# MOJAVE RIVER WATERSHED

# Water Quality Management Plan

**For:**

## DESERT TRAILS MIDDLE SCHOOL

**GRADING PERMIT NO., BUILDING PERMIT NO., TRACT NUMBER, LAND DEVELOPMENT FILE NO.,**

**APN# 3096-361-07**

**Prepared for:**

**Desert Trails Prepatory Academy**

**14530 Bellflower St.**

**Adelanto, CA 92301**

**760-530-7680**

**Prepared by:**

**Kolibrien Corp.**

**27919 Jefferson Ave. STE. 201**

**Temcula, CA 92590**

**951-252-1034**

**Submittal Date: 6/7/2019**

**Revision No. and Date: 1 9/20/2019**

**Revision No. and Date: 2 10/09/2019**

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**Revision No. and Date: Insert No and Current Revision Date**

**Revision No. and Date: Insert No and Current Revision Date**

**Final Approval Date:_____**

# Project Owner's Certification

This Mojave River Watershed Water Quality Management Plan (WQMP) has been prepared for Desert Trails Middle School by Kolibrien Corp. The WQMP is intended to comply with the requirements of the City of Victorville and the Phase II Small MS4 General Permit for the Mojave River Watershed. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the Phase II Small MS4 Permit and the intent of San Bernardino County (unincorporated areas of Phelan, Oak Hills, Spring Valley Lake and Victorville) and the incorporated cities of Hesperia and Victorville and the Town of Apple Valley. Once the undersigned transfers its interest in the property, its successors in interest and the city/county/town shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

| Project Data | | | |
|---|---|---|---|
| Permit/Application Number(s): | | Grading Permit Number(s): | |
| Tract/Parcel Map Number(s): | | Building Permit Number(s): | |
| CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract): | | | 3096-361-07 |

| Owner's Signature | | | |
|---|---|---|---|
| **Owner Name:** Debra Tarver | | | |
| Title | Owner | | |
| Company | Desert Trails Prepatory Academy | | |
| Address | 14530 Bellflower St., Adelanto, CA 92301 | | |
| Email | debbie.tarver@dtpacademy.com | | |
| Telephone # | 760-530-7680 | | |
| Signature | Debra Tarver<br>Debra Tarver (Sep 26, 2019) | Date | Sep 26, 2019 |

# Preparer's Certification

| Project Data | | | |
|---|---|---|---|
| Permit/Application Number(s): | | Grading Permit Number(s): | |
| Tract/Parcel Map Number(s): | | Building Permit Number(s): | |
| CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract): | | | 3096-361-07 |

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of the California State Water Resources Control Board Order No. 2013-0001-DWQ.

| **Engineer:** John H. Johnson | | PE Stamp Below |
|---|---|---|
| Title | Principal Engineer | |
| Company | Kolibrien Corp. | |
| Address | 27919 Jefferson Ave., STE. 201, Temecula, CA 92590 | |
| Email | info@kolibrien.biz | |
| Telephone # | 951-252-1034 | |
| Signature | | |
| Date | 9-26-19 | |

Exp. 9-30-2021

# Cert PWQMP

Final Audit Report 2019-09-27

| | |
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# Preparer's Certification

| Project Data | | | |
|---|---|---|---|
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| Tract/Parcel Map Number(s): | | Building Permit Number(s): | |
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| **Engineer:** John H. Johnson | | PE Stamp Below |
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| Address | 27919 Jefferson Ave., STE. 201, Temecula, CA 92590 | |
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| Telephone # | 951-252-1034 | |
| Signature | | |
| Date | 10/9/2019 | |

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# Section I – Introduction

This WQMP template has been prepared specifically for the Phase II Small MS4 General Permit in the Mojave River Watershed. This location is within the jurisdiction of the Lahontan Regional Water Quality Control Board (LRWQCB). This document should not be confused with the WQMP template for the Santa Ana Phase I area of San Bernardino County.

WQMP preparers must refer to the MS4 Permit for the Mojave Watershed WQMP template and Technical Guidance (TGD) document found at: http://cms.sbcounty.gov/dpw/Land/NPDES.aspx to find pertinent arid region and Mojave River Watershed specific references and requirements.

# Section 1 Discretionary Permit(s)

| Form 1-1 Project Information | | | | | |
|---|---|---|---|---|---|
| Project Name | Desert Trails Middle School | | | | |
| Project Owner Contact Name: | Desert Trails Prepatory Academy, Debra Tarver | | | | |
| Mailing Address: | 14530 Bellflower St., Adelanto, CA 92301 | E-mail Address: | | Telephone: | 760-530-7680 |
| Permit/Application Number(s): | | Tract/Parcel Map Number(s): | Parcel 4 o Map No. 2619 | | |
| Additional Information/ Comments: | South of Pepperwood Street, North of Forest Park Lane, East of Mesa View Dr. | | | | |
| Description of Project: | The project will construct a charter middle school. The project includes the main building, modular buildings, a trash enclosure, parking, fire access road, playground and landscaping. The project will also include all necessary infrastructure to support the facilities. | | | | |
| Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy. | The project constructs a middle school on an existing vacant lot. The site drains from the southwest corner to the northeast corner. The site will drain to inlets and to a storm drain system that conveys flow to stormwater retention basins to capture and treat site runoff.<br>The area of disturbance is 203,051 square feet. The existing site condition consists of 0 acres of impervious area and 4.66 acres of pervious area. The proposed site condition consists of 3.46 acres of impervious area and 1.20 acres of pervious area.<br>The site will be graded to drain away from the structures. Inlets are proposed at low points around the site and storm drain lines convey runoff to the proposed basins. Runoff will flow to the northeast corner to match the drainage pattern of the existing condition. | | | | |

# Section 2 Project Description

## 2.1 Project Information

The WQMP shall provide the information listed below. The information provided for Conceptual/ Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

### 2.1.1 Project Sizing Categorization

If the Project is greater than 5,000 square feet, and not on the excluded list as found on Section 1.4 of the TGD, the Project is a Regulated Development Project.

If the Project is creating and/or replacing greater than 2,500 square feet but less than 5,000 square feet of impervious surface area, then it is considered a Site Design Only project. This criterion is applicable to all development types including detached single family homes that create and/or replace greater than 2,500 square feet of impervious area and are not part of a larger plan of development.

**Form 2.1-1 Description of Proposed Project**

| | | | |
|---|---|---|---|
| **1** Regulated Development Project Category (Select all that apply): | | | |
| ☒ #1 New development involving the creation of 5,000 $ft^2$ or more of impervious surface collectively over entire site | ☐ #2 Significant re-development involving the addition or replacement of 5,000 $ft^2$ or more of impervious surface on an already developed site | ☐ #3 Road Project – any road, sidewalk, or bicycle lane project that creates greater than 5,000 square feet of contiguous impervious surface | ☐ #4 LUPs – linear underground/overhead projects that has a discrete location with 5,000 sq. ft. or more new constructed impervious surface |
| ☐ Site Design Only (Project Total Square Feet > 2,500 but < 5,000 sq.ft.) *Will require source control Site Design Measures. Use the "PCMP" Template. Do not use this WQMP Template.* | | | |

| | | | | | |
|---|---|---|---|---|---|
| **2** Project Area (ft2): | 203,051 | **3** Number of Dwelling Units: | | **4** SIC Code: | 821 |

**5** Is Project going to be phased? Yes ☐ No ☒ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*

## 2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

| Form 2.2-1 Property Ownership/Management |
| --- |
| Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities: |
| The property will be owned and managed by Desert Trails Prepatory Academy. Desert Trails Prepatory Academy will be responsible for long term maintenance of the WQMP stormwater facilities. |

## 2.3 Potential Stormwater Pollutants

Best Management Practices (BMP) measures for pollutant generating activities and sources shall be designed consistent with recommendations from the CASQA Stormwater BMP Handbook for New Development and Redevelopment (or an equivalent manual). Pollutant generating activities must be considered when determining the overall pollutants of concern for the Project as presented in Form 2.3-1.

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-2 in the TGD for WQMP).

