your final decision should also consider that it will cost you something to bring on and manage a contractor. Based on the communities we talked to you may spend one-third of a staff person's time for four or five months to research and write a request for proposal, and manage and evaluate the response. Contract management will also be required over the length of the contract term.

What Can I Expect When the Contract Operations Firm Takes Charge?

Typically, the firm's staff will:

- Immediately upgrade the plant's public image by improvements in physical appearance.
- Put a top quality superintendent in place (or keep a good one).
- Analyze the first steps toward fundamental improvement of operations.
- Fix gross deficiencies in the plant.
- Give the superintendent effective management techniques and efficient tools (e.g., automated systems for controlling operations maintenance, and administration).
- Adjust staffing; train and motivate.
- Stress efficiency and fine-tune operations to optimum levels.

What's the Best Way to Engage a Firm?

If you have completed the necessary facility evaluation and concluded that contract O&M is probably the best route to take, the next step is to develop and carry out a process for hiring a contractor. In our survey of plants across the country some chose to produce a request for proposal that clearly outlined their needs and then solicited technical and cost proposals from a number of contract firms. Others just accepted recommendations from other communities, professional organizations and other sources. In this case, bids from a small number of qualified firms were requested. Regardless of the approach taken to identify qualified firms, once information is received, you should review the materials and evaluate the following points at a minimum:

- Is the staff large enough to handle your needs along with other on-going work.
- Is the training and experience of the staff relevant and adequate for the work.
- Does the firm and the staff have experience with the treatment level and process type of your plant.
- Do reference checks verify that the firm's work has been professionally completed as scheduled and for the projected budgets.

Based on the review of qualifications, one or more firms should then be chosen and their bids evaluated. The first step is to compare the firms' projected costs to the in-house totals generated earlier. If they appear reasonable in this light, then compare the costs to each other. Make sure you know what each firm is promising for the cost—the number of meetings with the municipality, the types and frequency of reporting, the types of responsibilities the firm will assume, guarantees of performance and willingness to accept responsibility for fines, and most importantly, the basis of payment and willingness to rebate any savings. Negotiate with the top one or two firms until you are satisfied with one firm and feel that the bid price is best for the municipality. Before a contract is signed, make sure that it specifies the roles of the contractor and the community and that these roles are acceptable to you.

EVALUATING WASTEWATER PLANT OPERATIONS AND MAINTENANCE: A CHECKLIST

Is your plant experiencing some of these problems? If so, you may want to seek expert help from a contract operations firm.

Yes No

- | | | |
|-------|-------|--|
| _____ | _____ | Design Problems? Has your plant had trouble meeting design specifications from the beginning? Have increasing design problems come to light as the plant has aged? Have staff had to jerry-rig solutions to design problems continually? Is the plant being run to design parameters? |
| _____ | _____ | Excessive Costs? Has the wastewater budget been increasing disproportionately as the plant has aged? Are replacement costs high? Are the same items being replaced too frequently? |
| _____ | _____ | Personnel Problems? Is morale low? Are staff overworked, but poorly utilized? Is staffing out of synch with workload and shift requirements? Are there labor/management disputes? Is salary commensurate with performance? Is it hard to acquire and keep staff? |
| _____ | _____ | Public Image Issues? Do you hear complaints from citizens about overflow and backup problems? Odors? Appearance? High user charges? Water quality problems? |
| _____ | _____ | Operating Inefficiencies? Do plant managers fail to take advantage of opportunities for cost savings or economies of scale? Are certain operating units underutilized? Have chemical or energy costs risen excessively? |
| _____ | _____ | Compliance Difficulties? Has your effluent frequently been in violation of standards? Have you experienced enforcement actions or paid fines? Is compliance regularly marginal: right at the "line"? Are periodic problems from industrial loads frustrating compliance? |
| _____ | _____ | Training Issues? Do plant managers fail to provide training in a consistent, effective manner? Are staff inadequately prepared to deal with sophisticated equipment? Do you have too many specialists on staff and not enough generalists? Have you had safety problems or lost-time accidents? |

HOW SMOOTH IS THE PARTNERSHIP?

If you're like most municipal officials, you probably have concerns about relinquishing absolute public control of a municipal asset. There are probably nagging doubts about putting a profit-motivated enterprise in charge of the municipality's most costly capital investment. It may be helpful to describe the typical division of responsibilities and methods by which you will be able to exercise control over the contractor.

The contract operations firm will take over almost every aspect of plant O&M. Typically, the city is left with responsibility for the collection system including control of inflow and infiltration and industrial discharges, (although in some cases, it may be more cost-effective for pump stations and the collection system to be contracted also). In most cases, the municipality maintains responsibility for billing consumers, and property insurance. The accompanying chart shows a common division of labor between the city and the contractor.

The fear of losing control of the facility is a valid concern for officials who must answer to the public. However, the municipal managers in EPA's study did not raise this as a problem. In general, if you investigate the firm's reputation, carefully analyze its plan for plant improvement, read the contract carefully, establish regular reporting mechanisms, and keep a watchful eye on operations, you will have a great deal of control over plant O&M while getting rid of many of its headaches. These are simply common sense precautions that take few resources to carry out.

Because of public concerns that the firm's self-interest will tend to override the public interest, contract operations firms have wisely moved to allay fears by opening their books, committing to the payment of fines, rebating unspent maintenance funds, and engaging in other sunshine practices to attract customers. Also, because news of any wastewater "horror story" travels fast in the industry, firms make sure they can make a plant work before they accept a job, and take great pains to fulfill their contracts. Despite these developments, question the firms closely to satisfy your concerns and get specific commitments in writing.

SOUNDS GOOD, BUT SHOW ME

EPA's sample of contract operated plants revealed that contract operations is a successful technique for improving the performance and cost-effectiveness of many municipal treatment plants. Nearly all of the plants in the study experienced major problems prior to contracting out O&M. In most cases, conditions improved significantly after take-over by the contract firm. Often, however, the improvements came in the areas of performance and compliance, not necessarily cost. All but one of the plants studied have been brought into compliance on a regular basis, and even that one is coping well with high-strength industrial waste loads. As detailed below, some plants did experience significant decreases in total costs, while others experienced significant increases.

CONTRACT OPERATIONS: TYPICAL ROLES AND RESPONSIBILITIES

Action	Responsibility	Action	Responsibility
• Collection System Operation	City	• Maintenance Inventory Levels	Contractor
• Plant Operations	Contractor	• Residues from Facility	Contractor
• Plant Maintenance	Contractor	• Liability Insurance	Contractor
• Noncompliance Responsibility	Contractor (pays fines)	• Fire, Casualty Eminent Domain	City
• Service Charges Payment	City	• Grounds for Contract Termination	Contractor / City (Breach of Contract)
• User Charge System	City	• Equipment, Failure/Emergency Maintenance	Contractor
• Design Modification Clause	Contractor (with City approval)	Performance Payment	Contractor / City (Contractor) responsible up to \$1,000 per piece of equipment. City responsible for expenditures over \$1,000 per piece of equipment).

CONTRACT OPERATIONS: THE RESULTS

IMPROVING A PROBLEM LARGE PLANT

A large midwestern secondary activated sludge treatment plant which was in significant non-compliance prior to contracting now meets weekly BOD limits but still occasionally exceeds 30-day averages. Previously, sludge had been temporarily held in lagoons. An on-going land application program has now been put in place and both the stockpiled sludge and current production is being disposed. Odor problems have also been significantly reduced.

The contractor has reduced the staff by 35 percent, implemented a computerized preventive maintenance system, and put in place numerous cost-saving operating techniques such as improved methane recovery and increased blower efficiency. Though all of these efforts have yet to be totally successful, there has been an improvement in performance. Cost to the city in constant dollars has not increased significantly under contract firm operation even though solids disposal costs are now greater and effluent quality is improved.

SMALL AWT ACHIEVES MAJOR COST REDUCTION AND PERFORMANCE IMPROVEMENT

In another midwestern community contract operations was selected for a smaller, oxidation ditch plant with stringent limits for BOD and suspended solids, but no nutrient limits. This facility was brought under contract along with the town's water supply system when a newly appointed city manager found very poor management and operating conditions at both the facilities, and compliance problems with the wastewater plant. Three options were evaluated—turn things around with the existing staff, hire a new manager, or contract the entire operation out. Option three was chosen.

In the fifteen months since contract operation began the contractor has made numerous improvements at the plant. An energy audit was carried out, pumps and impellers were rebuilt, excessive sludge in the process units were gradually eliminated, and a computerized preventive maintenance system was put in place. Plant staff was trimmed, largely by cross-training operators so they can run both water and wastewater facilities. Major design problems with the plant have been identified and a correction program is about to get started. During this period, problems with solids have been eliminated, and effluent quality has increased. At this particular facility, the contractor has also been able to reduce annual costs to the municipality by over 50 percent.

LIMITED CHANGES AT SMALL WESTERN PLANT

A small western activated sludge plant was one of the exceptions to the overall finding of significant improvements. The key reason for this finding, however, may be that the facility was not experiencing significant cost or performance problems prior to contract operations. Effluent limits were routinely being met on a monthly average basis. However, the utilities director felt that it would be in the city's interest to put the facility under contract, partially because he was concerned that operation would become more complex with new units coming on-line.

Since the plant was put under contract, performance has remained about as it was previously. Improvements put in place by the contractor include redesign of sludge pumps to save on frequent replacement of pump diaphragms, implementation of a computerized preventive maintenance system, use of daily operating logs, and an increased emphasis on safety at the plant. Staffing at the plant has also been cut by over 20 percent. Opportunities to increase productivity of the staff, however, appear to have been missed, as there has been little salary increase for the remaining staff, and incentive pay has not been used to encourage performance or advancement as it has at other plants in the survey.

STAFF STABILITY AND BETTER EFFLUENT QUALITY ACHIEVED THROUGH CONTRACTING

Another western municipality with a small activated sludge plant has also selected contract O&M. Prior to contracting out, the plant was experiencing difficulties in meeting effluent permit limits. The mayor and city manager also had experienced great difficulty in attracting a qualified plant superintendent. They also felt that the staff was not adequately skilled and trained. Long-term cost stability was another major issue.

The plant has now been under contract for over four years. During this period, effluent quality has improved until it is now well within permit limits. The staff has also been trimmed by nearly 20 percent partially as a result of cross-training and combining staff with the city's water plant. Total costs for the plant have decreased, but not by a significant amount. The contractor has put more money into staff salaries, significantly cut chemical cost, and trimmed electrical cost. Sludge handling efficiency has been increased, cross-training has lowered maintenance cost by 41 percent and a preventive maintenance system has been put in place. Maintenance efficiency has been improved through the use of infrared and ultrasonic testing of mechanical equipment. The city received a refund based on cost savings last year, and overall, city officials are well satisfied with the program.

RECOVERY OF A PLANT WITH MAJOR PROBLEMS STILL NOT COMPLETE

The study also examined two southern communities which put contract O&M in place. The first community operated a moderately-sized secondary, activated sludge plant that was a classic example of what can happen when inadequate attention and resources are directed to the treatment facility. The plant suffered from design problems, high industrial loads, and inadequately trained staff. Solids handling and disposal equipment at the twelve-year old facility was completely broken down. As a result, the plant was experiencing major sludge disposal and compliance problems.

The plant has now been under contract operation for two years. Despite some mixed results, there have been significant overall improvements in operation and maintenance. A temporary solids handling system has been installed and plans have been developed for a major repair and replacement program. The staff has been trimmed, and remaining staff has become more productive through weekly training classes. A safety program has been put in place, as has a computerized preventive maintenance program and cost accounting system. As a result, effluent quality has improved and the solids disposal problem is on the way to resolution. Overall, contract operations have brought significant improvements to the facility. However, because of the number of major improvements required, the plant budget has increased over 15 percent.

