Aldersgate Place

KPFF Job # 2500219

HYDROLOGY AND LID REPORT

Prepared by:

KPFF Consulting Engineers

700 S Flower Street, Suite 2100

Los Angeles, CA 90017

213-418-0201 (O)

June 2026

1. Introduction

A. Vicinity Map

B. Project Description

The Aldersgate Place project is located in Covina, within Los Angeles County. The project site spans 1.25 acres and is located at 437 W San Bernardino Rd, Covina, California 91723. The site is currently a surface parking lot serving the Covina United Methodist Church and the Covina Development Center. It is bounded by Hollenbeck Avenue to the West, a residential development to the North, church 5th Avenue to the East, and W San Bernadino Road to the South. The project consists of a four-story multi-family residential development.

C. Purpose and Scope

The purpose of the report is:

- To reduce the proposed development's impact on existing hydrological conditions;
- To provide sufficient detailed information to support the design of stormwater treatment facilities; and

The Los Angeles County Hydrology Map shows the site to be in Soil Classification Area 6, with a 50-year 24-hour rainfall depth of 7.1 inches.

The following tables below summarize the output data from HydroCalc for the existing and proposed conditions for the 10-year storm events, respectively. Hydrology exhibits for the pre- and post-development conditions are included in Appendix A.

Table 1 - Pre-Development Hydrology Summary

Tributary Area	Area (ac)	Impervious (%)	Peak Flow Rate (cfs) – 10 year storm
Total	1.25	90%	**3.37**

Table 2 - Post-Development Hydrology Summary

Tributary Area	Area (ac)	Impervious (%)	Peak Flow Rate (cfs) – 10 year storm
DA-1	0.75	91%	2.03
DA-2	0.50	68%	1.32
Total	1.25	82%	**3.35**

Based on the analysis above, the proposed project results in a reduction in peak flow from 3.37 cfs to 3.35 cfs.

4. Proposed Low Impact Development (LID) Design

LID is a strategy implemented by the City of Covina and LA County to mitigate the impacts of runoff and stormwater pollution as close to the source as possible, using Best Management Practices (BMPs).

The stormwater quality control measures are typically categorized into the following types, listed by order of priority:

1. Infiltration/retention systems
2. Biofiltration
3. Vegetation systems
4. Media/treatment devices

It has been determined that infiltration is feasible at the site. Per the Geotechnical Report the design infiltration rate had been indicated as 9.8 inches per hour, inclusive of the City's required Factor of Safety of 3. According to the report, groundwater was not encountered to a maximum depth of 30.5 feet below the existing ground surface. Due to the site conditions and percolation rates, the geotechnical engineer has determined that infiltration is feasible. See Appendix D for the Geotechnical Report titled "Geotechnical Investigation" by *Geocon West, Inc.* for information regarding infiltration. The relevant pages have been extracted from the geotechnical report and included in Appendix C.

The following table below summarizes the LID calculations for the proposed conditions of an 85th percentile storm event which was determined to be 1.0 inch rainfall depth. The LA County GIS Map for the 85th percentile and the complete HydroCalc data are both included in Appendix B.

d_p is the ponding depth set at 1 ft, which is below the maximum allowed depth of 1.5 ft,

d_{pm} is the depth of the planting media layer set at 3 ft, which is greater than the minimum depth of 2 ft,

η_{pm} is porosity of planting media (typical 0.40) [ft/ft],

d_{gl} is the depth of the gravel layer set at the minimum required depth of 1 ft, and

η_{gl} is porosity of gravel layer, typical 0.30-0.40, set at 0.40 ft/ft.

4. Verify bioretention size meets SWQDv drawdown
   a. Check max depth

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

$$d_{max} = \frac{5\ in/hr \times 96\ hr}{12}$$

$$d_{max} = 40\ ft$$

Where:

d_{max} is maximum depth of water that can be infiltrated within the maximum drawdown time [ft],

f_{design} is the design infiltration rate [in/hr] from step 2,

t is the maximum drawdown time of 96 hr.

   b. Check effective depth

$$d_{max} \geq d_{eff} = d_p + (d_{pm} \times \eta_{pm}) + (d_{gl} \times \eta_{gl})$$

$$d_{eff} = 1 + (3 \times 0.4) + (1 \times 0.4)$$

$$(d_{max} = 40ft) \geq (d_{eff} = 2.6\ ft)$$

Where d_{eff} is the effective depth of bioretention area [ft].

B. Non-Structural BMPs

Education and Training

Annual training of employees on chemical management and proper methods of handling and disposal of waste shall be provided. Employees should understand the on-site BMPs and their maintenance requirements.