**Form 2.3-1 Pollutants of Concern**

| Pollutant | Please check: E=Expected, N=Not Expected | | Additional Information and Comments |
|---|---|---|---|
| Pathogens (Bacterial / Virus) | E ☒ | N ☐ | |
| Nutrients - Phosphorous | E ☒ | N ☐ | |
| Nutrients - Nitrogen | E ☒ | N ☐ | |
| Noxious Aquatic Plants | E ☐ | N ☒ | |
| Sediment | E ☒ | N ☐ | |
| Metals | E ☐ | N ☒ | |
| Oil and Grease | E ☒ | N ☐ | |
| Trash/Debris | E ☒ | N ☐ | |
| Pesticides / Herbicides | E ☒ | N ☐ | |
| Organic Compounds | E ☒ | N ☐ | |
| Other: | E ☐ | N ☐ | |
| Other: | E ☐ | N ☐ | |
| Other: | E ☐ | N ☐ | |

# Section 3 Site and Watershed Description

Describe the project site conditions that will facilitate the selection of BMPs through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed Drainage Management Areas (DMAs)) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. The form below is provided as an example. Then complete Forms 3.2 and 3.3 for each DA on the project site. ***If the project has more than one drainage area for stormwater management, then complete additional versions of these forms for each DA / outlet. A map presenting the DMAs must be included as an appendix to the WQMP document.***

## Form 3-1 Site Location and Hydrologic Features

| | | | |
|---|---|---|---|
| Site coordinates *take GPS measurement at approximate center of site* | Latitude 34.4898 N | Longitude 117.4071 W | Thomas Bros Map page |
| **1** San Bernardino County climatic region: ☒ Desert | | | |
| **2** Does the site have more than one drainage area (DA): Yes☒ No☐ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached* | | | |
| | | | |
| Conveyance | All runoff is conveyed through the storm drain system to the bio-retention basins, so all runoff is retained within the DMAs. | | |
| | | | |

| Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1 | | | | |
|---|---|---|---|---|
| For Drainage Area 1's sub-watershed DMA, provide the following characteristics | DMA A | DMA B | DMA C | DMA D |
| **1** DMA drainage area ($ft^2$) | 65210 | 19594 | 78740 | 39506 |
| **2** Existing site impervious area ($ft^2$) | 0 | 0 | 0 | 0 |
| **3** Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf* | 2 | 2 | 2 | 2 |
| **4** Hydrologic soil group *Refer to County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf* | A | A | A | A |
| **5** Longest flowpath length (ft) | 781 | 180 | 559 | 338 |
| **6** Longest flowpath slope (ft/ft) | 0.0068 | 0.0257 | 0.0106 | 0.0074 |
| **7** Current land cover type(s) *Select from Fig C-3 of Hydrology Manual* | Brush | Brush | Brush | Brush |
| **8** Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50%* ***Attach photos of site to support rating*** | Fair | Fair | Fair | Fair |

| Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1 (use only as needed for additional DMA w/in DA 1) | | | | |
|---|---|---|---|---|
| For Drainage Area 1's sub-watershed DMA, provide the following characteristics | DMA E | DMA F | DMA G | DMA H |
| **1** DMA drainage area ($ft^2$) | | | | |
| **2** Existing site impervious area ($ft^2$) | | | | |
| **3** Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf* | | | | |
| **4** Hydrologic soil group *County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf* | | | | |
| **5** Longest flowpath length (ft) | | | | |
| **6** Longest flowpath slope (ft/ft) | | | | |
| **7** Current land cover type(s) *Select from Fig C-3 of Hydrology Manual* | | | | |
| **8** Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating* | | | | |

| Form 3-3 Watershed Description for Drainage Area | |
|---|---|
| Receiving waters<br>Refer to SWRCB site:<br>http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml | Mojave River to the East |
| Applicable TMDLs<br>*http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml* | None |
| 303(d) listed impairments<br>*http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml* | Mojave River Reservoid Outlet to Upper narrows: Flouride<br>Upper Narrows to Lower Narros: Flouride, Sulfates, Total Dissolved Soilds |
| Environmentally Sensitive Areas (ESA)<br>*Refer to Watershed Mapping Tool –*<br>*http://sbcounty.permitrack.com/WAP* | Desert Tortouise Habitat Cat 2 |
| Hydromodification Assessment | ☒ Yes *Complete Hydromodification Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-9 in submittal*<br>☐ No |

# Section 4 Best Management Practices (BMP)

## 4.1 Source Control BMPs and Site Design BMP Measures

The information and data in this section are required for both Regulated Development and Site Design Only Projects. Source Control BMPs and Site Design BMP Measures are the basis of site-specific pollution management.

### 4.1.1 Source Control BMPs

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

The identified list of source control BMPs correspond to the CASQA Stormwater BMP Handbook for New Development and Redevelopment.

## Form 4.1-1 Non-Structural Source Control BMPs

| Identifier | Name | Check One | | Describe BMP Implementation OR, if not applicable, state reason |
|---|---|---|---|---|
| | | Included | Not Applicable | |
| N1 | Education of Property Owners, Tenants and Occupants on Stormwater BMPs | ☒ | ☐ | |
| N2 | Activity Restrictions | ☒ | ☐ | |
| N3 | Landscape Management BMPs | ☒ | ☐ | |
| N4 | BMP Maintenance | ☒ | ☐ | |
| N5 | Title 22 CCR Compliance (How development will comply) | ☒ | ☐ | |
| N6 | Local Water Quality Ordinances | ☒ | ☐ | |
| N7 | Spill Contingency Plan | ☐ | ☒ | There are no activities that would require this at the school. |
| N8 | Underground Storage Tank Compliance | ☐ | ☒ | Underground storage tanks are not proposed. |
| N9 | Hazardous Materials Disclosure Compliance | ☐ | ☒ | There are no known hazardous materials on site. |

## Form 4.1-1 Non-Structural Source Control BMPs

| Identifier | Name | Check One | | Describe BMP Implementation OR, if not applicable, state reason |
|---|---|---|---|---|
| | | Included | Not Applicable | |
| N10 | Uniform Fire Code Implementation | ☒ | ☐ | |
| N11 | Litter/Debris Control Program | ☒ | ☐ | |
| N12 | Employee Training | ☒ | ☐ | |
| N13 | Housekeeping of Loading Docks | ☐ | ☒ | There are no loading docks |
| N14 | Catch Basin Inspection Program | ☒ | ☐ | |
| N15 | Vacuum Sweeping of Private Streets and Parking Lots | ☒ | ☐ | |
| N16 | Other Non-structural Measures for Public Agency Projects | ☐ | ☒ | N/A since this is not a public project. |
| N17 | Comply with all other applicable NPDES permits | ☒ | ☐ | |

# Form 4.1-2 Structural Source Control BMPs

| Identifier | Name | Check One | | Describe BMP Implementation OR, If not applicable, state reason |
|---|---|---|---|---|
| | | Included | Not Applicable | |
| S1 | Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13) | ☒ | ☐ | |
| S2 | Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34) | ☐ | ☒ | This is not in the proposed project. |
| S3 | Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32) | ☒ | ☐ | |
| S4 | Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12) | ☒ | ☐ | |
| S5 | Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement | ☒ | ☐ | |
| S6 | Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10) | ☒ | ☐ | |
| S7 | Covered dock areas (CASQA New Development BMP Handbook SD-31) | ☐ | ☒ | This is not in the proposed project. |
| S8 | Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31) | ☐ | ☒ | This is not in the proposed project. |
| S9 | Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33) | ☐ | ☒ | This is not in the proposed project. |
| S10 | Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36) | ☐ | ☒ | This is not in the proposed project. |

## Form 4.1-2 Structural Source Control BMPs

| Identifier | Name | Check One | | Describe BMP Implementation OR, If not applicable, state reason |
|---|---|---|---|---|
| | | Included | Not Applicable | |
| S11 | Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33) | ☐ | ☒ | This is not in the proposed project. |
| S12 | Fueling areas (CASQA New Development BMP Handbook SD-30) | ☐ | ☒ | This is not in the proposed project. |
| S13 | Hillside landscaping (CASQA New Development BMP Handbook SD-10) | ☐ | ☒ | This is not in the proposed project. |
| S14 | Wash water control for food preparation areas | ☐ | ☒ | This is not in the proposed project. |
| S15 | Community car wash racks (CASQA New Development BMP Handbook SD-33) | ☐ | ☒ | This is not in the proposed project. |

### 4.1.2 Site Design BMPs

As part of the planning phase of a project, the site design practices associated with new LID requirements in the Phase II Small MS4 Permit must be considered. Site design BMP measures can result in smaller Design Capture Volume (DCV) to be managed by both LID and hydromodification control BMPs by reducing runoff generation.

As is stated in the Permit, it is necessary to evaluate site conditions such as soil type(s), existing vegetation and flow paths will influence the overall site design.

Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

| Form 4.1-3 Site Design Practices Checklist |
|---|
| Site Design Practices<br>*If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets* |
| Minimize impervious areas: Yes ☒ No ☐<br>Explanation: The site was designed to have only the required parking, roads and facilities needed to meet space and code requirements. |
| Maximize natural infiltration capacity; Including improvement and maintenance of soil: Yes ☒ No ☐<br>Explanation: The site has a significant amount of landscaped areas and the proposed BMPs are bioretention basins which will infiltrate. |
| Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐<br>Explanation: Drainage follows the same pattern of flow from the Southwest corner of the site to the northeast corner. The drainage pattern is extend since flow is directed to the basins. |
| Disconnect impervious areas. Including rerouting of rooftop drainage pipes to drain stormwater to storage or infiltration BMPs instead of to storm drain : Yes ☒ No ☐<br>Explanation: Roof drains and all impervious areas go to the basins. |
| Use of Porous Pavement.: Yes ☐ No ☒<br>Explanation: N/A |
| Protect existing vegetation and sensitive areas: Yes ☒ No ☐<br>Explanation: Sensitive vegetation, such as Joshua Treas, is being relocated. |
| Re-vegetate disturbed areas. Including planting and preservation of drought tolerant vegetation. : Yes ☒ No ☐<br>Explanation: All disturbed areas are being landscaped. |

| |
|---|
| Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐<br>Explanation: Areas will be protected from compaction. |
| Utilize naturalized/rock-lined drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐<br>Explanation: Surface drainage will direct flows towards the basins using swales and curb and gutter. |
| Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☒ No ☐<br>Explanation: Areas will be protected from compaction. |
| Use of Rain Barrels and Cisterns, Including the use of on-site water collection systems.: Yes ☐ No ☒<br>Explanation: N/A |
| Stream Setbacks. Includes a specified distance from an adjacent steam: : Yes ☐ No ☒<br>Explanation: N/A |

It is noted that, in the Phase II Small MS4 Permit, site design elements for green roofs and vegetative swales are required. Due to the local climatology in the Mojave River Watershed, proactive measures are taken to maximize the amount of drought tolerant vegetation. It is not practical in this region to have green roofs or vegetative swales. As part of site design the project proponent should utilize locally recommended vegetation types for landscaping. Typical landscaping recommendations are found in following local references:

**San Bernardino County Special Districts:**

Guide to High Desert Landscaping -
http://www.specialdistricts.org/Modules/ShowDocument.aspx?documentid=795

Recommended High-Desert Plants -
http://www.specialdistricts.org/modules/showdocument.aspx?documentid=553

**Mojave Water Agency:**

Desert Ranch: http://www.mojavewater.org/files/desertranchgardenprototype.pdf

Summertree: http://www.mojavewater.org/files/Summertree-Native-Plant-Brochure.pdf

Thornless Garden: http://www.mojavewater.org/files/thornlessgardenprototype.pdf

Mediterranean Garden: http://www.mojavewater.org/files/mediterraneangardenprototype.pdf

Lush and Efficient Garden: http://www.mojavewater.org/files/lushandefficientgardenprototype.pdf

Alliance for Water Awareness and Conservation (AWAC) outdoor tips – http://hdawac.org/save-outdoors.html

# 4.2 Treatment BMPs

After implementation and design of both Source Control BMPs and Site Design BMP measures, any remaining runoff from impervious DMAs must be directed to one or more on-site, treatment BMPs (LID or biotreatment) designed to infiltrate, evaportranspire, and/or bioretain the amount of runoff specified in Permit Section E.12.e (ii)(c) Numeric Sizing Criteria for Storm Water Retention and Treatment.

## 4.2.1 Project Specific Hydrology Characterization

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in Section E.12.e.ii.c and Section E.12.f of the Phase II Small MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection from hydromodification.

***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

***It is noted that in the Phase II Small MS4 Permit jurisdictions, the LID BMP Design Capture Volume criteria is based on the 2-year rain event. The hydromodification performance criterion is based on the 10-year rain event.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), San Bernardino County requires use of the $P_6$ method (Form 4.2-1) For pre- and post-development hydrologic calculation, San Bernardino County requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 $mi^2$), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for hydromodification performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

| Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1) | | |
|---|---|---|
| [1] Project area DA 1 ($ft^2$): 203050 | [2] Imperviousness after applying preventative site design practices (Imp%): 0.74 | [3] Runoff Coefficient (Rc): _0.535<br>*$R_c = 0.858(Imp\%)^3 - 0.78(Imp\%)^2 + 0.774(Imp\%) + 0.04$* |
| [4] Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.391 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html | | |
| [5] Compute $P_6$, Mean 6-hr Precipitation (inches): 0.484<br>*$P_6$ = Item 4 * $C_1$, where $C_1$ is a function of site climatic region specified in Form 3-1 Item 1 ( Desert = 1.2371)* | | |
| [6] Drawdown Rate<br>*Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.* | | 24-hrs ☐<br>48-hrs ☒ |
| [7] Compute design capture volume, DCV ($ft^3$): 8601<br>*DCV = 1/12 * [Item 1* Item 3 *Item 5 * $C_2$], where $C_2$ is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)*<br>*Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2* | | |

## Form 4.2-2 Summary of Hydromodification Assessment (DA 1)

Is the change in post- and pre- condition flows captured on-site? : Yes ☒ No ☐

If "Yes", then complete Hydromodification assessment of site hydrology for 10yr storm event using Forms 4.2-3 through 4.2-5 and insert results below *(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual- Addendum 1)*

If "No," then proceed to Section 4.3 BMP Selection and Sizing

| Condition | Runoff Volume ($ft^3$) | Time of Concentration (min) | Peak Runoff (cfs) |
|---|---|---|---|
| Pre-developed | [1] 1178<br>*Form 4.2-3 Item 12* | [2] 24.2<br>*Form 4.2-4 Item 13* | [3] 2.64<br>*Form 4.2-5 Item 10* |
| Post-developed | [4] 14839<br>*Form 4.2-3 Item 13* | [5] 19.56<br>*Form 4.2-4 Item 14* | [6] 6.92<br>*Form 4.2-5 Item 14* |
| Difference | [7] *13658*<br>*Item 4 – Item 1* | [8] *4.64*<br>*Item 2 – Item 5* | [9] *4.28*<br>*Item 6 – Item 3* |
| Difference (as % of pre-developed) | [10] *1159%*<br>*Item 7 / Item 1* | [11] *19.2%*<br>*Item 8 / Item 2* | [12] *162%*<br>*Item 9 / Item 3* |

# Form 4.2-3 Hydromodification Assessment for Runoff Volume (DA 1)

| **Weighted Curve Number Determination for: Pre-developed DA** | DMA A | DMA B | DMA C | DMA D | DMA E | DMA F | DMA G | DMA H |
|---|---|---|---|---|---|---|---|---|
| **1a** Land Cover type | Grass | | | | | | | |
| **2a** Hydrologic Soil Group (HSG) | A | | | | | | | |
| **3a** DMA Area, $ft^2$ *sum of areas of DMA should equal area of DA* | 203050 | | | | | | | |
| **4**a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP* | 50 | | | | | | | |
| **Weighted Curve Number Determination for: Post-developed DA** | DMA A | DMA B | DMA C | DMA D | DMA E | DMA F | DMA G | DMA H |
| **1b** Land Cover type | Commerci | Lanscapin | | | | | | |
| **2b** Hydrologic Soil Group (HSG) | A | A | | | | | | |
| **3b** DMA Area, $ft^2$ *sum of areas of DMA should equal area of DA* | 150506 | 52544 | | | | | | |
| **4b** Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP* | 90 | 32 | | | | | | |

| | | |
|---|---|---|
| **5** Pre-Developed area-weighted CN: 50 | **7** Pre-developed soil storage capacity, S (in): 10<br>*S = (1000 / Item 5) - 10* | **9** Initial abstraction, $I_a$ (in): 2<br>*$I_a$ = 0.2 * Item 7* |
| **6** Post-Developed area-weighted CN: 75 | **8** Post-developed soil storage capacity, S (in): 3.33<br>*S = (1000 / Item 6) - 10* | **10** Initial abstraction, $I_a$ (in): 0.67<br>*$I_a$ = 0.2 * Item 8* |

**11** Precipitation for 10 yr, 24 hr storm (in): 2.87
*Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*

**12** Pre-developed Volume ($ft^3$): 1178
*$V_{pre}$ =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

**13** Post-developed Volume ($ft^3$): 14839
*$V_{pre}$ =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

**14** Volume Reduction needed to meet hydromodification requirement, ($ft^3$): 12916
*Vhydro = (Item 13 * 0.95) – Item 12*

# Form 4.2-4 Hydromodification Assessment for Time of Concentration (DA 1)

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

| Variables | Pre-developed DA1 *Use additional forms if there are more than 4 DMA* | | | | Post-developed DA1 *Use additional forms if there are more than 4 DMA* | | | |
|---|---|---|---|---|---|---|---|---|
| | DMA A | DMA B | DMA C | DMA D | DMA A | DMA B | DMA C | DMA D |
| **1** Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition* | 737 | | | | 1370 | | | |
| **2** Change in elevation (ft) | 8 | | | | 7 | | | |
| **3** Slope (ft/ft), *$S_o$ = Item 2 / Item 1* | 0.0109 | | | | 0.0051 | | | |
| **4** Land cover | Grass/brush | | | | Pavement | | | |
| **5** Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP* | 24.2 | | | | 19.56 | | | |
| **6** Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet* | 0 | | | | 0 | | | |
| **7** Cross-sectional area of channel ($ft^2$) | | | | | | | | |
| **8** Wetted perimeter of channel (ft) | | | | | | | | |
| **9** Manning's roughness of channel (n) | | | | | | | | |
| **10** Channel flow velocity (ft/sec) *$V_{fps}$ = (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5* | | | | | | | | |
| **11** Travel time to outlet (min) *$T_t$ = Item 6 / (Item 10 * 60)* | 0 | | | | 0 | | | |
| **12** Total time of concentration (min) *$T_c$ = Item 5 + Item 11* | 24.2 | | | | 19.56 | | | |