MAJOR CHANGES IN OPERATION BRING BIG COST SAVINGS

In the second southern community difficulties were being encountered with the town's small advanced wastewater treatment facility. The plant's unique design was creating major operating difficulties for the city's superintendent and staff. The result was high operating cost and compliance problems. There was also a general feeling held by the city manager that a more reliable, professional method of operating the plant was necessary to ensure service to the community.

This plant has now been operated and maintained by a private firm for over two years. During this period, effluent quality has been brought into compliance and costs have been decreased by over forty percent. Major increases in efficiency have been achieved by taking almost half of the plant off-line and revising operation of the remaining on-line units. Significant cuts in staff have been put in place. A

project manager has been assigned to the facility, and a previous plant employee promoted to superintendent. A major training program has been put in place, resulting in significant improvements in staff capability and morale. Computerized operations and maintenance programs have also been installed at the plant. Town officials have been very pleased with the results of the contracting program. A number of cost rebates have been received, and it is felt that the stability and reliability of the wastewater system was instrumental in a major manufacturing facility locating in the community.

CONTRACT O&M PROVIDES STABLE MANAGEMENT AND IMPROVED EFFLUENT QUALITY

Two treatment plants in the northern United States were also included in the survey. One of these was a small, secondary activated sludge plant run by a volunteer sewer authority. Key problems at the plant included lack of a capable superintendent and trained staff and a number of small, but not insignificant design problems. Despite these conditions, effluent quality was being maintained within permit limits. When a contract firm responded to the authority's ad for a new superintendent, a proposal was requested and other firms were also asked to respond. One firm was selected, and the plant has now been under contract for three years. During this time, effluent quality has been further increased, computerized process control and preventive maintenance systems have been put in place. The total plant budget has decreased slightly since the contractor took over.

MID-SIZE PLANT IMPROVES MANAGEMENT AND COMPLIANCE

The final plant in the survey was a mid-sized secondary, activated sludge plant in the northern United States. This plant had experienced compliance difficulties and public image problems. The city also had significant personnel management problems. After being made aware of contract operation and maintenance through a National League of Cities meeting, the city manager researched contract firms and requested a bid from one firm.

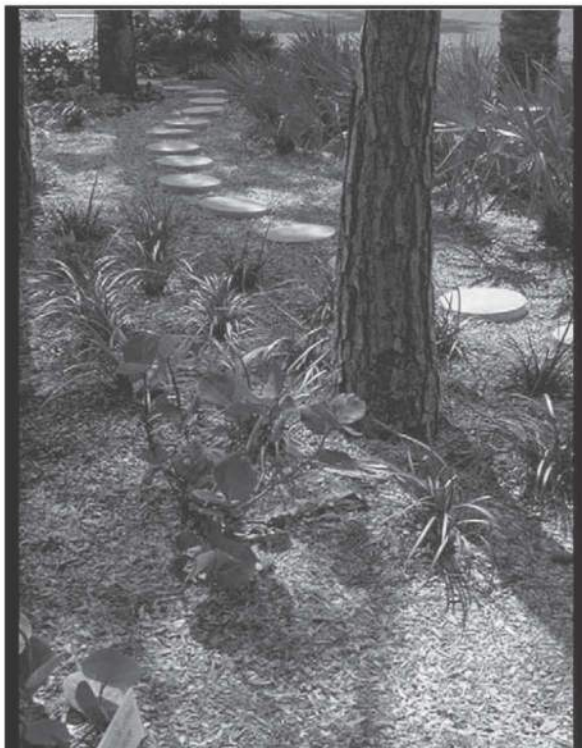
The contractor has now been on board for about one year. The city's staff was retained including the plant superintendent; however, training was significantly increased. During this time, operations have been improved, a computerized preventive maintenance system put in place, and economies have been achieved in chemical use and purchasing. As a result of these efforts, the plant has been brought into compliance and costs cut by about five percent. The city manager believes that the contract firm provides the skills and operating stability the city needed, and has brought about a complete turn around at the plant.

WHERE CAN I GO FROM HERE ?

If you are interested in obtaining further information about contract O&M there are a number of sources which we would recommend. A call to your state water quality management agency or EPA is a good starting point. Agency staff can probably provide names of O&M firms operating in your area. They may also know plants nearby that have turned to contract O&M. Most of the major, national firms advertise in wastewater and municipal management periodicals. Many of the firms have exhibits at municipal association conferences around the country. Once you have a list of names and references call the firms. They will be happy to send you further information and can probably have a representative come out and meet with you.

This brochure was prepared by EPA's Office of Municipal Pollution Control, Planning and Analysis Division. We wish to recognize the assistance of the following contract O&M firms: EOS; The Maryland Environmental Service; Metcalf and Eddy Services, Inc.; Operations Management International, Inc.; and Professional Services Group, Inc. We would particularly like to thank the employees at the eight survey plants who gave a significant amount of time and assistance. EPA was assisted in the preparation of this brochure by the staff of Roy F. Weston, Inc., and Peat, Marwick, Mitchell and Company.

Site Design & Landscape Planning SD-10



Design Objectives

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

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.



SD-10 Site Design & Landscape Planning

Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

Site Design & Landscape Planning SD-10

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

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.

SD-10 Site Design & Landscape Planning

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

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

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

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.



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.



- 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.

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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



– 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.

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Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

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

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

Design Objectives

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



- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

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.

Additional Information***Maintenance Considerations***

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

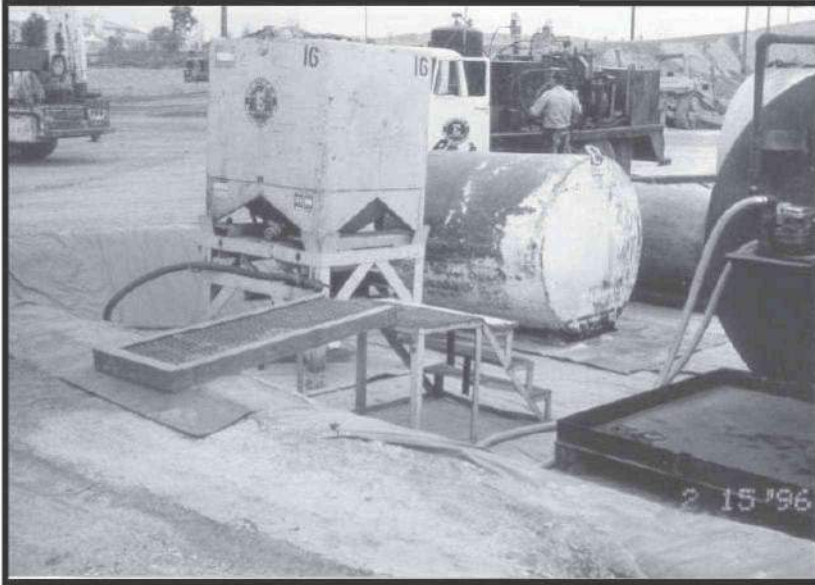
Other Resources

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

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Design Objectives

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

Description

Proper design of outdoor storage areas for materials reduces opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the stormwater conveyance system. Materials may be in the form of raw products, by-products, finished products, and waste products. The type of pollutants associated with the materials will vary depending on the type of commercial or industrial activity.

Approach

Outdoor storage areas require a drainage approach different from the typical infiltration/detention strategy. In outdoor storage areas, infiltration is discouraged. Containment is encouraged. Preventative measures include enclosures, secondary containment structures and impervious surfaces.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Some materials are more of a concern than others. Toxic and hazardous materials must be prevented from coming in contact with stormwater. Non-toxic or non-hazardous materials do not have to be prevented from stormwater contact. However, these materials may have toxic effects on receiving waters if allowed to be discharged with stormwater in significant quantities. Accumulated material on an impervious surface could result in significant impact on the rivers or streams that receive the runoff.

Material may be stored in a variety of ways, including bulk piles, containers, shelving, stacking, and tanks. Stormwater contamination may be prevented by eliminating the possibility of stormwater contact with the material storage areas either through diversion, cover, or capture of the stormwater. Control measures may also include minimizing the storage area. Design



SD-34 Outdoor Material Storage Areas

requirements for material storage areas are governed by Building and Fire Codes, and by current City or County ordinances and zoning requirements. Control measures are site specific, and must meet local agency requirements.

Designing New Installations

Where proposed project plans include outdoor areas for storage of materials that may contribute pollutants to the stormwater conveyance system, the following structural or treatment BMPs should be considered:

- Materials with the potential to contaminate stormwater should be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the stormwater conveyance system, or (2) protected by secondary containment structures such as berms, dikes, or curbs.
- The storage area should be paved and sufficiently impervious to contain leaks and spills.
- The storage area should slope towards a dead-end sump to contain spills and direct runoff from downspouts/roofs should be directed away from storage areas.
- The storage area should have a roof or awning that extends beyond the storage area to minimize collection of stormwater within the secondary containment area. A manufactured storage shed may be used for small containers.

Note that the location(s) of installations of where these preventative measures will be employed must be included on the map or plans identifying BMPs.

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.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permits.

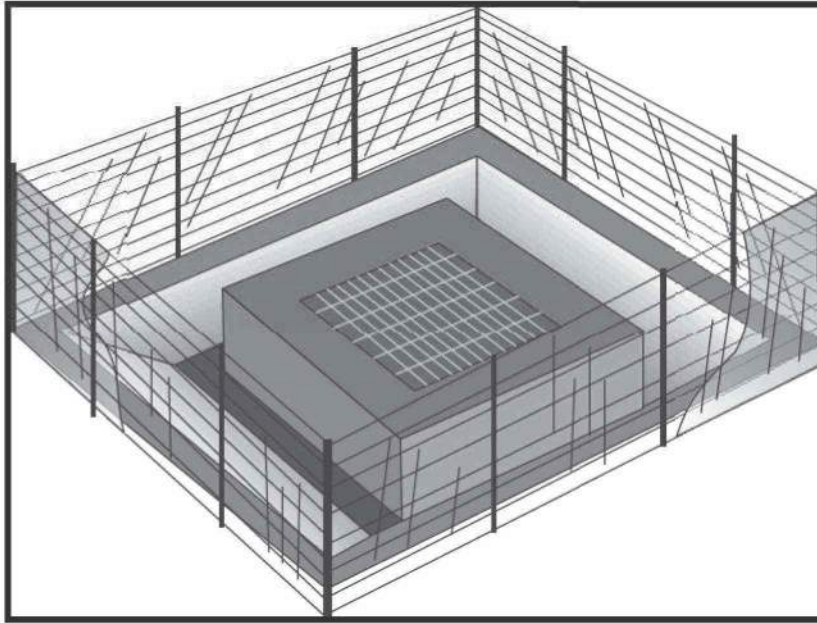
Other Resources

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

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Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction.

Suitable Applications

Every storm drain inlet receiving sediment-laden runoff should be protected.

Limitations

- Drainage area should not exceed 1 acre.
- Straw bales, while potentially effective, have not produced in practice satisfactory results, primarily due to improper installation.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.
- Inlet protection usually requires other methods of temporary protection to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are

Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

- ☒ Primary Objective
- ☐ Secondary Objective

Targeted Constituents

Sediment	☒
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

- SE-1 Silt Fence
- SE-5 Fiber Rolls
- SE-6 Gravel Bag Berm
- SE-8 Sandbag Barrier
- SE-9 Straw Bale Barrier



expected, use other onsite sediment trapping techniques in conjunction with inlet protection.