Monitoring and Maintenance

All BMPs shall be operated, monitored, and maintained for the life of the project and at a minimum, all structural BMPs shall be inspected, cleaned out, and where necessary, repaired, at the following minimum frequencies:

Appendix A
Hydrology Exhibits

PRE-DEVELOPMENT HYDROLOGY

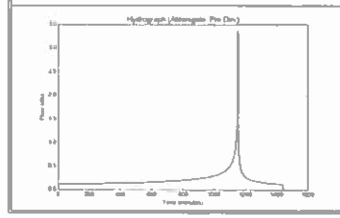
LEGEND

- LIMIT OF WORK
- PROPERTY LINE
- FLOW LINE
- PERVIOUS AREA

TOTAL AREA = 1.25 AC
TOTAL PERVIOUS AREA = 0.13 AC
IMPERVIOUSNESS = 89.8%

Peak Flow Hydrologic Analysis

Input Parameters	
Project Name	Aldersgate
Subarea ID	Pre-Dev
Area (ac)	1.25
Flow Path Length (ft)	290.75
Flow Path Slope (vft/hft)	[illegible]
50-yr Rainfall Depth (in)	7.1
Percent Impervious	[illegible]
Soil Type	[illegible]
Design Storm Frequency	[illegible]
Fire Factor	0
LID	False
Output Results	
Modeled Rainfall Depth (in)	[illegible]
Peak Intensity (in/hr)	[illegible]
Undeveloped Runoff Coefficient (Cu)	[illegible]
Developed Runoff Coefficient (Cd)	[illegible]
Time of Concentration (min)	[illegible]
Clear Peak Flow Rate (cfs)	[illegible]
Burned Peak Flow Rate (cfs)	[illegible]
24-Hr Clear Runoff Volume (ac-ft)	[illegible]
24-Hr Clear Runoff Volume (cu-ft)	[illegible]



STUDIO E ARCHITECTS

kpff

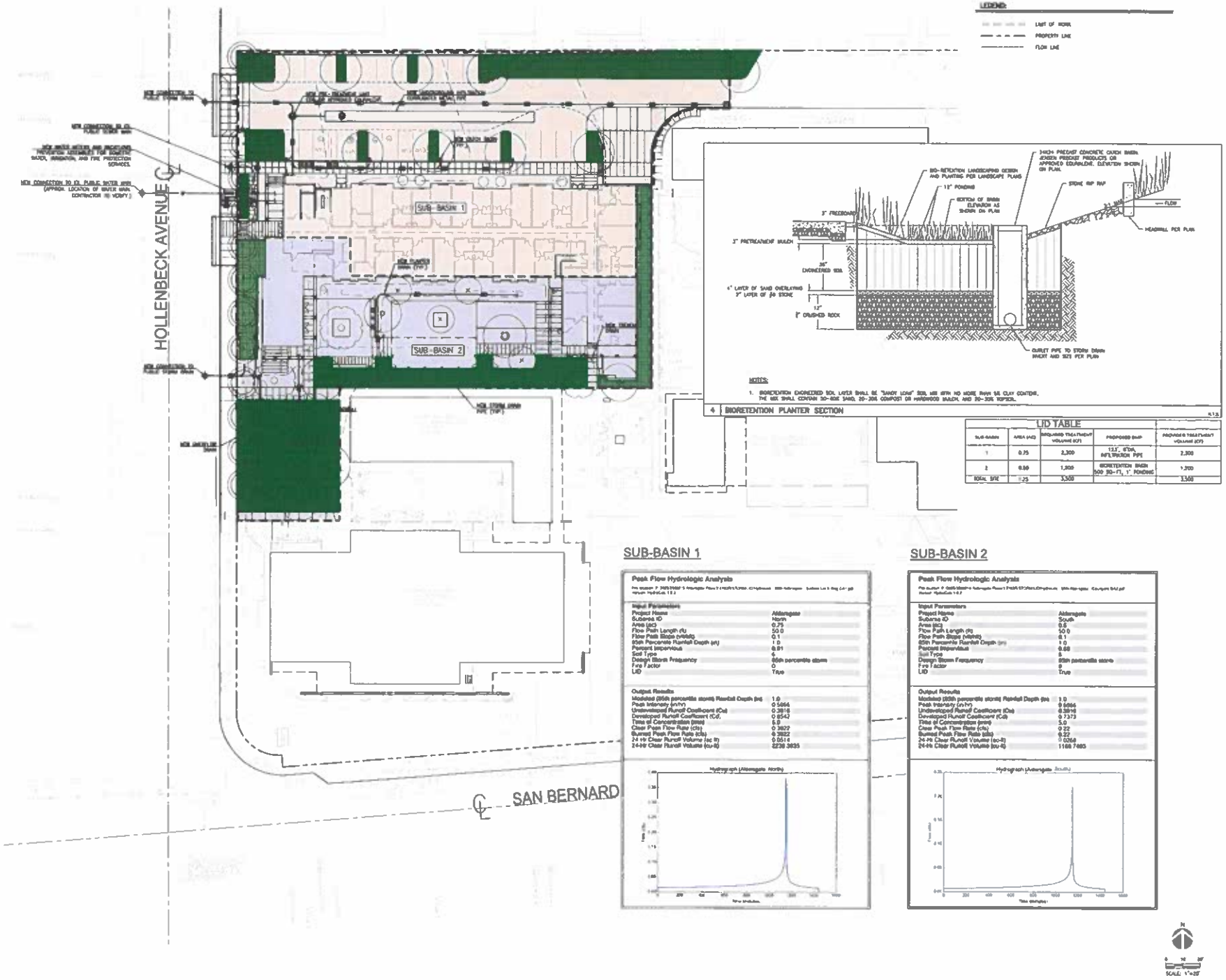
Aldersgate Place
437 W. San Bernardino Rd., Covina, CA
Wakeland Housing and Development Corporation