**13** Pre-developed time of concentration (min): 24.2 *Minimum of Item 12 pre-developed DMA*

**14** Post-developed time of concentration (min): 19.56 *Minimum of Item 12 post-developed DMA*

**15** Additional time of concentration needed to meet hydromodification requirement (min): 3.43 *$T_{C\text{-}Hydro}$ = (Item 13 * 0.95) – Item 14*

# Form 4.2-5 Hydromodification Assessment for Peak Runoff (DA 1)

Compute peak runoff for pre- and post-developed conditions

| Variables | | Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)* | | | Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)* | | |
|---|---|---|---|---|---|---|---|
| | | DMA A | DMA B | DMA C | DMA A | DMA B | DMA C |
| **1** Rainfall Intensity for storm duration equal to time of concentration<br>*$I_{peak}$ = 10^(LOG Form 4.2-1 Item 4 - 0.7 LOG Form 4.2-4 Item 5 /60)* | | 1.45 | | | 1.9 | | |
| **2** Drainage Area of each DMA (Acres)<br>*For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)* | | 4.66 | | | 4.66 | | |
| **3** Ratio of pervious area to total area<br>*For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)* | | 1 | | | 0.26 | | |
| **4** Pervious area infiltration rate (in/hr)<br>*Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP* | | 0.82 | | | 0.96 | | |
| **5** Maximum loss rate (in/hr)<br>*$F_m$ = Item 3 * Item 4*<br>*Use area-weighted $F_m$ from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)* | | 0.82 | | | 0.25 | | |
| **6** Peak Flow from DMA (cfs)<br>*$Q_p$ =Item 2 * 0.9 * (Item 1 - Item 5)* | | 2.64 | | | 6.92 | | |
| **7** Time of concentration adjustment factor for other DMA to site discharge point<br>*Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)* | DMA A | *n/a* | | | *n/a* | | |
| | DMA B | | *n/a* | | | *n/a* | |
| | DMA C | | | *n/a* | | | *n/a* |

| | | |
|---|---|---|
| **8** Pre-developed $Q_p$ at $T_c$ for DMA A: 2.64 *$Q_p$ = Item $6_{DMAA}$ + [Item $6_{DMAB}$ * (Item $1_{DMAA}$ - Item $5_{DMAB}$)/(Item $1_{DMAB}$ - Item $5_{DMAB}$)* Item $7_{DMAA/2}$] + [Item $6_{DMAC}$ * (Item $1_{DMAA}$ - Item $5_{DMAC}$)/(Item $1_{DMAC}$ - Item $5_{DMAC}$)* Item $7_{DMAA/3}$]* | **9** Pre-developed $Q_p$ at $T_c$ for DMA B: *$Q_p$ = Item $6_{DMAB}$ + [Item $6_{DMAA}$ * (Item $1_{DMAB}$ - Item $5_{DMAA}$)/(Item $1_{DMAA}$ - Item $5_{DMAA}$)* Item $7_{DMAB/1}$] + [Item $6_{DMAC}$ * (Item $1_{DMAB}$ - Item $5_{DMAC}$)/(Item $1_{DMAC}$ - Item $5_{DMAC}$)* Item $7_{DMAB/3}$]* | **10** Pre-developed $Q_p$ at $T_c$ for DMA C: *$Q_p$ = Item $6_{DMAC}$ + [Item $6_{DMAA}$ * (Item $1_{DMAC}$ - Item $5_{DMAA}$)/(Item $1_{DMAA}$ - Item $5_{DMAA}$)* Item $7_{DMAC/1}$] + [Item $6_{DMAB}$ * (Item $1_{DMAC}$ - Item $5_{DMAB}$)/(Item $1_{DMAB}$ - Item $5_{DMAB}$)* Item $7_{DMAC/2}$]* |
| **10** Peak runoff from pre-developed condition confluence analysis (cfs): 2.64 *Maximum of Item 8, 9, and 10 (including additional forms as needed)* | | |
| **11** Post-developed $Q_p$ at $T_c$ for DMA A: 6.92<br>*Same as Item 8 for post-developed values* | **12** Post-developed $Q_p$ at $T_c$ for DMA B:<br>*Same as Item 9 for post-developed values* | **13** Post-developed $Q_p$ at $T_c$ for DMA C:<br>*Same as Item 10 for post-developed values* |
| **14** Peak runoff from post-developed condition confluence analysis (cfs): 6.92 *Maximum of Item 11, 12, and 13 (including additional forms as needed)* | | |
| **15** Peak runoff reduction needed to meet Hydromodification Requirement (cfs): 3.93 *$Q_{p\text{-}hydro}$ = (Item 14 * 0.95) – Item 10* | | |

# 4.3 BMP Selection and Sizing

Complete the following forms for each project site DA to document that the proposed treatment (LID/Bioretention) BMPs conform to the project DCV developed to meet performance criteria specified in the Phase II Small MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the Phase II Small MS4 Permit (see Section 5.3 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design Measures (Form 4.3-2)
- Retention and Infiltration BMPs (Form 4.3-3) or
- Biotreatment BMPs (Form 4.3-4).

Please note that the selected BMPs may also be used as dual purpose for on-site, hydromodification mitigation and management.

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is “Yes,” provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Form 4.3-2 to determine the feasibility of applicable Site Design BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable Site Design BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of site design, retention and/or infiltration BMPs is unable to mitigate the entire DCV, then the remainder of the volume-based performance criteria that cannot be achieved with site design, retention and/or infiltration BMPs must be managed through biotreatment BMPs. If biotreatment BMPs are used, then they must be sized to provide equivalent effectiveness based on Template Section 4.3.4.

### 4.3.1 Exceptions to Requirements for Bioretention Facilities

Contingent on a demonstration that use of bioretention or a facility of equivalent effectiveness is infeasible, other types of biotreatment or media filters (such as tree-box-type biofilters or in-vault media filters) may be used for the following categories of Regulated Projects:

1) Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district (i.e., smart growth projects), and having at least 85% of the entire project site covered by permanent structures;

2) Facilities receiving runoff solely from existing (pre-project) impervious areas; and

3) Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

| Form 4.3-1 Infiltration BMP Feasibility (DA 1) |
|---|
| Feasibility Criterion – Complete evaluation for each DA on the Project Site |
| [1] Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒<br>*Refer to Section 5.3.2.1 of the TGD for WQMP* |
| If Yes, Provide basis: (attach) |
| [2] Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒<br>(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):<br>• The location is less than 50 feet away from slopes steeper than 15 percent<br>• The location is less than ten feet from building foundations or an alternative setback.<br>• A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards. |
| If Yes, Provide basis: (attach) |
| [3] Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒ |
| If Yes, Provide basis: (attach) |
| [4] Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒ |
| If Yes, Provide basis: (attach) |
| [5] Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☐ No ☒ |
| If Yes, Provide basis: (attach) |
| [6] Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒<br>*See Section 3.5 of the TGD for WQMP and WAP* |
| If Yes, Provide basis: (attach) |
| [7] Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒<br>*If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Selection and Evaluation of Biotreatment BMP.*<br>*If no, then proceed to Item 8 below.*<br>[8] Any answer from Item 4 through Item 6 is "Yes": Yes ☐ No ☒<br>*If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Site Design BMP.*<br>*If no, then proceed to Item 9, below.*<br>[9] All answers to Item 1 through Item 6 are "No":<br>*Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.*<br>*Proceed to Form 4.3-2, Site Design BMPs.* |

## 4.3.2 Site Design BMP

Section E.12.e. of the Small Phase II MS4 Permit emphasizes the use of LID preventative measures; and the use of Site Design Measures reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable Site Design Measures shall be provided except where they are mutually exclusive

with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of Site Design BMPs. If a project cannot feasibly meet BMP sizing requirements or cannot fully address hydromodification, feasibility of all applicable Site Design BMPs must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design BMP. Refer to Section 5.4 in the TGD for more detailed guidance.