- Frequent maintenance is required.
- For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this handbook should be approved by the local stormwater management agency.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- Limit upstream drainage area to 1 acre maximum. For larger drainage areas, use SE-2, Sediment Basin, or SE-3, Sediment Trap, upstream of the inlet protection device.
- The key to successful and safe use of storm drain inlet protection devices is to know where runoff will pond or be diverted.
 - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
 - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the

inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Four types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
 - Filter Fabric Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
 - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
 - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
 - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- **DI Protection Type 1 - Filter Fabric Fence** - The filter fabric fence (Type 1) protection is shown in the attached figure. Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.
 1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
 2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes must be at least 48 in.
 3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
 4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.
 5. Backfill the trench with gravel or compacted earth all the way around.
- **DI Protection Type 2 - Excavated Drop Inlet Sediment Trap** - The excavated drop inlet sediment trap (Type 2) is shown in the attached figures. Install filter fabric fence in

accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd³/acre of drainage area.

- **DI Protection Type 3 - Gravel bag** - The gravel bag barrier (Type 3) is shown in the figures. Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability.
 1. Use sand bag made of geotextile fabric (not burlap) and fill with 0.75 in. rock or 0.25 in. pea gravel.
 2. Construct on gently sloping street.
 3. Leave room upstream of barrier for water to pond and sediment to settle.
 4. Place several layers of sand bags – overlapping the bags and packing them tightly together.
 5. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.
- **DI Protection Type 4 – Block and Gravel Filter** - The block and gravel filter (Type 4) is shown in the figures. Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction.
 1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
 2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
 3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
 4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

Costs

- Average annual cost for installation and maintenance (one year useful life) is \$200 per inlet.

Inspection and Maintenance

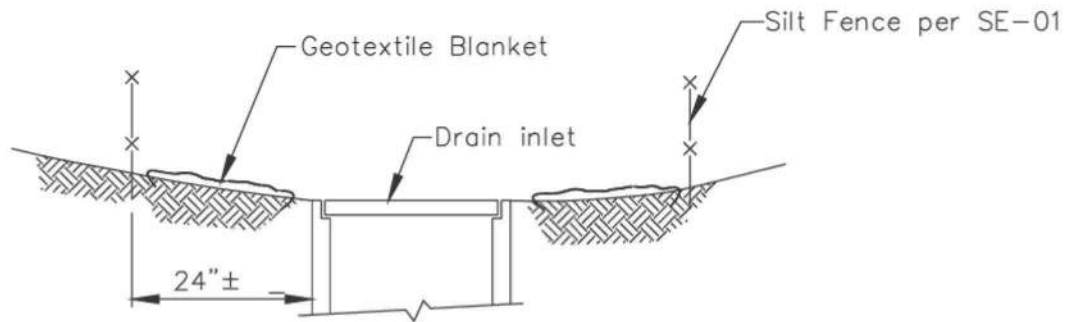
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- **Filter Fabric Fences.** If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.
- **Gravel Filters.** If the gravel becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.
- **Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness.** Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- **Remove storm drain inlet protection once the drainage area is stabilized.**
 - Clean and regrade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

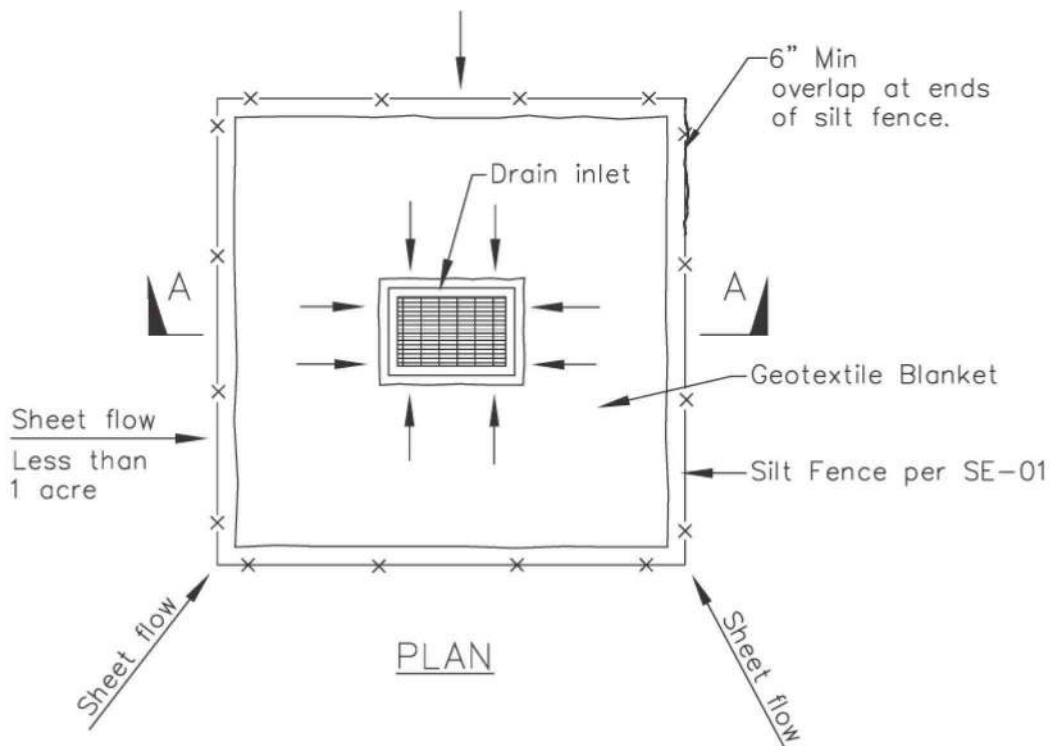
References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.



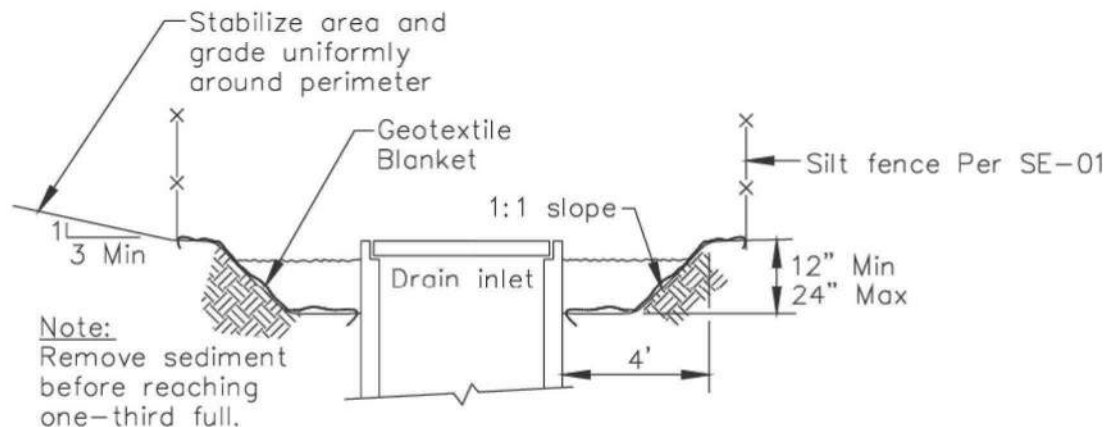
SECTION A-A



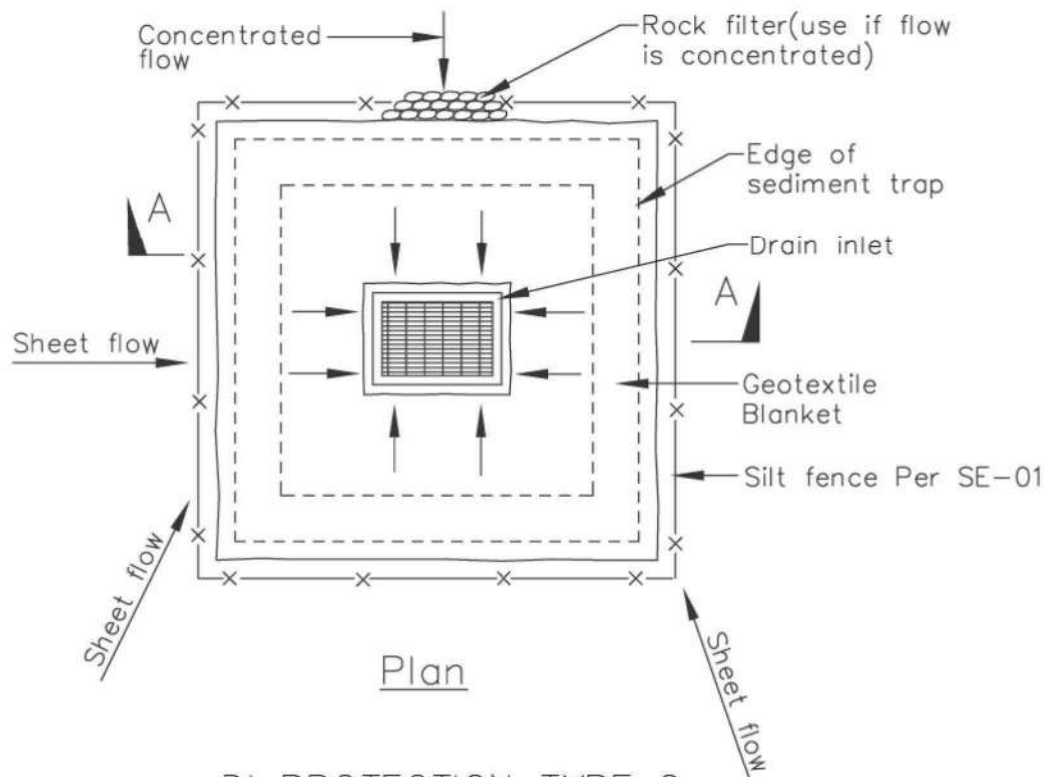
DI PROTECTION TYPE 1
NOT TO SCALE

NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.