Project 23014

4/10/25 City Pre-App
08/30/26 Major Site Plan

HYDROLOGY EXHIBIT PRE-DEV

Appendix B
LID Exhibit and Details



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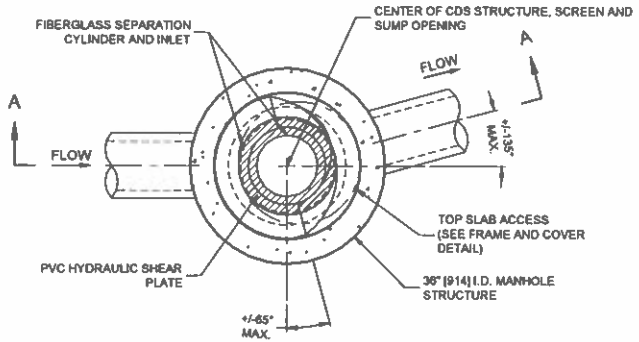
Aldersgate Place
437 W. San Bernardino Rd., Covina, CA
Wakeland Housing and Development Corporation

Project 23014

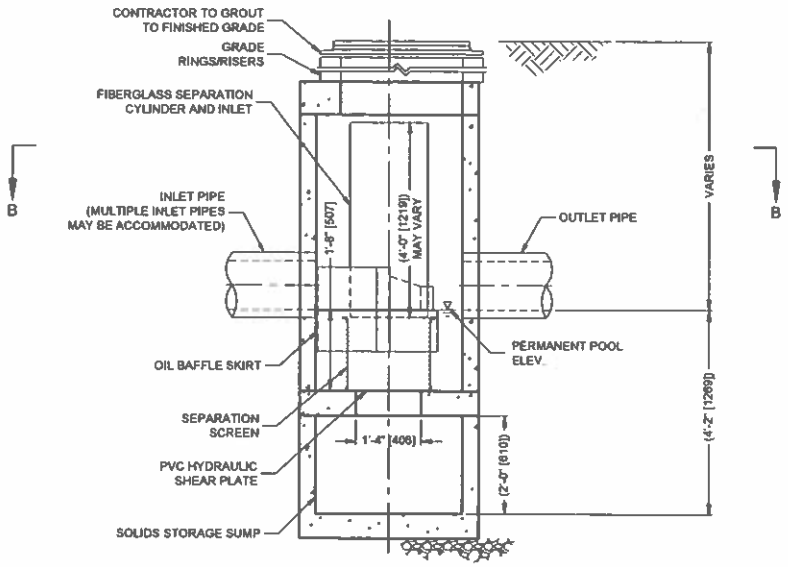
4/10/25 City Pre-App
06/30/26 Major Site Plan

UTILITY PLAN

C110



PLAN VIEW B-B
NOT TO SCALE



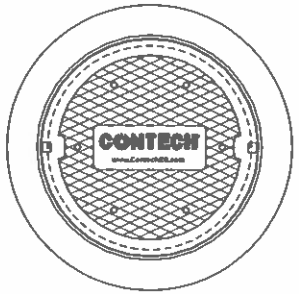
ELEVATION A-A
NOT TO SCALE

CDS1515-3-C DESIGN NOTES

CDS1515-3-C RATED TREATMENT CAPACITY IS 0.50 CFS (14.16 L/s), OR PER LOCAL REGULATIONS. IF THE SITE CONDITIONS EXCEED MAXIMUM HYDRAULIC CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CDS1515-3-C STANDARD CONFIGURATION IS SHOWN.

FOR NJDEP PROJECTS, PLEASE CONTACT YOUR LOCAL CONTECH REPRESENTATIVE FOR APPROVED CONFIGURATIONS.



FRAME AND COVER
(DIAMETER VARIES)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

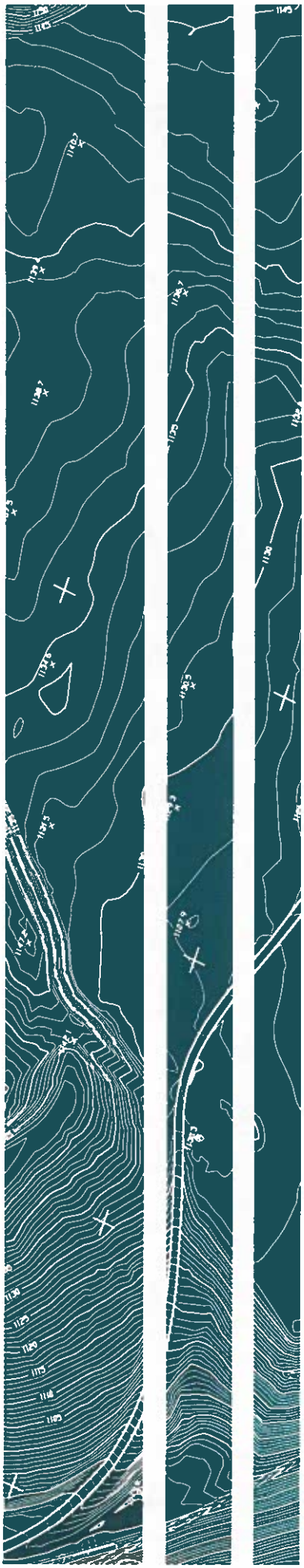
* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS1515-3-C
ONLINE CDS
STANDARD DETAIL