| **Form 4.3-2 Site Design BMPs (DA 1)** | | | |
|---|---|---|---|
| **1** Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ *If yes, complete Items 2-5; If no, proceed to Item 6* | DA DMA BMP Type | DA DMA BMP Type | DA DMA BMP Type *(Use additional forms for more BMPs)* |
| **2** Total impervious area draining to pervious area ($ft^2$) | | | |
| **3** Ratio of pervious area receiving runoff to impervious area | | | |
| **4** Retention volume achieved from impervious area dispersion ($ft^3$) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff* | | | |
| **5** Sum of retention volume achieved from impervious area dispersion ($ft^3$): *$V_{retention}$ =Sum of Item 4 for all BMPs* | | | |
| **6** Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14* | DA DMA BMP Type | DA DMA BMP Type | DA DMA BMP Type *(Use additional forms for more BMPs)* |
| **7** Ponding surface area ($ft^2$) | | | |
| **8** Ponding depth (ft) (min. 0.5 ft.) | | | |
| **9** Surface area of amended soil/gravel ($ft^2$) | | | |
| **10** Average depth of amended soil/gravel (ft) (min. 1 ft.) | | | |
| **11** Average porosity of amended soil/gravel | | | |
| **12** Retention volume achieved from on-lot infiltration ($ft^3$) *$V_{retention}$ = (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)* | | | |
| **13** Runoff volume retention from on-lot infiltration ($ft^3$): 0 *$V_{retention}$ =Sum of Item 12 for all BMPs* | | | |

## Form 4.3-2 cont. Site Design BMPs (DA 1)

| | | | |
|---|---|---|---|
| **14** Implementation of Street Trees: Yes ☐ No ☒<br>*If yes, complete Items 14-18. If no, proceed to Item 19* | DA DMA<br>BMP Type | DA DMA<br>BMP Type | DA DMA<br>BMP Type<br>*(Use additional forms for more BMPs)* |
| **15** Number of Street Trees | | | |
| **16** Average canopy cover over impervious area ($ft^2$) | | | |
| **17** Runoff volume retention from street trees ($ft^3$)<br>*$V_{retention}$ = Item 15 * Item 16 * (0.05/12) assume runoff retention of 0.05 inches* | | | |
| **18** Runoff volume retention from street tree BMPs ($ft^3$): 0 *$V_{retention}$ = Sum of Item 17 for all BMPs* | | | |
| **19** Total Retention Volume from Site Design BMPs: 0 *Sum of Items 5, 13 and 18* | | | |

### 4.3.3 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix C of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

#### 4.3.3.1 Allowed Variations for Special Site Conditions

The bioretention system design parameters of this Section may be adjusted for the following special site conditions:

1) Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.

2) Facilities with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).

3) Facilities located in areas of high groundwater, highly infiltrative soils or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.

4) Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide adequate pretreatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with no chance of spill migration.

.

# Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 1)

| | | | |
|---|---|---|---|
| **1** Remaining LID DCV not met by site design BMP ($ft^3$): 8601 *$V_{unmet}$ = Form 4.2-1 Item 7 - Form 4.3-2 Item19* | | | |
| BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs* | DA 1 DMA A BMP Type Bioretention | DA 1 DMA B BMP Type Bioretention | DA 1 DMA C BMP Type Bioretention *(Use additional forms for more BMPs)* |
| **2** Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix C of the TGD for WQMP for minimum requirements for assessment methods* | 1.1 | 1.1 | 1.1 |
| **3** Infiltration safety factor *See TGD Section 5.4.2 and Appendix D* | 1.5 | 1.5 | 1.5 |
| **4** Design percolation rate (in/hr) *$P_{design}$ = Item 2 / Item 3* | 0.74 | 0.74 | 0.74 |
| **5** Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1* | 48 | 48 | 48 |
| **6** Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details* | .5 | .5 | .5 |
| **7** Ponding Depth (ft) *$d_{BMP}$ = Minimum of (1/12*Item 4*Item 5) or Item 6* | .5 | .5 | .5 |
| **8** Infiltrating surface area, $SA_{BMP}$ ($ft^2$) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP* | 1486 | 1486 | 3106 |
| **9** Amended soil depth, $d_{media}$ (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details* | 2 | 2 | 2 |
| **10** Amended soil porosity | .3 | .3 | .3 |
| **11** Gravel depth, $d_{media}$ (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details* | 1 | 1 | 1 |
| **12** Gravel porosity | .4 | .4 | .4 |
| **13** Duration of storm as basin is filling (hrs) *Typical ~ 3hrs* | 3 | 3 | 3 |
| **14** Above Ground Retention Volume ($ft^3$) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]* | 2504 | 2504 | 5234 |
| **15** Underground Retention Volume ($ft^3$) *Volume determined using manufacturer's specifications and calculations* | | | |
| **16** Total Retention Volume from LID Infiltration BMPs: 15799 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)* | | | |
| **17** Fraction of DCV achieved with infiltration BMP: 184% *Retention% = Item 16 / Form 4.2-1 Item 7* | | | |
| **18** Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☒ No ☐ *If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.* | | | |

# Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 1)

| | | | |
|---|---|---|---|
| **1** Remaining LID DCV not met by site design BMP ($ft^3$): 8601 *$V_{unmet}$ = Form 4.2-1 Item 7 - Form 4.3-2 Item19* | | | |
| BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs* | DA 1 DMA D BMP Type BIORETENTION | DA DMA BMP Type | DA DMA BMP Type *(Use additional forms for more BMPs)* |
| **2** Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix C of the TGD for WQMP for minimum requirements for assessment methods* | 1.1 | | |
| **3** Infiltration safety factor *See TGD Section 5.4.2 and Appendix D* | 1.5 | | |
| **4** Design percolation rate (in/hr) *$P_{design}$ = Item 2 / Item 3* | 0.74 | | |
| **5** Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1* | 48 | | |
| **6** Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details* | 0.5 | | |
| **7** Ponding Depth (ft) *$d_{BMP}$ = Minimum of (1/12*Item 4*Item 5) or Item 6* | 0.5 | | |
| **8** Infiltrating surface area, $SA_{BMP}$ ($ft^2$) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP* | 3298 | | |
| **9** Amended soil depth, $d_{media}$ (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details* | 2 | | |
| **10** Amended soil porosity | 0.3 | | |
| **11** Gravel depth, $d_{media}$ (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details* | 1 | | |
| **12** Gravel porosity | 0.4 | | |
| **13** Duration of storm as basin is filling (hrs) *Typical ~ 3hrs* | 3 | | |
| **14** Above Ground Retention Volume ($ft^3$) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]* | 5557 | | |
| **15** Underground Retention Volume ($ft^3$) *Volume determined using manufacturer's specifications and calculations* | | | |
| **16** Total Retention Volume from LID Infiltration BMPs: 15799 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)* | | | |
| **17** Fraction of DCV achieved with infiltration BMP: 184% *Retention% = Item 16 / Form 4.2-1 Item 7* | | | |
| **18** Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☒ No ☐ *If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.* | | | |

### 4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-4 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV. Biotreatment computations are included as follows:

- Use Form 4.3-5 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-6 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-7 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

**Form 4.3-4 Selection and Evaluation of Biotreatment BMP (DA 1)**

| | | |
|---|---|---|
| **1** Remaining LID DCV not met by site design , or infiltration, BMP for potential biotreatment ($ft^3$): 0 *Form 4.2-1 Item 7 - Form 4.3-2 Item 19 – Form 4.3-3 Item 16* | List pollutants of concern *Copy from Form 2.3-1.* | |
| **2** Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)* | Volume-based biotreatment *Use Forms 4.3-5 and 4.3-6 to compute treated volume* | Flow-based biotreatment *Use Form 4.3-7 to compute treated flow* |
| | ☐ Bioretention with underdrain<br>☐ Planter box with underdrain<br>☐ Constructed wetlands<br>☐ Wet extended detention<br>☐ Dry extended detention | ☐ Vegetated swale<br>☐ Vegetated filter strip<br>☐ Proprietary biotreatment |
| **3** Volume biotreated in volume based biotreatment BMP ($ft^3$): *Form 4.3-5 Item 15 + Form 4.3-6 Item 13* | **4** Compute remaining LID DCV with implementation of volume based biotreatment BMP ($ft^3$): *Item 1 – Item 3* | **5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % *Item 4 / Item 1* |
| **6** Flow-based biotreatment BMP capacity provided (cfs): *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)* | | |
| **7** Metrics for MEP determination:<br>• Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.* | | |

# Form 4.3-5 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains

| Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)* | DA DMA BMP Type | DA DMA BMP Type | DA DMA BMP Type *(Use additional forms for more BMPs)* |
|---|---|---|---|
| **1** Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP* | | | |
| **2** Amended soil infiltration rate *Typical ~ 5.0* | | | |
| **3** Amended soil infiltration safety factor *Typical ~ 2.0* | | | |
| **4** Amended soil design percolation rate (in/hr) $P_{design}$ *= Item 2 / Item 3* | | | |
| **5** Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1* | | | |
| **6** Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **7** Ponding Depth (ft) $d_{BMP}$ *= Minimum of (1/12 * Item 4 * Item 5) or Item 6* | | | |
| **8** Amended soil surface area ($ft^2$) | | | |
| **9** Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **10** Amended soil porosity, *n* | | | |
| **11** Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **12** Gravel porosity, *n* | | | |
| **13** Duration of storm as basin is filling (hrs) *Typical ~ 3hrs* | | | |
| **14** Biotreated Volume ($ft^3$) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]* | | | |
| **15** Total biotreated volume from bioretention and/or planter box with underdrains BMP: *Sum of Item 14 for all volume-based BMPs included in this form* | | | |