Section A-A

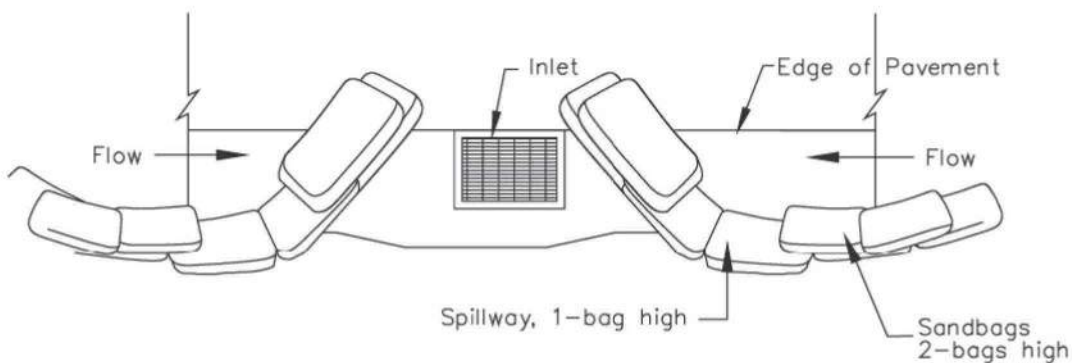


Plan

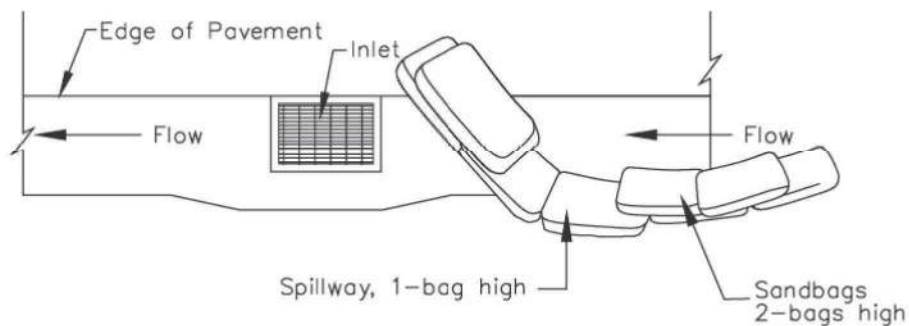
DI PROTECTION TYPE 2
NOT TO SCALE

Notes

1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET ON SUMP

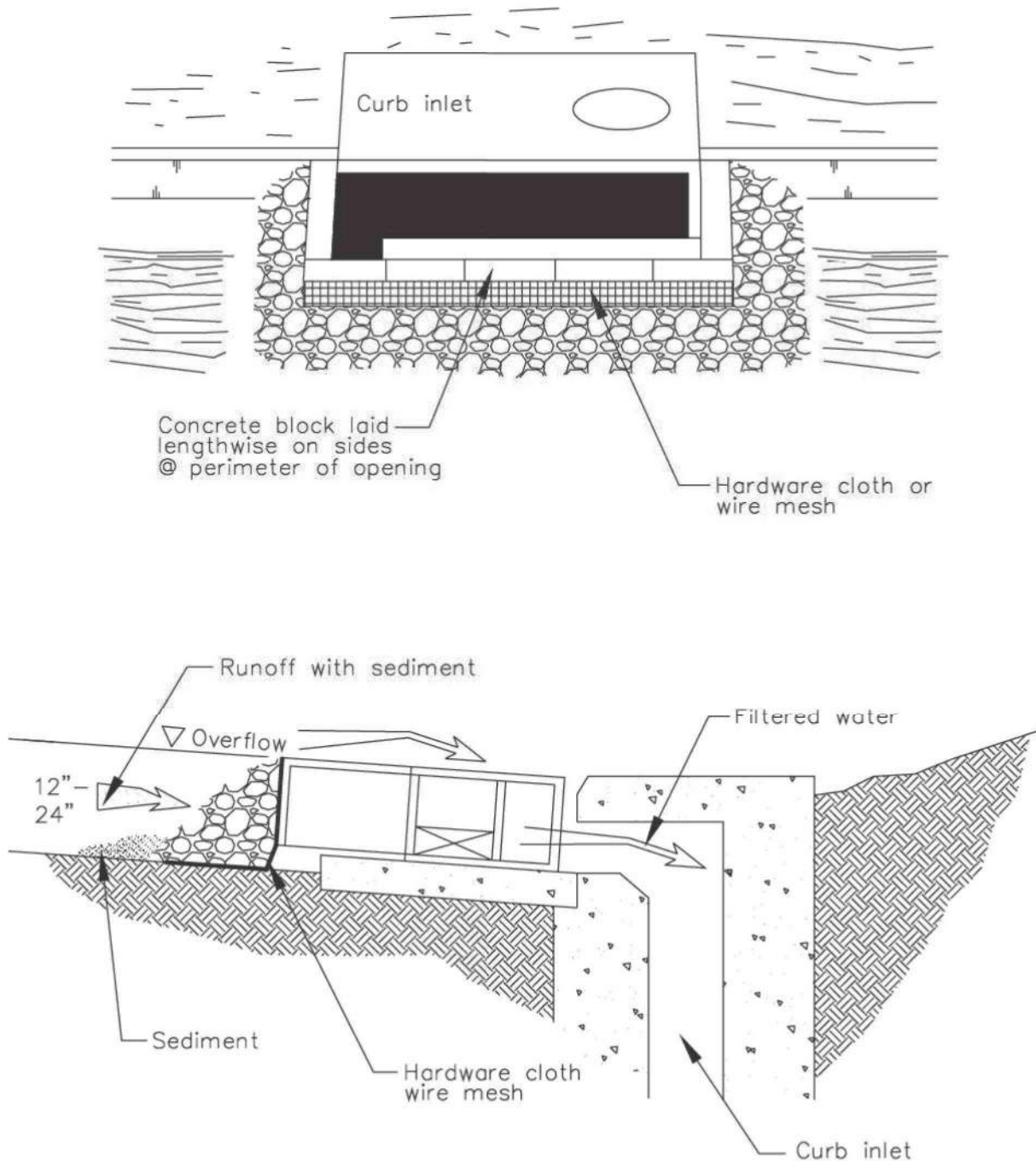


TYPICAL PROTECTION FOR INLET ON GRADE

NOTES:

1. Intended for short-term use.
2. Use to inhibit non-storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE



DI PROTECTION - TYPE 4
NOT TO SCALE

Description

Drain inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris. There are a multitude of inserts of various shapes and configurations, typically falling into one of three different groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are one box; that is, the setting area and filtration through media occur in the same box. Some products consist of one or more trays or mesh grates. The trays may hold different types of media. Filtration media vary by manufacturer. Types include polypropylene, porous polymer, treated cellulose, and activated carbon.

California Experience

The number of installations is unknown but likely exceeds a thousand. Some users have reported that these systems require considerable maintenance to prevent plugging and bypass.

Advantages

- Does not require additional space as inserts as the drain inlets are already a component of the standard drainage systems.
- Easy access for inspection and maintenance.
- As there is no standing water, there is little concern for mosquito breeding.
- A relatively inexpensive retrofit option.

Limitations

Performance is likely significantly less than treatment systems that are located at the end of the drainage system such as ponds and vaults. Usually not suitable for large areas or areas with trash or leaves than can plug the insert.

Design and Sizing Guidelines

Refer to manufacturer's guidelines. Drain inserts come in many configurations but can be placed into three general groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are

Design Considerations

- Use with other BMPs
- Fit and Seal Capacity within Inlet

Targeted Constituents

- ☒ Sediment
- ☒ Nutrients
- ☒ Trash
- ☒ Metals
- Bacteria
- ☒ Oil and Grease
- ☒ Organics

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.



one box; that is, the settling area and filtration through media occurs in the same box. One manufacturer has a double-box. Stormwater enters the first box where settling occurs. The stormwater flows into the second box where the filter media is located. Some products consist of one or more trays or mesh grates. The trays can hold different types of media. Filtration media vary with the manufacturer: types include polypropylene, porous polymer, treated cellulose, and activated carbon.

Construction/Inspection Considerations

Be certain that installation is done in a manner that makes certain that the stormwater enters the unit and does not leak around the perimeter. Leakage between the frame of the insert and the frame of the drain inlet can easily occur with vertical (drop) inlets.

Performance

Few products have performance data collected under field conditions.

Siting Criteria

It is recommended that inserts be used only for retrofit situations or as pretreatment where other treatment BMPs presented in this section area used.

Additional Design Guidelines

Follow guidelines provided by individual manufacturers.

Maintenance

Likely require frequent maintenance, on the order of several times per year.

Cost

- The initial cost of individual inserts ranges from less than \$100 to about \$2,000. The cost of using multiple units in curb inlet drains varies with the size of the inlet.
- The low cost of inserts may tend to favor the use of these systems over other, more effective treatment BMPs. However, the low cost of each unit may be offset by the number of units that are required, more frequent maintenance, and the shorter structural life (and therefore replacement).

References and Sources of Additional Information

Hrachovec, R., and G. Minton, 2001, Field testing of a sock-type catch basin insert, Planet CPR, Seattle, Washington

Interagency Catch Basin Insert Committee, Evaluation of Commercially-Available Catch Basin Inserts for the Treatment of Stormwater Runoff from Developed Sites, 1995

Larry Walker Associates, June 1998, NDMP Inlet/In-Line Control Measure Study Report

Manufacturers literature

Santa Monica (City), Santa Monica Bay Municipal Stormwater/Urban Runoff Project - Evaluation of Potential Catch basin Retrofits, Woodward Clyde, September 24, 1998

Woodward Clyde, June 11, 1996, Parking Lot Monitoring Report, Santa Clara Valley Nonpoint Source Pollution Control Program.

T-5: Permeable Pavement with an Underdrain

Description

Permeable pavement includes permeable interlocking concrete pavers, pervious concrete, or porous asphalt pavement that is flat in all directions. Permeable pavement can be used to infiltrate stormwater runoff into the porous pavement and sublayers of sand and gravel and subsequently into the underlying soil and slowly exits through an underdrain.



Permeable interlocking concrete pavement is comprised of a layer of durable concrete pavers or blocks separated by joints filled with small stones. Pervious concrete is made from carefully controlled amounts of water and cement materials used to create a paste that forms a thick coat around aggregate particles. Unlike conventional concrete, the mixture contains little or no sand, which creates a substantial void content (between 15 and 25 percent). Porous asphalt, or “open-graded” asphalt, pavement contains no fine aggregate particles, which creates void spaces in the pavement and allows water to collect within and drain through the pavement. An alternative approach for permeable pavement is to use stabilized grassy porous pavement, consisting of grass turf reinforced with plastic rings and filter fabric underlain by gravel.

A schematic of permeable pavement with an underdrain is presented in Figure E-22.

For advantages and disadvantages, general constraints and implementation considerations, and design specifications with the exception of the underdrain design, see Fact Sheet RET-5 (Permeable Pavement without an Underdrain).

LID Ordinance Requirements

Permeable pavement with an underdrain can be used as a stormwater quality control measure to treat stormwater runoff for the following alternative compliance measures:

- Off-site infiltration;
- Groundwater replenishment projects; and
- Off-site retrofit of existing development.

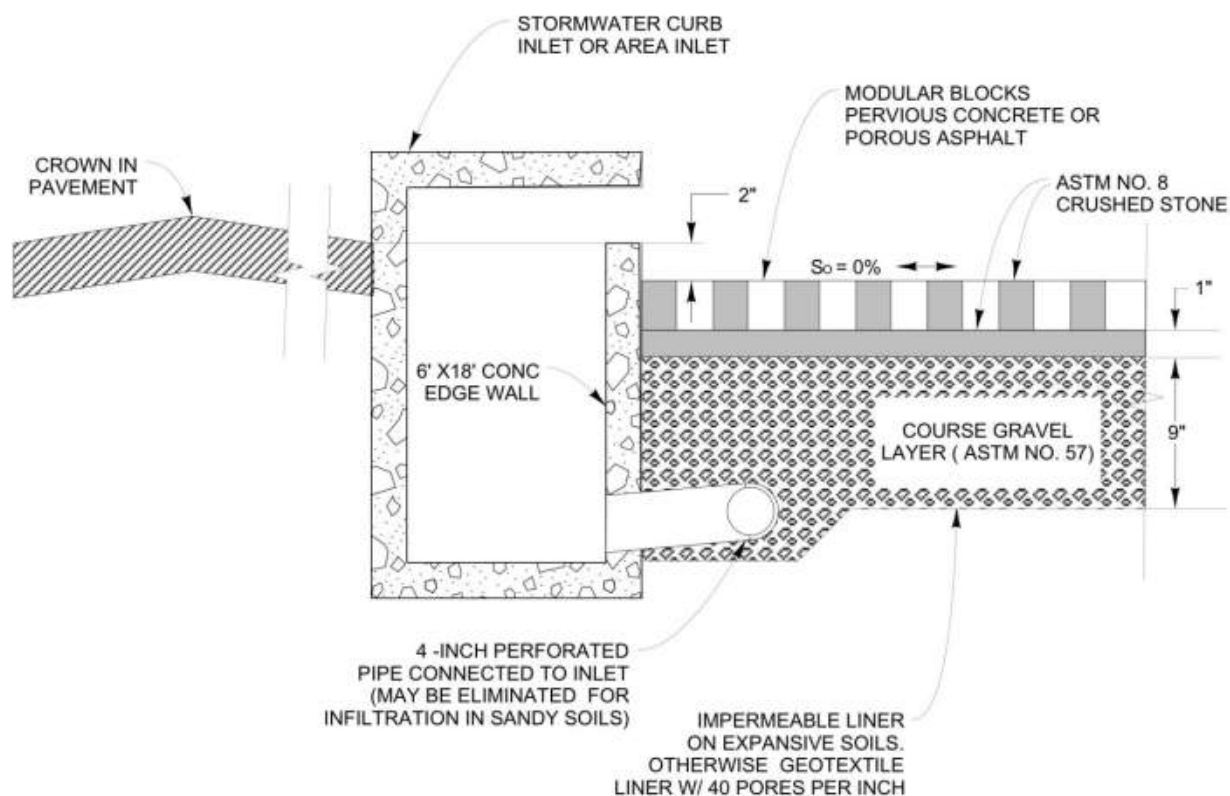
The project applicant must ensure that all pollutants of concern are addressed when using permeable pavement with an underdrain (see Section 7.4). The following table

T-5: Permeable Pavement with an Underdrain

identifies the pollutants of concern that are treated to the water quality benchmark (see Table 7-2 of the LID Standards Manual) by permeable pavement with an underdrain:

Pollutant of Concern	Treated by Permeable Pavement with an Underdrain?
Suspended solids	Yes
Total phosphorus	Yes
Total nitrogen	No
Total Kjeldahl nitrogen	Yes
Cadmium, total	Yes
Chromium, total	No
Copper, total	No
Lead, total	Yes
Zinc, total	Yes

Source: Treatment Best Management Practices Performance, Los Angeles Regional Water Quality Control Board, December 9, 2013.