GEOCON

GEOTECHNICAL INVESTIGATION

PROPOSED AFFORDABLE SENIOR HOUSING & PERMANENT SUPPORTIVE HOUSING DEVELOPMENT 415 AND 437 WEST SAN BERNARDINO ROAD COVINA, CALIFORNIA

SEPTEMBER 12, 2025
PROJECT NO. W21452-06-01

PREPARED FOR:
Wakeland Aldersgate, LP
Los Angeles, California

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LIMITATIONS AND UNIFORMITY OF CONDITIONS

LIST OF REFERENCES

7.17.3 It is recommended that vertical point-loads, from construction equipment outriggers or adjacent building columns use horizontal pressures generated from NAV-FAC DM 7.2. The governing equations are:

$$For\ {}^{x}/_{H} \leq 0.4$$

$$\sigma_H(z) = \frac{0.28 \times \left(\frac{z}{H}\right)^2}{\left[0.16 + \left(\frac{z}{H}\right)^2\right]^3} \times \frac{Q_P}{H^2}$$

and

$$For\ {}^{x}/_{H} > 0.4$$

$$\sigma_H(z) = \frac{1.77 \times \left(\frac{x}{H}\right)^2 \times \left(\frac{z}{H}\right)^2}{\left[\left(\frac{x}{H}\right)^2 + \left(\frac{z}{H}\right)^2\right]^3} \times \frac{Q_P}{H^2}$$

then

$$\sigma'_H(z) = \sigma_H(z)cos^2(1.1\theta)$$

where x is the distance from the face of the excavation/wall to the vertical point-load, H is distance from the outrigger/bottom of column footing to the bottom of excavation, z is the depth at which the horizontal pressure is desired, Qp is the vertical point-load, $\sigma_H(z)$ is the horizontal pressure at depth z, θ is the angle between a line perpendicular to the excavation/wall and a line from the point-load to location on the excavation/wall where the surcharge is being evaluated, and $\sigma_H(z)$ is the horizontal pressure at depth z.

7.18 Stormwater Infiltration

7.18.1 During the site exploration on July 24, 2025, boring B2 was utilized to perform percolation testing. The boring was excavated to a depth of 20 feet below ground surface. Slotted casing was placed in the boring, and the annular space between the casing and excavation was filled with sand. The boring was then filled with water to pre-saturate the soil. The casing was refilled with water and percolation test readings were performed after repeated flooding of the cased excavation.

7.18.6 Where the 15-foot horizontal setback cannot be maintained between the infiltration system and an adjacent footing, and the infiltration system penetrates below the foundation influence line, the proposed stormwater infiltration system must be designed to resist the surcharge from the adjacent foundation. The foundation surcharge line may be assumed to project down away from the bottom of the foundation at a 1:1 gradient. The stormwater infiltration system must still be sufficiently deep to maintain the 15-foot vertical offset between the bottom of the footing and the zone of saturation.

7.18.7 Subsequent to the placement of the infiltration system, it is acceptable to backfill the resulting void space between the excavation sidewalls and the infiltration system with minimum two-sack slurry provided the slurry is not placed in the infiltration zone. It is recommended that pea gravel be utilized adjacent to the infiltration zone so communication of water to the soil is not hindered.

7.18.8 Due to the preliminary nature of the project at this time, the type of stormwater infiltration system and location of the stormwater infiltration systems has not yet been determined. The design drawings should be reviewed and approved by the Geotechnical Engineer. The installation of the stormwater infiltration system should be observed and approved by the Geotechnical Engineer (a representative of Geocon).

7.19 Surface Drainage

7.19.1 Proper surface drainage is critical to the future performance of the project. Uncontrolled infiltration of excess irrigation and storm runoff into the soils can adversely affect the performance of the planned improvements. Saturation of a soil can cause it to lose internal shear strength and increase its compressibility, resulting in a change in the original designed engineering properties. Proper drainage should be maintained at all times.

7.19.2 All site drainage should be collected and controlled in non-erosive drainage devices. Drainage should not be allowed to pond anywhere on the site, and especially not against any foundation or retaining wall. The site should be graded and maintained such that surface drainage is directed away from structures in accordance with 2022 CBC 1804.4 or other applicable standards. In addition, drainage should not be allowed to flow uncontrolled over any descending slope. Discharge from downspouts, roof drains, and scuppers is not recommended onto unprotected soils within 5 feet of the building perimeter. Planters that are located adjacent to foundations should be sealed to prevent moisture intrusion into the soils providing foundation support. Landscape irrigation is not recommended within 5 feet of the building perimeter footings except when enclosed in protected planters.