# Form 4.3-6 Volume Based Biotreatment (DA 1) – Constructed Wetlands and Extended Detention

| Biotreatment BMP Type<br>*Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (E.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.* | DA DMA<br>BMP Type | | DA DMA<br>BMP Type<br>*(Use additional forms for more BMPs)* | |
|---|---|---|---|---|
| | Forebay | Basin | Forebay | Basin |
| **1** Pollutants addressed with BMP forebay and basin<br>*List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP* | | | | |
| **2** Bottom width (ft) | | | | |
| **3** Bottom length (ft) | | | | |
| **4** Bottom area ($ft^2$) $A_{bottom}$ = *Item 2 * Item 3* | | | | |
| **5** Side slope (ft/ft) | | | | |
| **6** Depth of storage (ft) | | | | |
| **7** Water surface area ($ft^2$)<br>$A_{surface}$ =*(Item 2 + (2 * Item 5 * Item 6)) * (Item 3 + (2 * Item 5 * Item 6))* | | | | |
| **8** Storage volume ($ft^3$) *For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details*<br>V =*Item 6 / 3 * [Item 4 + Item 7 + (Item 4 * Item 7)^0.5]* | | | | |
| **9** Drawdown Time (hrs) *Copy Item 6 from Form 2.1* | | | | |
| **10** Outflow rate (cfs) $Q_{BMP}$ = *(Item* $8_{forebay}$ *+ Item* $8_{basin}$*) / (Item 9 * 3600)* | | | | |
| **11** Duration of design storm event (hrs) | | | | |
| **12** Biotreated Volume ($ft^3$)<br>$V_{biotreated}$ = *(Item* $8_{forebay}$ *+ Item* $8_{basin}$*) +( Item 10 * Item 11 * 3600)* | | | | |
| **13** Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention :<br>*(Sum of Item 12 for all BMP included in plan)* | | | | |

# Form 4.3-7 Flow Based Biotreatment (DA 1)

| Biotreatment BMP Type<br>*Vegetated swale, vegetated filter strip, or other comparable proprietary BMP* | DA DMA<br>BMP Type | DA DMA<br>BMP Type | DA DMA<br>BMP Type<br>*(Use additional forms for more BMPs)* |
|---|---|---|---|
| **1** Pollutants addressed with BMP<br>*List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5* | | | |
| **2** Flow depth for water quality treatment (ft)<br>*BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **3** Bed slope (ft/ft)<br>*BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **4** Manning's roughness coefficient | | | |
| **5** Bottom width (ft)<br>$b_w$ *= (Form 4.3-5 Item 6 * Item 4) / (1.49 * Item 2^1.67 * Item 3^0.5)* | | | |
| **6** Side Slope (ft/ft)<br>*BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **7** Cross sectional area ($ft^2$)<br>*A = (Item 5 * Item 2) + (Item 6 * Item 2^2)* | | | |
| **8** Water quality flow velocity (ft/sec)<br>*V = Form 4.3-5 Item 6 / Item 7* | | | |
| **9** Hydraulic residence time (min)<br>*Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details* | | | |
| **10** Length of flow based BMP (ft)<br>*L = Item 8 * Item 9 * 60* | | | |
| **11** Water surface area at water quality flow depth ($ft^2$)<br>$SA_{top}$ *= (Item 5 + (2 * Item 2 * Item 6)) * Item 10* | | | |

### 4.3.5 Conformance Summary

Complete Form 4.3-8 to demonstrate how on-site LID DCV is met with proposed site design, infiltration, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

**Form 4.3-8 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)**

**1** Total LID DCV for the Project DA-1 ($ft^3$): 8601 *Copy Item 7 in Form 4.2-1*

**2** On-site retention with site design BMP ($ft^3$): *Copy Item18 in Form 4.3-2*

**3** On-site retention with LID infiltration BMP ($ft^3$): 15799 *Copy Item 16 in Form 4.3-3*

**4** On-site biotreatment with volume based biotreatment BMP ($ft^3$): *Copy Item 3 in Form 4.3-4*

**5** Flow capacity provided by flow based biotreatment BMP (cfs): *Copy Item 6 in Form 4.3-4*

**6** LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design or infiltration BMP: Yes ☒ No ☐
  *If yes, sum of Items 2, 3, and 4 is greater than Item 1*
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☐
  *If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized*
- On-site retention and infiltration is determined to be infeasible; therefore biotreatment BMP provides biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☐
  *If yes, Form 4.3-1 Items 7 and 8 were both checked yes*

**7** If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of Site Design, retention and infiltration, , and biotreatment BMPs provide less than full LID DCV capture: ☐
  *Checked yes if Form 4.3-4 Item 7is checked yes, Form 4.3-4 Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance,* $V_{alt}$ *= (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*

- Facilities, or a combination of facilities, of a different design than in Section E.12.e.(ii)(f) may be permitted if all of the following Phase II Small MS4 General Permit 2013-0001-DWQ 55 February 5, 2013 measures of equivalent effectiveness are demonstrated:
  1) Equal or greater amount of runoff infiltrated or evapotranspired; ☐
  2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment; ☐
  3) Equal or greater protection against shock loadings and spills; ☐
  4) Equal or greater accessibility and ease of inspection and maintenance. ☐

### 4.3.6 Hydromodification Control BMP

Use Form 4.3-9 to compute the remaining runoff volume retention, after Site Design BMPs are implemented, needed to address hydromodification, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential hydromodification. Describe the proposed hydromodification treatment control BMP. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

| Form 4.3-9 Hydromodification Control BMPs (DA 1) | |
|---|---|
| **1** Volume reduction needed for hydromodification performance criteria ($ft^3$): 12917<br>*(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1* | **2** On-site retention with site design and infiltration, BMP ($ft^3$): 15799 *Sum of Form 4.3-8 Items 2, 3, and 4. Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving hydromodification volume reduction* |
| **3** Remaining volume for hydromodification volume capture ($ft^3$): -2882 *Item 1 – Item 2* | **4** Volume capture provided by incorporating additional on-site BMPs ($ft^3$): |
| **5** Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒<br>*If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:*<br>• Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site BMP ☒<br>• Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐ | |
| **6** Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒<br>*If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:*<br>• Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site retention BMPs ☒ | |

## 4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance.

Alternative Designs — Facilities, or a combination of facilities, of a different design than in Permit Section E.12.e.(ii)(f) may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

1) Equal or greater amount of runoff infiltrated or evapotranspired;

2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;

3) Equal or greater protection against shock loadings and spills;

4) Equal or greater accessibility and ease of inspection and maintenance.

The Project Proponent will need to obtain written approval for an alternative design from the Lahontan Regional Water Board Executive Officer (see Section 6 of the TGD for WQMP).

# Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMPs included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and a Maintenance Agreement. The Maintenance Agreement must also be attached to the WQMP.

Note that at time of Project construction completion, the Maintenance Agreement must be completed, signed, notarized and submitted to the County Stormwater Department

**Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)**

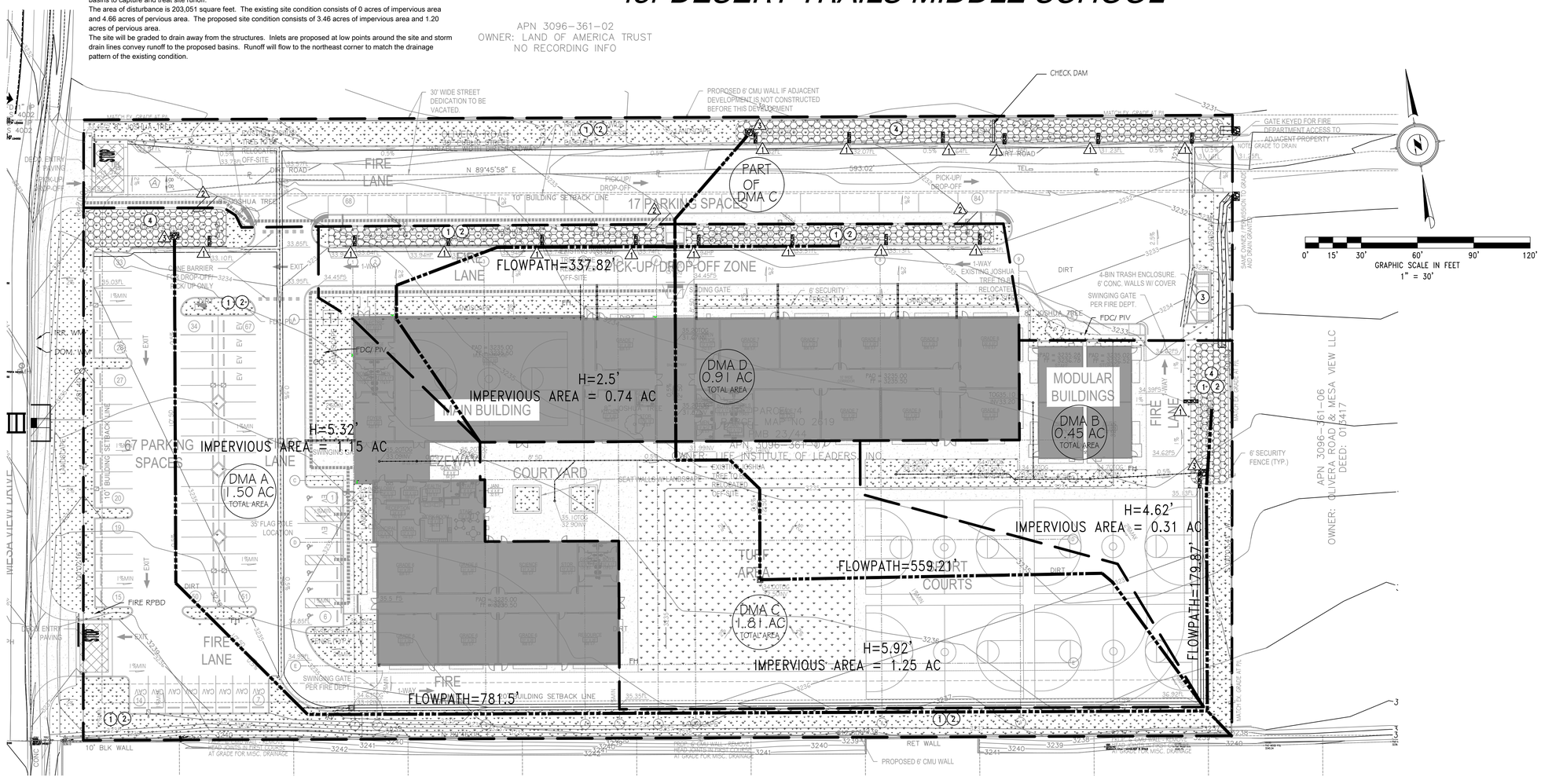
| BMP | Reponsible Party(s) | Inspection/ Maintenance Activities Required | Minimum Frequency of Activities |
|---|---|---|---|
| SD-10 | Desert Trails Prepatory Academy | Maintain Landscaping and stabilize any eroded areas. | Weekly and after storm events |
| SD-12 | Desert Trails Prepatory Academy | Check irrigation systems and repair as needed. | Monthly |
| SD-32 | Desert Trails Prepatory Academy | Check trash area and enclosure, repair as needed. Keep clean. | Weekly |
| TC-32 | Desert Trails Prepatory Academy | Maintain Landscaping and stabilize any eroded areas. Remove trash and debris. Remove Sediment. Check ponding time. | Weekly and after storm events |
| | | | |
| | | | |
| | | | |
| | | | |

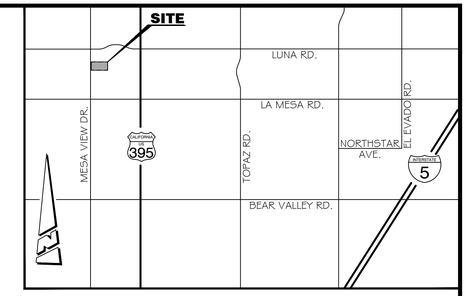
# Section 6 WQMP Attachments

# SECTION 6.1
# WQMP MAP

# LID BMP SITE MAP
## for DESERT TRAILS MIDDLE SCHOOL

Notes:
The project constructs a middle school on an existing vacant lot. The site drains from the southwest corner to the northeast corner. The site will drain to inlets and to a storm drain system that conveys flow to stormwater retention basins to capture and treat site runoff.
The area of disturbance is 203,051 square feet. The existing site condition consists of 0 acres of impervious area and 4.66 acres of pervious area. The proposed site condition consists of 3.46 acres of impervious area and 1.20 acres of pervious area.
The site will be graded to drain away from the structures. Inlets are proposed at low points around the site and storm drain lines convey runoff to the proposed basins. Runoff will flow to the northeast corner to match the drainage pattern of the existing condition.




VICINITY MAP
NOT TO SCALE

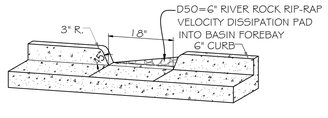
## SITE ADDRESS:
MESA VIEW DRIVE, VICTORVILLE, CA 92392
SOUTH OF PEPPERWOOD STREET, NORTH OF FOREST PARK LANE, EAST OF MESA VIEW DRIVE

## ASSESSOR'S PARCEL NO.:
3096-361-07

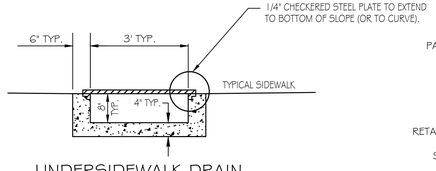
## FLOOD ZONE DESIGNATION:
THIS PROPERTY IS IN FLOODWAY AREA ZONE X, AS IS SHOWN ON FLOOD INSURANCE RATE MAPS FOR THE COUNTY OF SAN BERNARDINO, CALIFORNIA, SHOWN ON COMMUNITY PANEL NUMBER 06071C6475H.

## ON-SITE DISTURBED AREA:
4.66 ACRES

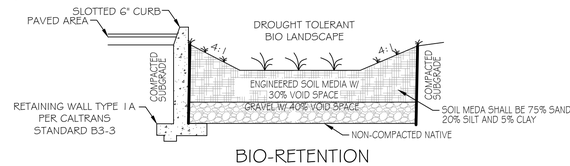
## LEGEND:
- DX X / X.XX AC / XXXXXXXXXXXX — AREA ID / AREA IN ACRES / DESCRIPTION
- DA 1
- DMA 1
- FLOW LINE
- DRAINAGE FLOW DIRECTION
- PROP. BLDG PERIMETER
- BOUNDARY LINE
- RIGHT OF WAY
- CENTERLINE
- FLOW LINE
- FENCE LINE
- DRAINAGE MANAGEMENT AREA
- (XXX) EX. CONTOUR
- [XXX] PROP. CONTOUR
- EX. PALM TREE
- EX. TREE
- EX. FIRE HYDRANT
- LANDSCAPING
- P.C.C. CONCRETE SURFACE
- PAINT HANDICAP/CROSSWALK
- PAINT DIRECTION ARROW
- PAINT PARKING STALL



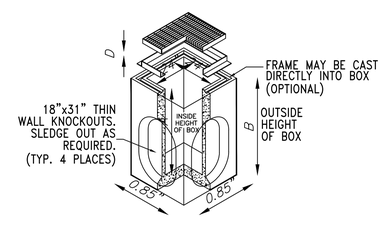

1 BIO-RETENTION INLET
N.T.S



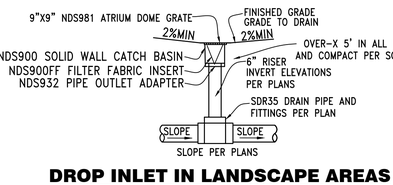

2 UNDERSIDEWALK DRAIN CROSS SECTION
N.T.S.



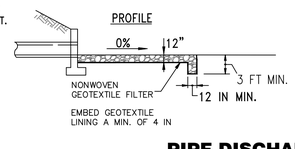

BIO-RETENTION
N.T.S

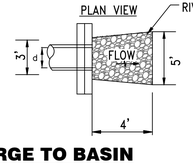



**24" X 24" JENSEN PRECAST DROP INLET IN TURF AREA**
NOT TO SCALE

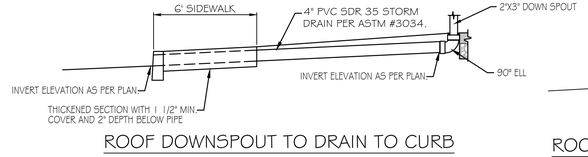



**DROP INLET IN LANDSCAPE AREAS**
NOT TO SCALE

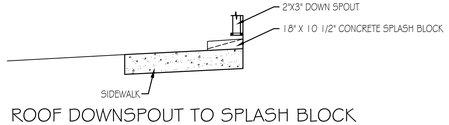



3 **PIPE DISCHARGE TO BASIN**
NOT TO SCALE




ROOF DOWNSPOUT TO DRAIN TO CURB
NTS




ROOF DOWNSPOUT TO SPLASH BLOCK
NTS

## BMP NOTES
1. 5D-10 DROUGHT TOLERANT LANDSCAPING AREA PER LANDSCAPE ARCHITECTURE PLANS USED TO MAXIMIZE PERVIOUS AREAS AND TREAT RUNNOFF WHERE POSSIBLE.
2. 5D-12 MINIMIZE NON-STORMWATER SITE RUNOFF THROUGH EFFICIENT IRRIGATION SYSTEM DESIGN AND CONTROLLERS
3. 5D-32 PROVIDE SOLID ROOFS OVER TRASH ENCLOSURE.
4. TC-32 BIORETENTION BASIN