ADAPTED FROM UDFCD, 1999

Figure E-122. Permeable Pavement with an Underdrain Schematic

T-5: Permeable Pavement with an Underdrain

Design Specifications

The following sections provide design specifications for the underdrain.

Underdrain

Permeable pavement can be used with an underdrain to collect and discharge stormwater runoff that has been filtered through the soil media, but not infiltrated, to another stormwater quality control measure, storm drain system, or receiving water. The underdrain shall have a mainline diameter of eight inches using slotted PVC SDR 26 or PVC C9000. Slotted PVC allows for pressure water cleaning and root cutting, if necessary. The slotted pipe should have two to four of slots cut perpendicular to the axis of the pipe or at right angles to the pitch of corrugations. Slots should be 0.04 to 0.1 inches wide with a length of 1 to 1.25 inches. Slots should be longitudinally-spaced such that the pipe has a minimum of one square inch opening per lineal foot and should face down.

The underdrain should be placed in a gravel envelope (Class 2 Permeable Material per Caltrans Spec. 68-1.025) that measures three feet wide and six inch deep bed of gravel. The underdrain is elevated from the bottom of the permeable pavement by six inches within the gravel envelope to create a fluctuating anaerobic/aerobic zone below the underdrain to facilitate denitrification within the anaerobic/anoxic zone and reduce nutrient concentrations. The top and sides of the underdrain pipe should be covered with gravel to a minimum depth of 12 inches. The underdrain and gravel envelope should be covered with a geomembrane liner to prevent clogging. The following aggregate should be used for the gravel envelope:

Particle Size (ASTM D422)	% Passing by Weight
¾ inch	100%
¼ inch	30-60%
#8	20-50%
#50	3-12%
#200	0-1%

Underdrains should be sloped at a minimum of 0.5 percent, and must drain freely to an acceptable discharge point.

Rigid non-perforated observation pipes with a diameter equal to the underdrain diameter should be connected to the underdrain to provide a clean-out port as well as an observation well to monitor drainage rates. The wells/clean-outs should be connected to the perforated underdrain with the appropriate manufactured connections. The wells/clean-outs must be capped with a lockable screw cap. The ends of underdrain pipes not terminating in an observation well/clean-out should also be capped.

Maintenance Requirements

Maintenance and regular inspections are of important for proper function of permeable pavement with an underdrain. The following are general maintenance requirements:

- Inspect permeable pavement to determine if stormwater runoff is infiltrating properly at least twice during the wet season after significant storms. If infiltration is significantly reduced, remove surface aggregate by vacuuming. Dispose of and replace old aggregate with fresh aggregate as needed.
- Sweep permeable pavement as needed to clean it of leaves, debris, and sediment. Do not overlay permeable pavement with an impermeable surface.
- Prune vegetation and large shrubs/trees that limit access or interfere with permeable pavement operation. Rake and remove fallen leaves and debris from deciduous plant foliage. Remove poisonous, nuisance, dead, or odor-producing vegetation immediately. Mow grass to less than four inches and bag and remove grass clippings.
- Provide irrigation as needed.
- Exercise spill prevention measures when handling substances that can contaminate stormwater runoff. Implement a spill prevention plan at all non-residential sites and in areas where there is likelihood of spills.
- Eliminate standing water to prevent vector breeding.
- Inspect overflow devices for obstructions or debris, which should be removed immediately. Repair or replace damaged pipes upon discovery.
- Provide safe and efficient access to permeable pavement. Egress and ingress routes must be maintained to design standards. Roadways must be maintained to accommodate size and weight of vehicles if applicable.
- Remove obstacles that may prevent maintenance personnel and/or equipment access to the permeable pavement.
- Limit and control application of pesticides (using Integrated Pest Management practices) and fertilizers to reduce potential pollutant runoff.
- Fill and compact holes in the ground located in and around permeable pavement.
- Identify and control sources of erosion damage when native soil is exposed near the overflow device.
- Add gravel or ground cover if erosion occurs due to vehicular or pedestrian traffic.
- Inspect, and clean if necessary, the underdrain.

A summary of potential problems that may need to be addressed by maintenance activities is presented in Table E-29.

T-5: Permeable Pavement with an Underdrain

The County requires execution of a maintenance agreement to be recorded by the property owner for the on-going maintenance of any privately-maintained stormwater quality control measures. The property owner is responsible for compliance with the maintenance agreement. A sample maintenance agreement is presented in Appendix H.

Table E-29. Permeable Pavement Troubleshooting Summary

Problem	Conditions When Maintenance Is Needed	Maintenance Required
Vegetation	Overgrown vegetation	Mow and trim vegetation.
	Presence of invasive, poisonous, nuisance, or noxious vegetation or weeds	Remove this vegetation.
	Excessive loss of turf or ground cover	Replant and/or reseed as needed.
Trash and Debris	Trash and debris present	Remove and dispose of trash and debris.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	Remove any evidence of visual contamination.
Sediment Accumulation	Accumulation of sediment, debris, and oil/grease on surface, inlet or overflow structures	Remove sediment, debris, and/or oil/grease.
Erosion	Eroded areas at overflow structures	Fill eroded areas and re-grade if necessary.
Water Drainage Rate	Standing water	Vacuum aggregate to remove sediment. Replace aggregate if necessary. Inspect, and clean as needed, the underdrain to ensure proper function. Clear clogs as needed.

RET-5: Permeable Pavement without an Underdrain

Description

Permeable pavement includes permeable interlocking concrete pavers, pervious concrete, or porous asphalt pavement that is flat in all directions. Permeable pavement can be used to infiltrate stormwater runoff into the porous pavement and sublayers of sand and gravel and subsequently into the underlying soil and groundwater, if present.



Permeable interlocking concrete pavement is comprised of a layer of durable concrete pavers or blocks separated by joints filled with small stones. Pervious concrete is made from carefully controlled amounts of water and cement materials used to create a paste that forms a thick coat around aggregate particles. Unlike conventional concrete, the mixture contains little or no sand, which creates a substantial void content (between 15 and 25 percent). Porous asphalt, or “open-graded” asphalt, pavement contains no fine aggregate particles, which creates void spaces in the pavement and allows water to collect within and drain through the pavement. An alternative approach for permeable pavement is to use stabilized grassy porous pavement, consisting of grass turf reinforced with plastic rings and filter fabric underlain by gravel. Permeable pavement is highly versatile and can be used in place of impermeable asphalt in many situations.

A schematic of a typical permeable pavement system without an underdrain is presented in Figure E-5.

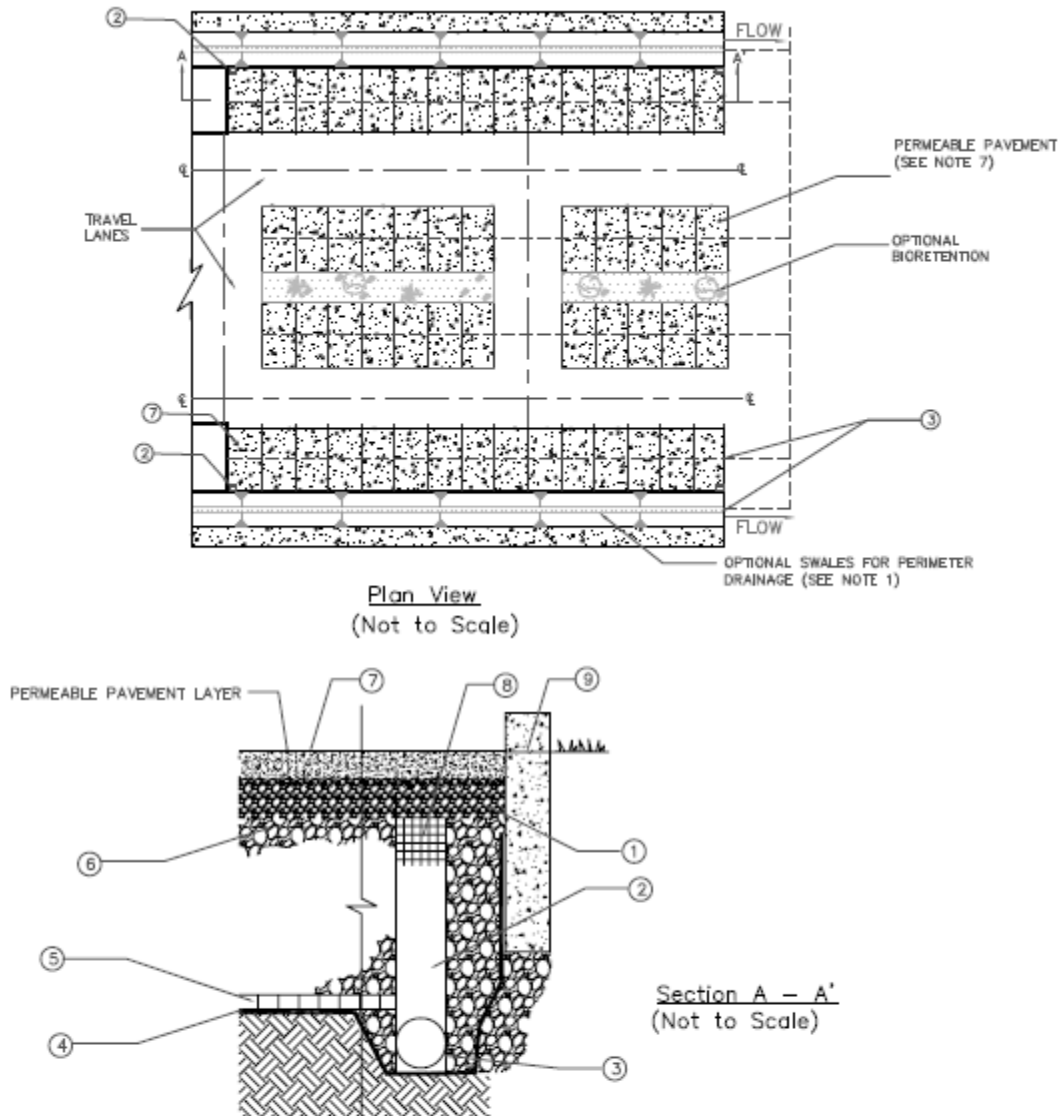
LID Ordinance Requirements

Permeable pavement without an underdrain may be used to comply with the on-site retention requirements of the LID Ordinance for at least its tributary area. The remaining project site SWQDv may need to be routed to other stormwater quality control measures for on-site retention. Permeable pavement without an underdrain will prevent pollutants in the SWQDv from its tributary area from being discharged off-site.