BORING PERCOLATION TEST FIELD LOG

Date:	Thursday, July 24, 2025	**Boring/Test Number:**	B2	
Project Number:	W2142-06-01	**Diameter of Boring:**	8	inches
Project Location:	Project Name	**Diameter of Casing:**	2	inches
Earth Description:	ML/SM	**Depth of Boring:**	20	feet
Tesed By:	JJK	**Depth to Invert of BMP:**	10	feet
Liquid Description:	Water	**Depth to Water Table:**	50	feet
Measurement Method:	Sounder	**Depth to Initial Water Depth (d_1)**	120	inches
		Filter Pack Porosity:	0.2	
		Height of Filter Pack:	10.00	feet

Start Time for Pre-Soak:	10:00 AM	**Water Remaining in Boring (Y/N):**	No
Start Time for Standard:	11:00 AM	**Standard Time Interval Between Readings:**	10 min

Reading Number	Start Time (hh:mm)	Time End (hh:mm)	Elasped Time Δtime (min)	Water Drop During Standard Time Interval, Δd (in)	Soil Despcription Notes Comments
1	1:00 PM	1:10 PM	10	120.0	
2	1:15 PM	1:25 PM	10	120.0	
3	1:30 PM	1:40 PM	10	120.0	
4	1:45 PM	1:55 PM	10	120.0	
5	2:00 PM	2:10 PM	10	120.0	
6	2:15 PM	2:25 PM	10	120.0	Stabilized Readings
7	2:30 PM	2:40 PM	10	120.0	Achieved with Readings
8	2:45 PM	2:55 PM	10	120.0	6, 7, and 8

MEASURED PERCOLATION RATE AND DESIGN INFILTRATION RATE CALCULATIONS*

* Calculations Below Based on Stabilized Readings Only

Boring Radius, r: **4** inches
Test Section Height, h: **120** inches
Adj. Cross Sectional Area = **12.6** $inches^2$

$$Discharged\ Water\ Volume, V = \pi r^2 \Delta d$$

Reading 6 V= **1508** in^3
Reading 7 V= **1508** in^3
Reading 8 V= **1508** in^3

$$Test\ Section\ Surface\ Area, A = 2\pi rh + \pi r^2$$

A= **3066** in^2

$$Percolation\ Rate = \left(\frac{V/A}{\Delta T}\right)$$

Percolation Rate = 29.51 inches/hour
Percolation Rate = 29.51 inches/hour
Percolation Rate = 29.51 inches/hour

Measured Percolation Rate = **29.51** inches/hour

Reduction Factors

Small Diameter Boring, RF_t = 1
Site Variability, RF_v = 1
Long Term Siltation, RF_s = 1

$$Total\ Reduction\ Factor, RF = RF_t + RF_v + RF_s$$

Total Reduction Factor = 3

Design Infiltration Rate

Design Infiltration Rate = **9.84** inches/hour

GEOCON WEST, INC.
ENVIRONMENTAL GEOTECHNICAL MATERIALS
500 NORTH VICTORY BOULEVARD - BURBANK, CA 91502
PHONE: 818-841-8388 FAX: 818-841-1704

DRAFTED BY: JJK | CHECKED BY: HHD

PERCOLATION TEST RESULTS AND CALCULATIONS

415 & 437 WEST SAN BERNARDINO ROAD
COVINA, CALIFORNIA

SEPT. 2025 | PROJECT NO. W2142-06-01 | FIG. 7

APPENDIX A
FIELD INVESTIGATION

The site was explored on July 24, 2025, by excavating four 8-inch-diameter borings using a truck-mounted hollow-stem auger drilling machine to a maximum depth of approximately 30½ feet beneath the ground surface. Representative and relatively undisturbed samples were obtained by driving a 3-inch, O. D., California Modified Sampler into the "undisturbed" soil mass with blows from a 140-pound auto-hammer falling 30 inches. The California Modified Sampler was equipped with 1-inch by 2⅜-inch diameter brass sampler rings to facilitate soil removal and testing. Bulk samples were obtained, and percolation testing was also performed.

The soil conditions encountered in the borings were visually examined, classified and logged in general accordance with the Unified Soil Classification System (USCS). The logs of the borings are presented on Figures A1 through A4. The logs depict the soil and geologic conditions encountered and the depth at which samples were obtained. The logs also include our interpretation of the conditions between sampling intervals. Therefore, the logs contain both observed and interpreted data. We determined the lines designating the interface between soil materials on the logs using visual observations, penetration rates, excavation characteristics and other factors. The transition between materials may be abrupt or gradual. Where applicable, the logs were revised based on subsequent laboratory testing. The approximate locations of the borings are shown on Figure 2.