Advantages

- Reduces stormwater runoff volume and peak flows during small storm events
- Can serve functional and aesthetic purposes
- Can reduce heat island effects if light color concrete pavements are used
- Creates dual use for limited space (e.g., parking and stormwater management provided within same space) and can reduce the need and space required for separate stormwater quality control measures

RET-5: Permeable Pavement without an Underdrain



NOTES:

- ① BEDDING COURSE SHALL BE 1½" TO 3" MIN THICKNESS (TYP NO. 8 AGGREGATE).
- ② OPTIONAL OVERFLOW PIPE(S) SHALL BE PROVIDED IF OVERFLOWS ARE NOT MANAGED VIA PERIMETER DRAINAGE TO SWALES, BIORETENTION OR STORM WATER CONVEYANCE SYSTEM INLETS.
- ③ CONNECT OUTFALL PIPES TO DOWNSTREAM STORMWATER CONVEYANCE SYSTEM. OUTFALL PIPES SHALL BE SLOPED TOWARDS COLLECTION SYSTEM.
- ④ SOIL SUBGRADE SHALL HAVE ZERO SLOPE.
- ⑤ INSTALL GEOTEXTILE OR CHOKING LAYER ON BOTTOM & SIDES OF OPEN-GRADED BASE FOR FULL AND PARTIAL INFILTRATION, OR AN IMPERMEABLE LINER FOR NO INFILTRATION.
- ⑥ OPEN-GRADED BASE THICKNESS AND GRADATION VARIES WITH DESIGN. TYP. NO. 57 AGGREGATE OR 4" THICK NO. 57 OVER NO. 2 STONE SUBBASE THICKNESS OF SUB-BASE VARIES WITH DESIGN.
- ⑦ PERMEABLE PAVEMENT INFILTRATIVE LAYER
- ⑧ OPTIONAL RIGID PLASTIC SCREEN FASTENED OVER OVERFLOW INLETS.
- ⑨ CURB/EDGE RESTRAINT WITH CUT-OUTS FOR OVERFLOW DRAINAGE TO PERIMETER BMPs, STORMWATER CONVEYANCE SYSTEM INLETS OR OPTIONAL OVERFLOW PIPES.

Figure E-5. Permeable Pavement without an Underdrain Schematic

Disadvantages

- May not be appropriate for industrial sites or locations with contaminated soils or where spills may occur because of the potential threat to groundwater contamination
- Is not appropriate for high turning areas or areas with heavy truck or equipment use
- A sacrificial non-infiltrating area will develop in the transition area between the permeable pavement and natural areas
- Results in an uneven driving surfaces and potential traps for high-heeled shoes
- Requires frequent maintenance to maintain effectiveness due to clogging from sediment if not situated properly
- Has a high cost for restorative maintenance if the system seals with sediment and can no longer function properly as permeable pavement

General Constraints and Implementation Considerations

- Permeable pavement may be used for sidewalks, walkways, and patios.
- Permeable pavement may be used in low vehicle-movement areas. Potential applications may include the following:
 - Low vehicle movement airport zones;
 - Parking aprons and maintenance roads;
 - Crossover/emergency stopping/parking lanes on divided highways;
 - Residential street parking lanes;
 - Residential driveways;
 - Overflow parking; and
 - Emergency vehicle and fire access lanes in apartment/multi-family/complex facilities.
- Permeable pavement must be installed on relatively flat surfaces with slopes less than 10 percent.
- Solid asphalt or concrete pavement for vehicle movement lanes should be used leading up to permeable pavement parking pads.
- Grass may be planted in block voids, but would require irrigation and lawn care.
- If possible, the entire tributary area of the permeable pavement area should be stabilized before construction begins. If this is not possible, all flows should be diverted around the permeable pavement area to protect it from sediment loads during construction.

RET-5: Permeable Pavement without an Underdrain

- The equipment used to construct the permeable pavement should have extra wide low-pressure tires. Construction traffic should not enter the permeable pavement area because it can compact soil, which reduces infiltration capacity.
- Permeable pavement should not be installed during periods of extreme high or low temperatures. The mix should be transported to the project site in clean vehicles with smooth dump beds that have been sprayed with a non-petroleum release agent. The mix should be covered during transit to limit cooling.
- The surface should be compacted when it is cool enough to resist a 9-Mg roller (class equivalent of a 10-ton roller). One or two passes are needed to provide proper compaction. Any additional passes may reduce porosity.
- Vehicular traffic is prohibited until cooling and hardening have taken place, which is no sooner than six hours, but preferably two days.

Design Specifications

Minimum and maximum dimensions and other specifications are product-specific and must comply with manufacturer's recommendations. The following sections provide design specifications for permeable pavement systems without an underdrain.

Geotechnical

Due to the potential to contaminate groundwater, cause slope instability, impact surrounding structures, and potential for insufficient infiltration capacity, an extensive geotechnical site investigation must be conducted during the site planning process to verify site suitability for permeable pavement without an underdrain. All geotechnical investigations must be performed according to the most recent GMED Policy GS 200.1. Soil infiltration rates and the groundwater table depth must be evaluated to ensure that conditions are satisfactory for proper operation of a permeable pavement system. The project applicant must demonstrate through infiltration testing, soil logs, and the written opinion of a licensed civil engineer that sufficiently permeable soils exist on-site to allow the construction of a properly functioning permeable pavement system without an underdrain.

Permeable pavement systems without an underdrain are appropriate for soils with a minimum corrected in-situ infiltration rate of 0.3 in/hr. The geotechnical report must determine if the proposed project site is suitable for a permeable pavement system without an underdrain and must recommend a design infiltration rate (see "Design Infiltration Rate" under the "Sizing" section). The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move through the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Setbacks

Permeable pavement must be sited following the setbacks from the most recent GMED Policy GS 200.1.

Sizing

Permeable pavement is sized using a simple sizing method where the SWQDv must be completely infiltrated within 96 hours. Permeable pavement provides stormwater runoff storage in the voids of the sub-base reservoir layer.

Step 1: Determine the SWQDv

Dry wells must be designed to capture and retain the SWQDv (see Section 6 for SWQDv calculation procedures).

Step 2: Determine the design infiltration rate

Determine the corrected in-situ infiltration rate (f_{design}) of the native soil using the procedures described in the most recent GMED Policy GS 200.1.

Step 3: Calculate the surface area

The depth of the sub-base reservoir layer is calculated using the following equation:

$$d_{\text{max}} = \frac{f_{\text{design}}}{12} \times t$$

Where:

d_{max} = Maximum depth of sub-base reservoir layer [ft];

f_{design} = Design infiltration rate [in/hr];

t = Maximum retention time (max 96 hrs) [hr]; and

Select the permeable pavement sub-base reservoir layer depth (d_t) such that:

$$d_t \leq \frac{d_{\text{max}}}{n_t}$$

Where:

d_t = Depth of permeable pavement sub-base reservoir layer [ft];

d_{max} = Maximum depth of water that can be infiltrated within the maximum retention time [ft]; and

n_t = permeable pavement sub-base reservoir layer porosity.

The required permeable pavement surface area is calculated using the following equation:

$$A_s = \frac{SWQDv}{d_t \times n_t}$$

RET-5: Permeable Pavement without an Underdrain

Where:

A_s = Permeable pavement surface area [ft^2];
 SWQDv = Stormwater quality design volume [ft^3]; and
 d_t = Depth of permeable pavement sub-base reservoir layer [ft]; and
 n_t = Infiltration trench porosity.

Underlying Base Layers

The cross-section of a permeable pavement typically consists of the four layers discussed below:

Asphalt Layer

The surface asphalt layer consists of an open-graded asphalt mixture with a two- to four-inch depth depending on required bearing strength and permeable pavement design requirements. Permeable pavement contains approximately 16 percent voids, compared to 3 to 5 percent for conventional pavements, to allow quick stormwater runoff infiltration.

The asphalt layer must be laid over the top filter layer in one lift. The laying temperature should be between 240 and 260 degrees Fahrenheit with an ambient temperature above 50 degrees Fahrenheit.

Top Filter Layer

The top filter layer, which stabilizes the asphalt layer, consists of one to two inches of 0.5-inch-diameter crushed stone.

Reservoir Layer

The reservoir layer consists of 1.5- to 3-inch crushed stone. The depth of this layer depends on the desired storage volume, which is a function of the infiltration rate, void spaces, and in colder climates the depth of the frost line, but typically ranges from two to four feet. The reservoir layer must be constructed in lifts and lightly compacted. The base courses should be kept free of all dirt and debris during construction. The reservoir layer should be designed to completely drain in 96 hours.

Bottom Filter Layer

This bottom filter layer, which stabilizes the reservoir layer and is the interface between the reservoir layer and the geomembrane liner covering the underlying soil, consists of a two inch thick layer of 0.5-inch crushed stone.

Hydraulic Restriction Layer

The entire area where permeable pavement will be used must be lined with a geomembrane liner to prevent soil from migrating into the reservoir layer and reducing

RET-5: Permeable Pavement without an Underdrain

storage capacity. The specifications of the geomembrane liner are presented in Table E-9. The entire permeable pavement area, including the sides, must be lined with geomembrane liner prior to placing the aggregate. Provide generous overlap at the seams.

Table E-9. Geomembrane Liner Specifications for Permeable Pavement

Parameter	Test Method	Specifications
Material		Nonwoven geomembrane liner
Unit weight		8 oz/yd ³ (minimum)
Filtration rate		0.08 in/sec (minimum)
Puncture strength	ASTM D-751 (Modified)	125 lbs (minimum)
Mullen burst strength	ASTM D-751	400 lb/in ² (minimum)
Tensile strength	AST D-1682	300 lbs (minimum)
Equiv. opening size	US Standard Sieve	No. 80 (minimum)

Overflow Device

Provide an overflow device to convey high stormwater runoff flows to another stormwater quality control measure, the storm drain system, or receiving water, as appropriate. Place the overflow device a maximum of two inches above the level of the permeable pavement surface. Ensure that the two inch ponding depth is contained and does not flow out of the area at the ends or the sides.

Maintenance Requirements

Maintenance and regular inspections are important for proper function of permeable pavement without an underdrain. The following are general maintenance requirements:

- Inspect permeable pavement to determine if stormwater runoff is infiltrating properly at least twice during the wet season after significant storms. If infiltration is significantly reduced, remove surface aggregate by vacuuming. Dispose of and replace old aggregate with fresh aggregate as needed.
- Sweep permeable pavement as needed to clean it of leaves, debris, and sediment. Do not overlay permeable pavement with an impermeable surface.
- Prune vegetation and large shrubs/trees that limit access or interfere with permeable pavement operation. Rake and remove fallen leaves and debris from deciduous plant foliage. Remove poisonous, nuisance, dead, or odor-producing vegetation immediately. Mow grass to less than four inches and bag and remove grass clippings.
- Provide irrigation as needed.
- Exercise spill prevention measures when handling substances that can contaminate stormwater runoff. Implement a spill prevention plan at all non-residential sites and in areas where there is likelihood of spills.

RET-5: Permeable Pavement without an Underdrain

- Eliminate standing water to prevent vector breeding.
- Inspect overflow devices for obstructions or debris, which should be removed immediately. Repair or replace damaged pipes upon discovery.
- Provide safe and efficient access to permeable pavement. Egress and ingress routes must be maintained to design standards. Roadways must be maintained to accommodate size and weight of vehicles if applicable.
- Remove obstacles that may prevent maintenance personnel and/or equipment access to the permeable pavement.
- Limit and control application of pesticides (using Integrated Pest Management practices) and fertilizers to reduce potential pollutant runoff.
- Fill and compact holes in the ground located in and around permeable pavement.
- Identify and control sources of erosion damage when native soil is exposed near the overflow device.
- Add gravel or ground cover if erosion occurs due to vehicular or pedestrian traffic.

A summary of potential problems that may need to be addressed by maintenance activities is presented in Table E-10.

The County requires execution of a maintenance agreement to be recorded by the property owner for the on-going maintenance of any privately-maintained stormwater quality control measures. The property owner is responsible for compliance with the maintenance agreement. A sample maintenance agreement is presented in Appendix H.