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SOIL BORING: B-1

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description	Bulk	Driven	Sample Number	Blow Counts/6"	Dry Density (pcf)	Moisture Content (%)
				SP	light grayish brown, coarse-grained, fine gravel, some medium-grained, some coarse gravel		■	B1@20'	13 16 17	128.4	1.5
				ML	**Sandy SILT**, hard, moist, brown, some coarse gravel, cobbles						
22											
24											
	505				cobble fragment		■	B1@25'	35 50/6"	87.2	3.0
26											
28											
	500										
30							■	B1@30'	8 13 30	122.4	13.3
					Total depth of boring: 30.5 feet Fill to 5.5 feet. No groundwater encountered. Backfilled with soil cuttings and tamped. Patched with cold patch AC.						
32											
34											
	495										
36											
38											

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES. THE STRATIFICATION LINES PRESENTED HEREIN REPRESENT THE APPROXIMATE BOUNDARY BETWEEN EARTH TYPES; THE TRANSITIONS MAY BE GRADUAL.

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SOIL BORING: B-2

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description	Bulk	Driven	Sample Number	Blow Counts/6"	Dry Density (pcf)	Moisture Content (%)
	510			ML	SILT, firm, moist, brown		■	B2@20'	10 8 8	106.3	8.0
22					Total depth of boring: 20.5 feet Fill to 2 feet. No groundwater encountered. Backfilled with soil cuttings and tamped. Patched with cold patch AC.						
24											
26	505										
28											
30											
32	500										
34											
36	495										
38											

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES. THE STRATIFICATION LINES PRESENTED HEREIN REPRESENT THE APPROXIMATE BOUNDARY BETWEEN EARTH TYPES; THE TRANSITIONS MAY BE GRADUAL.

GEOCON

Soil Boring Number: B-4

PROJECT NAME West San Bernardino Road | **LOGGED BY** JJK

PROJECT NUMBER W2142-06-01 | **LATITUDE / LONGITUDE** 34.09038, -117.89825

BORING DATE 07/24/2025 | **FIGURE NUMBER** A4 | **DEPTH** 25.5' | **SURFACE ELEVATION** 530.0'

LOCATION 437 West San Bernardino Road, Covina, CA | **CLIENT NAME** Wakeland Aldersgate LP

DRILLING FIRM 2025-07-24- | **COMPLETED** 07/24/2025 | **EQUIPMENT** Hollow Stem Auger | -

METHOD Cal-Mod | **BORING DIAMETER** 8 in | **HAMMER TYPE** Auto | **NOTES** -

HAMMER WEIGHT / DROP 140 lb / 30 in

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description	Bulk	Driven	Sample Number	Blow Counts/6"	Dry Density (pcf)	Moisture Content (%)
	530			Fill	**ARTIFICIAL FILL (AC: 4.5" BASE: NONE)** **Silty SAND**, loose, moist, dark brown, fine-grained, trace medium- to coarse-grained			BULK: 0-5'			
2				SM	**ALLUVIUM** **Silty SAND**, loose, moist, grayish brown, fine-grained, some medium-grained			B4@2.5'	4 5 5	113.9	8.3
4	525				medium- to coarse-grained, some fine gravel, trace cobbles			B4@5'	7 6 7	108.0	7.8
6				ML	**Sandy SILT**, firm, moist, brown, fine-grained			B4@7.5'	5 6 7	122.8	10.6
8	520			SM	**Silty SAND**, medium dense, moist, brown, fine-grained			B4@10'	8 11 14	111.5	8.0
10											
12				SP	**SAND**, poorly graded, medium dense, moist, light brown, fine-grained, some medium- to coarse-grained, some fine to coarse gravel						
14	515							B4@15'	22 21 31	115.1	2.2
16											
18											

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES. THE STRATIFICATION LINES PRESENTED HEREIN REPRESENT THE APPROXIMATE BOUNDARY BETWEEN EARTH TYPES; THE TRANSITIONS MAY BE GRADUAL.

Appendix D

Operations and Maintenance Guidance

RET-1: BIORETENTION

DESCRIPTION

A bioretention area is a vegetated shallow depression that is designed to receive, retain, and infiltrate stormwater runoff from downspouts, piped inlets, or sheet flow from adjoining paved areas. A shallow ponding zone is provided above the vegetated surface for temporary storage of stormwater runoff. During storm events, stormwater runoff accumulates in the ponding zone and gradually filters through the bioretention soil media before infiltrating the underlying soil.

Stormwater runoff treatment occurs through a variety of natural mechanisms as stormwater runoff filters through the vegetated root zone. A portion of the water held in the root zone of the soil media is returned to the atmosphere through transpiration by the plants. Bioretention areas are typically planted with native, drought-tolerant plant species (e.g., wildflowers, sedges, rushes, ferns, shrubs, small trees) that do not require fertilization and can withstand wet soil for at least 24 hours.

A schematic of a typical bioretention area is presented in Figure D-1.

LID Ordinance Requirements

Bioretention can be used to meet the on-site retention requirement of the LID Ordinance. Bioretention will prevent pollutants in the SWQDv from being discharged off-site.

Advantages

- Provides shade and windbreaks
- Enhances site aesthetics
- Retains stormwater runoff and eliminates pollutant discharge to receiving waters
- May conserve water

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 suitable for areas with a shallow groundwater table or unstable surface stratum, including steep (greater than 20 percent) or unstable slopes
- May result in standing water, which may allow vector breeding

  - Landscaped parking lot islands
  - Within rights-of-way along roads
  - Common landscaped areas in apartment complexes or other multi-family housing designs
  - Parks and along open space perimeters
- If tire curbs are provided and parking stalls are shortened, cars may overhang the bioretention area.
- Bioretention areas must be located sufficiently far from structure foundations to avoid damage to structures (as determined by a certified structural or geotechnical engineer).
- The overflow device must drain away from building foundations to the storm drain system or other suitable infiltration area.
- Bioretention areas cannot be located on sites with a slope greater than 20 percent (5:1).
- The project site must be graded to minimize erosion as stormwater runoff enters the bioretention area by creating sheet flow conditions rather than a concentrated stream condition or by providing energy dissipation devices at the inlet.
- The general landscape irrigation system should incorporate the bioretention area, as applicable. Sediment controls (e.g., silt fences) can be used around the bioretention area to prevent high sediment loads from entering the area during construction activities.
- During construction, activities should avoid compaction of native soils below planting media layer or gravel zone.
- Stormwater runoff must be diverted around the bioretention area during the period of vegetation establishment. If diversion is not feasible, the graded and seeded areas must be protected with suitable sediment controls (e.g., silt fences).

DESIGN SPECIFICATIONS

The following sections describe the design specifications for bioretention areas.

Geotechnical

Due to the potential to contaminate groundwater, cause slope instability, impact surrounding structures, and potential for insufficient infiltration capacity, a geotechnical site investigation must be conducted during the site planning process to verify site suitability for bioretention. All geotechnical investigations must be performed according to the most recent Geotechnical and Materials Engineering Division (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 bioretention area. 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 implementation of a properly functioning bioretention system.

Bioretention is 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

Determine the bottom surface area of the bioretention area (surface area at the base of side slopes, not at the top of side slopes) using the following equation:

$$A = \frac{SWQDv}{d_p + (d_{pm} \times \eta_{pm}) + (d_{gl} \times \eta_{gl})}$$

Where:

A	Bottom surface area of bioretention area [ft^2]
SWQDv	Stormwater quality design volume [ft^3]
d_p	Ponding depth (max 1.5 ft) [ft]
d_{pm}	Depth of planting media layer (min 2 ft) [ft]
η_{pm}	Porosity of planting media (typical 0.40) [ft/ft]
d_{gl}	Depth of gravel layer (min 1 ft) [ft]
η_{gl}	Porosity of gravel layer (typical 0.30-0.40) [ft/ft]

Verify that the proposed size of the bioretention area will infiltrate the SWQDv within the maximum drawdown time (96 hours) with the following equations:

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

Where:

d_{max}	Maximum depth of water that can be infiltrated within the maximum drawdown time [ft]
f_{design}	Design infiltration rate [in/hr]
t	Maximum drawdown time (max 96 hrs) [hr]

$$d_{max} \geq d_{eff} = d_p + (d_{pm} \times \eta_{pm}) + (d_{gl} \times \eta_{gl})$$

Where:

d_{max}	Maximum depth of water that can be infiltrated within the maximum drawdown time [ft]
d_{eff}	Effective depth of bioretention area [ft]
d_p	Ponding depth (max 1.5 ft) [ft]
d_{pm}	Depth of planting media layer (min 2 ft) [ft]
η_{pm}	Porosity of planting media (typical 0.40) [ft/ft]
d_{gl}	Depth of gravel layer (min 1 ft) [ft]
η_{gl}	Porosity of gravel layer (typical 0.30-0.40) [ft/ft]

Table D-1. Geomembrane Liner Specifications for Bioretention Areas

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

Planting and Storage Media

- The planting media placed in the bioretention area should achieve a long-term, in-place infiltration rate of at least 5 in/hr and up to 12 in/hr. The bioretention soil media must retain sufficient moisture to support vigorous plant growth.
- The planting media mix must consist of 60 to 80 percent sand and 20 to 40 percent compost.
- Sand should be free of wood, waste, coatings such as clay, stone dust, carbonate, or any other deleterious material. All aggregate passing the #200 sieve size should be non-plastic. Sand for bioretention should be analyzed by an accredited laboratory using #200, #100, #40, #30, #16, #8, #4, and 3/8-inch sieves (ASTM D-422 or as approved by the local permitting authority) and meet the following gradations (Note: all sand complying with ASTM C-33 for fine aggregate comply with the gradation requirements listed below):

Particle Size (ASTM D-422)	% Passing by Weight
3/8 inch	100
#4	90-100
#8	70-100
#16	40-95
#30	15-70
#40	5-55
#110	0-15
#200	0-5

Note: The gradation of the sand component of the bioretention soil media is believed to be a major factor in the infiltration rate of the soil media mix. If the desired infiltration

Tests should be sufficiently recent to represent the actual material that is anticipated to be delivered to the site. If processes or sources used by the supplier have changed significantly since the most recent testing, new tests should be requested.