RET-5: Permeable Pavement without an Underdrain

Table E-10. Permeable Pavement Troubleshooting Summary

Problem	Conditions When Maintenance Is Needed	Maintenance Required
Vegetation	Overgrown vegetation	Mow and trim vegetation.
	Presence of invasive, poisonous, nuisance, or noxious vegetation or weeds	Remove this vegetation.
	Excessive loss of turf or ground cover	Replant and/or reseed as needed.
Trash and Debris	Trash and debris present	Remove and dispose of trash and debris.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	Remove any evidence of visual contamination.
Erosion/Sediment Accumulation	Eroded areas at overflow structures	Fill eroded areas and re-grade if necessary.
	Accumulation of sediment, debris, and oil/grease on surface, inlet or overflow structures	Remove sediment, debris, and/or oil/grease.
Water Drainage Rate	Standing water	Vacuum aggregate to remove sediment. Replace aggregate if necessary.

Tab D

Master Covenant and Agreement

RECORDING REQUESTED BY
AND MAIL TO:

Space above this line is for Recorder's use

COVENANT AND AGREEMENT
REGARDING THE MAINTENANCE OF LOW IMPACT DEVELOPMENT (LID) &
NATIONAL POLLUTANTS DISCHARGE ELIMINATION SYSTEM (NPDES) BMPs

The undersigned, _____ ("Owner"), hereby certifies that it owns the real property described as follows ("Subject Property"), located in the County of Los Angeles, State of California:

LEGAL DESCRIPTION

ASSESSOR'S ID # _____ TRACT NO. _____ LOT NO. _____

ADDRESS: _____

Owner is aware of the requirements of County of Los Angeles' Green Building Standards Code, Title 31 Section 4.106.5 (LID), and Title 12, Chapter 12.84 – Low Impact Development Standards. The following post-construction BMP features have been installed on the Subject Property:

- ☐ Porous pavement
- ☐ Cistern/rain barrel
- ☐ Infiltration trench/pit
- ☐ Bioretention or biofiltration
- ☐ Rain garden/planter box
- ☐ Disconnect impervious surfaces
- ☐ Dry Well
- ☐ Storage containers
- ☐ Landscape and landscape irrigation
- ☐ Green roof
- ☐ Other _____

The location, including GPS x-y coordinates, and type of each post-construction BMP feature installed on the Subject Property is identified on the site diagram attached hereto as Exhibit 1.

Owner hereby covenants and agrees to maintain the above-described post-construction BMP features in a good and operable condition at all times, and in accordance with the LID/NPDES Maintenance Guidelines, attached hereto as Exhibit 2.

Owner further covenants and agrees that the above-described post-construction BMP features shall not be removed from the Subject Property unless and until they have been replaced with other post-construction BMP features in accordance with County of Los Angeles' Title 12, Chapter 12.84 – Low Impact Development Standards.

Owner further covenants and agrees to maintain all drainage devices located within his/her property in good condition and operable condition at all times.

Owner further covenants and agrees that if Owner hereafter sells the Subject Property, Owner shall provide printed educational materials to the buyer regarding the post-construction BMP features that are located on the Subject Property, including the type(s) and location(s) of all such features, and instructions for properly maintaining all such features.

Owner makes this Covenant and Agreement on behalf of itself and its successors and assigns. This Covenant and Agreement shall run with the Subject Property and shall inure to the benefit of the County of Los Angeles and be binding upon Owner, future owners, and their heirs, successors and assignees, and shall continue in effect until the release of this Covenant and Agreement by the County of Los Angeles, in its sole discretion.

Owner(s):

By: _____ Date: _____

By: _____ Date: _____

A notary public or other officer completing the attached certificate verifies only the identity of the individual who signed the document to which the certificate is attached, and not the truthfulness, accuracy, or validity of that document.

(PLEASE ATTACH NOTARY)

FOR DEPARTMENT USE ONLY:

MUST BE APPROVED BY COUNTY OF LOS ANGELES BUILDING AND SAFETY DIVISION PRIOR TO RECORDING.

APPROVED BY: _____ Date _____ Permit No. _____
(Print Name) (Signature)



County of Los Angeles - Department of Public Works

Building and Safety/Land Development Division

LOW IMPACT DEVELOPMENT REVIEW SHEET

(2017 Los Angeles County Building Code, Residential Code,
and Green Building Standards Code)

GENERAL PROJECT INFORMATION

PLAN CHECK: 0 DISTRICT No: 0.00
JOB ADDRESS: 0 CITY: 0.00
APPLICANT: 0 EMAIL: 0

Your application for a permit, together with plans and specifications, has been examined and you are advised that the issuance of a permit is withheld for the reasons hereinafter set forth. The approval of plans and specifications does not permit the violation of any section of the Building Code, or other local ordinance or state law.

NOTE: Numbers in the parenthesis () refer to sections of the 2017 edition of County of Los Angeles Building Code, Appendix J of the LACBC (J), Residential Code (R), Green Building (GB), Table (T), and Building Code Manual (BCM).

INSTRUCTIONS

- Corrections shown below apply to this plan check. See plans and calculations for additional comments.
- In the right hand column, please indicate the sheet number and detail or note number on the plan where the corrections are made. Resubmit PDF copies of corrected plans, calculations, and this plan review list with annotation.
- Incorporate all comments as marked on check set of plans, calculations, and these correction sheets.

LOW IMPACT DEVELOPMENT (LID) Requirements

All development must comply with the County of Los Angeles' Title 12, Chapter 12.84 (LID).

LID standards are intended to distribute stormwater and urban runoff across developed sites to help reduce adverse water quality impacts and replenish groundwater supplies. The County of Los Angeles, LID Manual 2014 is available at the following link: <http://dpw.lacounty.gov/lid/web/>

Under the County of Los Angeles LID Ordinance, Title 12, Section 12.84.430, designated projects are required to prohibit the discharge of pollutants from property developments. Preventing these pollutants from entering stormwater discharge system will be accomplished by requiring the installation and maintenance of post-construction treatment controls. (Best Management Practices (BMPs))

LID Requirement (Priority and Non-Priority Projects):

Date of Maintenance Agreement:	
Proposed Impervious Area:	10,702 sq. ft.
Design Storm: (check box) ☒ 85th percentile ☐ 0.75-inch	
SWQDv: 920.94 ft ³	% to retain onsite
LID Solution: (check box) ☒ Infiltration ☐ Biofiltration	

NON-RESIDENTIAL DEVELOPMENTS (Commercial or Industrial) must comply with LID as follows:

Section Response:

2. The following is a list of new development and redevelopment projects/activities that require compliance with LA County's LID ordinance. (See LID manual for additional information)

- o All development projects equal to 1 acre or greater of disturbed area and adding more than 10,000 square feet of impervious surface area
- o Residential new or redeveloped projects that creates, adds, or replaces >10,000 square feet of impervious surface area.

- o Industrial parks 10,000 square feet or more of surface area.
- o Commercial malls 10,000 square feet or more surface area.
- o Retail gasoline outlets 5,000 square feet or more of surface area.
- o Restaurants (SIC 5812) 5,000 square feet or more of surface area.
- o Parking lots 5,000 square feet or more of impervious surface area, or with 25 or more parking spaces.
- o Street and road construction of 10,000 square feet or more of impervious surface area.
- o Automotive service facilities with 5,000 square feet or more of surface area.
- o
- Projects located in or directly adjacent to, or discharging directly to a Significant Ecological Area (SEA), where the development will discharge storm water runoff that is likely to impact a sensitive biological species or habitat; and Create 2,500 square feet or more of impervious surface area.
- o Redevelopment projects identified below*:
 - Land-disturbing activity that results in the creation or addition or replacement of 5,000 square feet or more of impervious surface area.
 - Development which alters less than 50% of impervious surfaces. Only proposed re-development needs to meet NPDES requirements.
 - Development which alters 50% or more of impervious surfaces. Entire site shall meet NPDES requirements.

*Impervious surface replacement, such as the reconstruction of parking lots and roadways which does not disturb additional area and maintains the original grade and alignment, is considered a routine maintenance activity. Redevelopment does not include the repaving of existing roads to maintain original line and grade.

REQUIREMENTS

- a. New Development and Re-Development Projects must control runoff through infiltration, bioretention, and/or rainfall harvest and use. Project must retain onsite the Stormwater Quality Design Volume (SWQDv) as defined by the greater of the following:
 - The 0.75-inch, 24 hour rain event or
 - The 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map (www.dpw.lacounty.gov/wrd/hydrologygis).
- b. Bioretention and biofiltration systems shall meet the design specifications provided in Appendix E (BIO-1) of LA County's LID manual. (See <http://dpw.lacounty.gov/idd/web/>). Biofiltration systems shall be entirely open-bottom.
- c. When evaluating the potential for onsite retention, each projects must consider the maximum potential for evapotranspiration from green roofs and rainfall harvest and reuse for both indoor and outdoor use.
- d. To demonstrate technical infeasibility, it must be shown that a project site cannot reliably retain 100 percent of the SWQDv onsite. Technical infeasibility may result from the following:
 - i. The infiltration rate of saturated in-situ soils less than 0.3 inch per hour.
 - ii. Seasonal high ground water is within 5 to 10 feet of the surface.
 - iii. Locations within 100 feet of a ground water well used for drinking water.
 - iv. Brownfield development sites where infiltration poses a risk of pollutant mobilization.
 - v. Locations with potential geotechnical hazards.
- e. When technical infeasibility has been demonstrated the site must biofiltrate using the following equation for volume required:

$$Bv = 1.5 * [SWQDv - Rv]$$

Where: Bv = Biofiltration volume
 SWQDv = Stormwater runoff as defined in 85 A
 Rv = Volume reliably retained onsite (amount infiltrated)
 *** Show volumes and flow rates on plans as applicable.

Note: For additional alternative compliance measures see Regional Water Quality Control Board Order No. R4-2012-0175 section VI.D.7.c.iii
http://www.waterboards.ca.gov/losangeles/water_issues/programs/stormwater/municipal/index.shtml

- f. Project sites that outlet to natural drainage systems that are subject to hydromodification shall be in compliance with LA County's LID manual, Section 8. (available at <http://dpw.lacounty.gov/idd/web/>).

- g. The plans must show complete construction details, materials, manufacturer, model number, dimensions, location, structures, slopes, construction notes, specifications, cross sections, elevations, GPS x-y coordinates for each BMP, and setbacks from property lines needed to construct proposed LID BMPs. BMPs should be designed as not to adversely impact building foundations, pavement, slope stability, or an adjacent property.
- h. Clearly show driveway/access road drainage and provide BMPs for treatment of driveway flows. Provide elevations, cross sections, or slopes as applicable.
- i. Submit and obtain approval from Environmental Programs Division, Industrial Waste Unit. An annual operating permit may be required. Environmental Programs Division (EPD), Industrial Waste Unit - 900 S. Fremont, Alhambra, Annex Building, 3rd floor, (626) 458-3517. Please contact EPD for required fees and minimum submittal requirements. Please note: prior to obtaining approval from EPD the location and the design flows for all BMPs must be shown on plans and approved by Building and Safety. (This may apply to non-residential projects that propose proprietary filters, drywells, or hydrodynamic separators)
- j. Pre-treatment BMPs are required.

4. For LID compliance, all catch basins and inlets that discharge into an existing or proposed storm drain must be labeled to discourage illegal dumping of pollutants. Stencils are available at your local Building and Safety office.

5. All infiltration basins, dry wells, or planters must comply with the following setbacks

Infiltration Facility Setbacks*	
Setback from	Distance in feet
Property lines & Public Right of Way	5' minimum
Any Foundation	15' or within a 1:1 plane drawn up from the bottom of foundation
Face of any slope	H/2, 5' minimum (H is height of slope)*
Seasonal high ground water	10' minimum depth to invert
Water wells	100' minimum

Required Infiltration Time (due to vector control)	
BMP Type	Duration
Open above ground (includes planting soil or open gravel pit)	48 hours to drain completely
Underground retention	96 hours to drain completely

*unless otherwise recommended by a Soils Engineer and approved by Geotechnical and Materials Engineering Division.

Note: Infiltration is not allowed in areas where pollutant mobilization is a documented concern, or where undisturbed soil infiltration rates are less than 0.3 inches per hour, or where infiltration could cause adverse impacts to biological resources.

6. An Infiltration Report by a Soils Engineer and the grading plans must be reviewed and recommended for approval by the Geology and Soils Section prior to approval of an Infiltration/Retention - Low Impact Development (LID) BMP. The Infiltration Report must comply with GMED Geotechnical Memo GS 200.1 and should be presented as its own report. All recommendations and notes as indicated in the soils engineering report and/or GMED review sheets must be incorporated into the grading plans. The GS 200.1 memo can be found at: <http://dpw.lacounty.gov/gmed/permits/docs/policies/GS200.1.pdf>

7. Rainwater harvest and reuse systems that are NOT gravity fed require approval from LA County Public Health, Cross Connection & Water Pollution Control Program. The application and further information is found at http://publichealth.lacounty.gov/eh/EP/cross_con/cross_con_main.htm. In addition, approval from LA County, Building and Safety Plumbing Section is required. Rainwater harvest design and plans must comply with County of Los Angeles, Plumbing Code, Chapter 16 – Non-Potable Rainwater Catchment Systems.

8. Different types of infiltration facilities such as dry wells, unlined sumps, seepage pits, and infiltration galleries are some of the terms used to describe Class V injection wells as defined by the EPA. Register the proposed infiltration facility at the following online registration form:
<http://www.epa.gov/uic/forms/underground-injection-wells-registration>.

9. A recorded covenant indicating that the owner of the subject development is aware and agrees to maintain all stormwater BMP features for this project is required. The covenant shall include operation and maintenance guidelines prepared by the project civil engineer/architect. See attached LID Covenant Preparation and Recordation instructions. A draft copy of the covenant including all exhibits must be reviewed prior to recordation.

10. A Statement of Understanding and/or O&M Guidelines must be provided for Capital Projects.

Plan Checker:	0	Email:	0
Phone Number:	-	Date:	

Operations and Maintenance Plan

Operations and Maintenance (O&M) Plan

For

Starbucks

**109 S. Del Mar Avenue
San Gabriel, CA 91776**

Operations and Maintenance Plan

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Non-Structural Source Control BMPs			
Yes	Education for Property Owners, Tenants and Occupants Education for Property Owners, Tenants and Occupants will be provided to the first residents/occupants/tenants on general housekeeping practices that contribute to the protection of stormwater quality. These materials will be initially developed and provided by Starbucks Coffee. Thereafter such materials will be available through the Permittees' education program. The owner/tenant shall periodically provide environmental awareness education materials, made available by the municipalities, to all of its members. Among other things, these materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of wastes via hosing or other direct discharge to gutters, catch basins and storm drains.	Education of employees/owner(s) shall be done within 4 weeks of startup and continue on an annual refreshing basis with each new onsite employee/owner(s) being given a water quality orientation using this LID as reference within two weeks of hire date.	<i>Owner</i>
Yes	Activity Restriction Activity Restrictions must be prepared for the purpose of surface water quality protection. An example would be not allowing car washing outside of established community car wash areas in multi-unit complexes. Alternatively, use restrictions may be developed by a building operator through lease terms, etc.	Daily	<i>Owner</i>
Yes	Common Area Landscape Management Identify on-going landscape maintenance requirements that are consistent with those in the County Water Conservation Resolution (or city equivalent) that include fertilizer and/or pesticide usage consistent with Management Guidelines for Use of Fertilizers.	Landscape maintenance shall be performed on a weekly basis. Irrigation systems shall be inspected monthly for leaks. Leaks shall be repaired as soon as they are observed	<i>Owner</i>
Yes	BMP Maintenance The Project LID shall identify responsibility for implementation of all BMPs and scheduled cleaning and/or maintenance of all structural BMP facilities.	As needed	<i>Owner</i>
No	Title 22 CCR Compliance t		

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Yes	Spill Contingency Plan A Spill Contingency Plan is prepared by building operator or occupants for use by specified types of building or suite occupancies. The Spill Contingency Plan describes how the occupants will prepare for and respond to spills of hazardous materials. Plans typically describe stockpiling of cleanup materials, notification of responsible agencies, disposal of cleanup materials, documentation, etc.	Daily	<i>Owner</i>
No	Underground Storage Tank Compliance		
No	Hazardous Materials Disclosure Compliance		
Yes	Uniform Fire Code Implementation Compliance with the Uniform Fire Code enforced by fire protection agency.	Daily	<i>Owner</i>
Yes	Common Area Litter Control For industrial/commercial developments the owner/tenant should be required to implement trash management and litter control procedures in the common areas aimed at reducing pollution of drainage water. The owner/tenant may contract with their landscape maintenance firms to provide this service during regularly scheduled maintenance, which should consist of litter patrol, emptying of trash receptacles in common areas, and noting trash disposal violations by tenants/homeowners or businesses and reporting the violations to the owner/tenant for investigation.	Daily	<i>Owner</i>
Yes	Employee Training Starbucks Coffee will provide environmental awareness education materials containing use of chemicals that should be limited to the property, with no discharge or specified wastes via hosing or other direct discharge to gutters, catch basins, and storm drains. Ensuring that employees are properly trained will help to reduce all anticipated and potential pollutants from the site. All new employees will be trained on how to minimize impacts to water quality.	Education of employees/owner(s) shall be done within 4 weeks of startup and continue on an annual refreshing basis with each new onsite employee/owner(s) being given a water quality orientation using this LID as reference within two weeks of hire date.	<i>Owner</i>
No	Housekeeping of Loading Docks		

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Yes	Common Area Catch Basin Inspection For industrial/commercial developments and for developments with privately maintained drainage systems, the owner is required to have at least 80 percent of drainage facilities inspected, cleaned and maintained on an annual basis with 100 percent of the facilities included in a two-year period. Cleaning should take place in the late summer/early fall prior to the start of the rainy season. Records should be kept to document the annual maintenance.	Inspect area in around catch basins for trash/debris and clean as necessary. Once prior to the rainy season (by Oct. 1st) and every four months thereafter	<i>Owner</i>
Yes	Street Sweeping Private Streets and Parking Lots Streets and parking lots are required to be swept prior to the storm season, in late summer or early fall, prior to the start of the rainy season or equivalent as required by the governing jurisdiction.	The access roads and drive aisles shall be swept on a regular basis to remove debris. Street sweeping shall be inspected twice a month to remove debris.	<i>Owner</i>
No	Retail Gasoline Outlets		
Structural Source Control BMPs			

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Yes	Provide Storm Drain System Stenciling and Signage Storm drain stencils are highly visible source control messages, typically placed directly adjacent to storm drain inlets. The stencils contain a brief statement that prohibits the dumping of improper materials into the municipal storm drain system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message. Stencils and signs alert the public to the destination of pollutants discharged into stormwater. The following requirements should be included in the project design and shown on the project plans: 1. Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language (such as: "NO DUMPING- DRAINS TO OCEAN") and/or graphical icons to discourage illegal dumping. 2. Post signs and prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area. 3. Maintain legibility of stencils and signs. See CASQA Stormwater Handbook BMP Fact Sheet SD-13 for additional information.	As needed	<i>Owner</i>

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Yes	Design and Construct Outdoor Material Storage Areas to Reduce Pollutant Introduction Improper storage of materials outdoors may increase the potential for toxic compounds, oil and grease, fuels, solvents, coolants, wastes, heavy metals, nutrients, suspended solids, and other pollutants to enter the municipal storm drain system. Where the plan of development includes outdoor areas for storage of hazardous materials that may contribute pollutants to the municipal storm drain system, or include transfer areas where incidental spills often occur, the following stormwater BMPs are required: 1. Hazardous materials with the potential to contaminate urban runoff shall either be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with storm water or spillage to the municipal storm drain system; or (2) protected by secondary containment structures (not double wall containers) such as berms, dikes, or curbs. 2. The storage area shall be paved and sufficiently impervious to contain leaks and spills. 3. The storage area shall have a roof or awning to minimize direct precipitation and collection of stormwater within the secondary containment area. 4. Any stormwater retained within the containment structure must not be discharged to the street or storm drain system. 5. Location(s) of installations of where these preventative measures will be employed must be included on the map or plans identifying BMPs. See CASQA Stormwater Handbook Section 3.2.6 and BMP Fact Sheet SD-34 for additional information.	Daily	<i>Owner</i>

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Yes	Design and Construct Trash and Waste Storage Areas to Reduce Pollutant Introduction Design trash storage areas to reduce pollutant introduction. All trash container areas shall meet the following requirements (limited exclusion: detached residential homes): 1. Paved with an impervious surface, designed not to allow run-on from adjoining areas, designed to divert drainage from adjoining roofs and pavements diverted around the area, screened or walled to prevent off-site transport of trash; - and 2. Provide solid roof or awning to prevent direct precipitation. Connection of trash area drains to the municipal storm drain system is prohibited. Potential conflicts with fire code and garbage hauling activities should be considered in implementing this source control. See CASQA Stormwater Handbook Section 3.2.9 and BMP Fact Sheet SD-32 for additional information.	Daily	<i>Owner</i>

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
Yes	Use Efficient Irrigation Systems & Landscape Design Projects shall design the timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the municipal storm drain system. (Limited exclusion: detached residential homes.) The following methods to reduce excessive irrigation runoff shall be considered, and incorporated on common areas of development and other areas where determined applicable and feasible by the Permittee: 1. Employing rain shutoff devices to prevent irrigation after precipitation. 2. Designing irrigation systems to each landscape area's specific water requirements. 3. Using flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines. 4. Implementing landscape plan consistent with County Water Conservation Resolution or city equivalent, which may include provision of water sensors, programmable irrigation times (for short cycles), etc. 5. The timing and application methods of irrigation water shall be designed to minimize the runoff of excess irrigation water into the municipal storm drain system. 6. Employing other comparable, equally effective, methods to reduce irrigation water runoff. 7. 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 other design features, such as: - Use mulches (such as wood chips or shredded wood products) in planter areas without ground cover to minimize sediment in runoff. - Install appropriate plant materials for the location, in accordance with amount of sunlight and climate, native plant material where possible and/or as recommended by the landscape architect. - Leave a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible. - Choose plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth.	Daily	Owner

BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance, and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
No	Protect Slopes and Channels and Provide Energy Dissipation		
No	Loading Docks		
No	Maintenance Bays		
No	Vehicle Wash Areas		
No	Outdoor Processing Areas		
No	Equipment Wash Areas		
No	Fueling Areas		
No	Hillside Landscaping		
Yes	Wash Water Controls for Food Preparation Areas Food establishments (per State Health & Safety Code 27520) shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. If located outside, the contained areas, sinks shall also be structurally covered to prevent entry of stormwater.	Daily	Owner
No	Community Car Wash Racks		
Treatment Control BMPs			
Yes	Low Impact Development BMP # 1 RET-5: Permeable Pavement without an Underdrain	Refer to the following page for Implementation, Maintenance and inspection frequency	Owner

Note:

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.”

Required Permits

This section must list any permits required for the implementation, operation, and maintenance of the BMPs. Possible examples are:

- Permits for connection to sanitary sewer
- Permits from California Department of Fish and Game
- Encroachment permits

If no permits are required, a statement to that effect should be made.

Forms to Record BMP Implementation, Maintenance, and Inspection

The form that will be used to record implementation, maintenance, and inspection of BMPs is attached.

Recordkeeping

All records must be maintained and kept on site indefinitely and must be made available for review upon request.

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

**Name of Person Performing Activity
(Printed):** _____

Signature: _____

BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

Geotechnical Engineering Investigation