The gradation of compost used in bioretention soil media is believed to play an important role in the saturated infiltration rate of the bioretention soil media. To achieve a higher saturated infiltration, it may be necessary to utilize compost at the coarser end of the range (minimum percent passing). The percent passing the #200 sieve (fines) is believed to be the most important factor in the infiltration rate.

Additionally, coarser compost mix provides more heterogeneity of the bioretention soil media, which may be advantageous for more rapid development of soil structure needed to support healthy biological processes. This may result in plant establishment with lower nutrient and water input.

Bioretention soil media not meeting the above criteria should be evaluated on a case-by-case basis. Alternative bioretention soil media must meet the following specifications:

- "Soils for bioretention facilities must be sufficiently permeable to infiltrate stormwater runoff at a minimum of rate of 5 in/hr during the life of the facility and provide sufficient retention of moisture and nutrients to support healthy vegetation." The following steps shall be followed by LACPW to verify that alternative bioretention soil media mixes meet the specification:
    - Submittals – The applicant must submit to LACPW for approval:
        - A sample of mixed bioretention soil media.
        - Certification from the soil supplier or an accredited laboratory that the bioretention soil media meets the requirements of this specification.
        - Certification from an accredited geotechnical testing laboratory that the bioretention soil media has an infiltration rate between 5 and 12 in/hr.
        - Organic content test results of the bioretention soil media. Organic content test shall be performed in accordance with the Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
        - Organic grain size analysis results of mixed bioretention soil media performed in accordance with ASTM D-422, Standard Test Method for Particle Size Analysis of Soils.
        - A description of the equipment and methods used to mix the sand and compost to produce the bioretention soil media.
    - The name of the testing laboratory(ies) and the following information:
        - Contact person(s)
        - Address(es)
        - Phone contact(s)
        - E-mail address(es)

- Native plant species and/or hardy cultivars that are not invasive and do not require chemical inputs must be used to the maximum extent practicable (MEP).

The bioretention area should be vegetated to resemble a terrestrial forest community ecosystem, which is dominated by understory trees, a shrub layer, and herbaceous ground cover. Select vegetation that:

- Will be dense and strong enough to stay upright, even in flowing water
- Has minimum need for fertilizers
- Is not prone to pests and is consistent with Integrated Pest Management practices
- Will withstand being inundated for periods of time
- Is consistent with local water conservation ordinance requirements

Irrigation System

Provide an irrigation system to maintain viability of vegetation, if necessary. The irrigation system must be designed to local code or ordinance specifications.

Restricted Construction Materials

Use of pressure-treated wood or galvanized metal at or around a bioretention area is prohibited.

Overflow Device

An overflow device is required at the 18-inch ponding depth. The following, or equivalent, should be provided:

- A vertical PVC pipe (SDR 26) to act as an overflow riser.
- The overflow riser(s) should be eight inches or greater in diameter, so it can be cleaned without damage to the pipe.
- The inlet to the riser should be at the ponding depth (18 inches for fenced bioretention areas and 6 inches for areas that are not fenced) and capped with a spider cap to exclude floating mulch and debris. Spider caps should be screwed in or glued (e.g., not removable). The overflow device should convey stormwater runoff exceeding the SWQDv to an approved discharge location (e.g., another stormwater quality control measure, storm drain system, receiving water).

MAINTENANCE REQUIREMENTS

Maintenance and regular inspections are important for proper function of bioretention areas. Bioretention areas require annual plant, soil, and mulch layer maintenance to ensure optimal infiltration, storage, and pollutant removal capabilities. In general, bioretention maintenance requirements are typical landscape care procedures, which include:

- Irrigate plants as needed during prolonged dry periods. Plants should be selected to be drought-tolerant and not require irrigation after establishment (two to three years).
- Inspect flow entrances, ponding area, and surface overflow areas periodically, and replace soil, plant material, and/or mulch layer in areas if erosion has occurred.

Table D-2. Bioretention Troubleshooting Summary

Problem	Conditions When Maintenance Is Needed	Maintenance Required
Vegetation	Overgrown vegetation	Mow and prune vegetation as appropriate.
	Presence of invasive, poisonous, nuisance, or noxious vegetation or weeds	Remove this vegetation and plant native species as needed.
Trash and Debris	Trash, plant litter, and dead leaves present	Remove and properly dispose of trash and debris.
Irrigation (if applicable)	Not functioning correctly	Check irrigation system for clogs or broken lines and repair as needed.
Flow Entrance/Overflow Device	Flow entrance/overflow areas clogged with sediment and/or debris	Remove material.
	Overflow device blocked or broken	Clean and/or repair as needed.
Erosion/Sediment Accumulation	Presence of erosion or sediment accumulation	Check flow entrance to ensure proper function. Repair or replace the flow entrance. Repair eroded areas with gravel as needed. Re-grade the bioretention area as needed.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	Remove any evidence of visual contamination from floatables such as oil and grease.
Standing water	Standing water observed for more than 96 hours after storm event	Remove and replace plant media (sand, gravel, topsoil, mulch) and vegetation.