REGISTERED PROFESSIONAL ENGINEER
JOHN H. JOHNSON
No. 83934
Exp. 9/30/19
CIVIL
STATE OF CALIFORNIA

JOHN H. JOHNSON R.C.E. 83934 DATE
MY REGISTRATION EXPIRES ON 09/30/2019

KOLIBRIEN®
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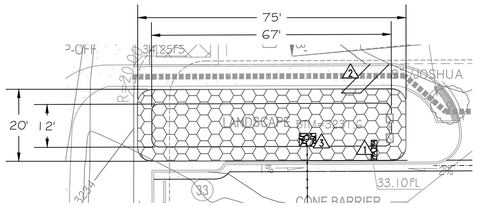
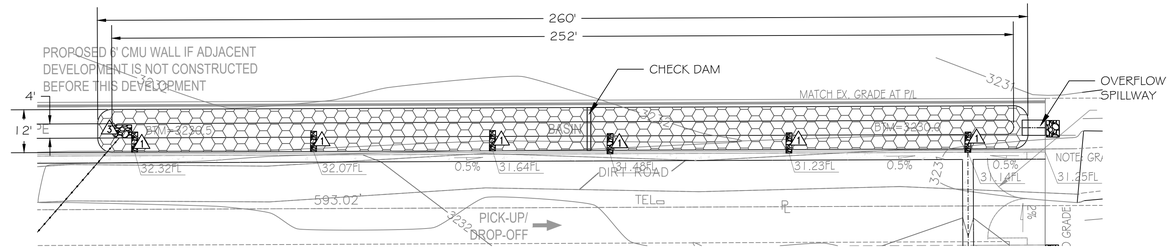
SHEET 1 OF 1
File: L02001

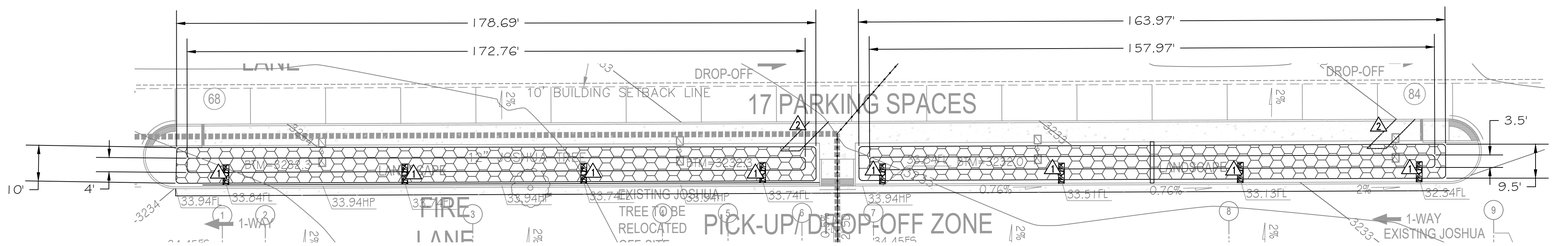
# BIORETENTION BASIN DETAILS
## for DESERT TRAILS MIDDLE SCHOOL



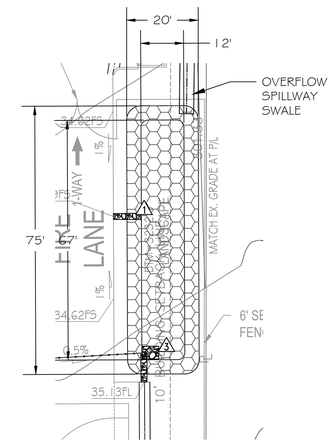

BIO-RETENTION BASIN A
SCALE 1"=20'



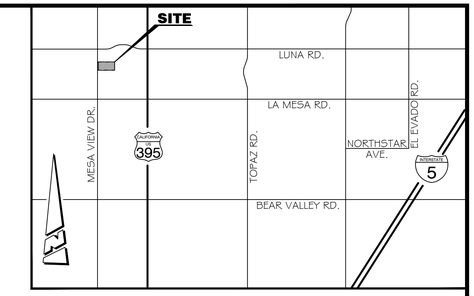

BIO-RETENTION BASIN C
SCALE 1"=20'




BIO-RETENTION BASIN D
SCALE 1"=20'




BIO-RETENTION BASIN B
SCALE 1"=20'




VICINITY MAP
NOT TO SCALE

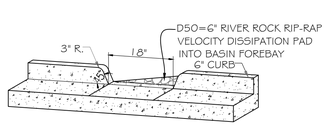
### SITE ADDRESS:
MESA VIEW DRIVE, VICTORVILLE, CA 92392
SOUTH OF PEPPERWOOD STREET, NORTH OF FOREST PARK LANE, EAST OF MESA VIEW DRIVE

### ASSESSOR'S PARCEL NO.:
3096-361-07

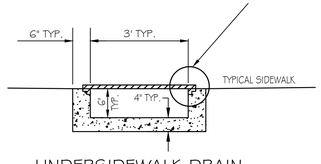
### FLOOD ZONE DESIGNATION:
THIS PROPERTY IS IN FLOODWAY AREA ZONE X, AS IS SHOWN ON FLOOD INSURANCE RATE MAPS FOR THE COUNTY OF SAN BERNARDINO, CALIFORNIA, SHOWN ON COMMUNITY PANEL NUMBER 06071C6475H.

### ON-SITE DISTURBED AREA:
4.66 ACRES

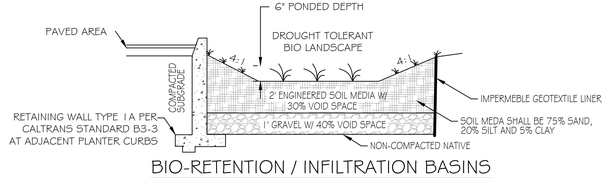
### LEGEND:
- DX X / X.XX AC / XXXXXXXXXXXX — AREA ID / AREA IN ACRES / DESCRIPTION
- DA 1
- DMA 1
- FLOW LINE
- DRAINAGE FLOW DIRECTION
- PROP. BLDG PERIMETER
- BOUNDARY LINE
- RIGHT OF WAY
- CENTERLINE
- FLOW LINE
- FENCE LINE
- DRAINAGE MANAGEMENT AREA
- (XXX) EX. CONTOUR
- [XXX] PROP. CONTOUR
- EX. PALM TREE
- EX. TREE
- EX. FIRE HYDRANT
- LANDSCAPING
- P.C.C. CONCRETE SURFACE
- PAINT HANDICAP/CROSSWALK
- PAINT DIRECTION ARROW
- PAINT PARKING STALL



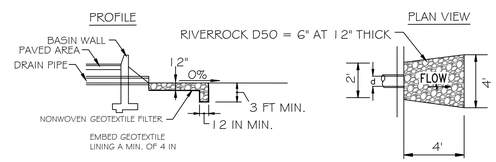

1 BIO-RETENTION INLET
N.T.S




2 UNDERSIDEWALK DRAIN CROSS SECTION
N.T.S.
SECTION PER S.B. CO. STDS.




BIO-RETENTION / INFILTRATION BASINS
N.T.S




3 **PIPE DISCHARGE TO BASIN**
NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER JOHN H. JOHNSON No. 83934 Exp. 9/30/19 CIVIL STATE OF CALIFORNIA

JOHN H. JOHNSON R.C.E. 83934 DATE
MY REGISTRATION EXPIRES ON 09/30/2019

**KOLIBRIEN**®
LAND SURVEYING - CIVIL ENGINEERING - STRUCTURAL ENGINEERING

SHEET 1 OF 1
File: D03001

**NOAA Atlas 14, Volume 6, Version 2**
**Location name: Victorville, California, USA***
**Latitude: 34.4898°, Longitude: -117.4071°**
**Elevation: 3239.42 ft****
* source: ESRI Maps
** source: USGS

## POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.078 (0.064-0.095) | 0.112 (0.093-0.137) | 0.158 (0.130-0.193) | 0.195 (0.159-0.241) | 0.245 (0.194-0.314) | 0.284 (0.220-0.371) | 0.324 (0.245-0.434) | 0.365 (0.268-0.503) | 0.421 (0.297-0.604) | 0.465 (0.316-0.690) |
| 10-min | 0.112 (0.092-0.137) | 0.161 (0.133-0.197) | 0.226 (0.186-0.277) | 0.279 (0.228-0.345) | 0.352 (0.278-0.450) | 0.408 (0.315-0.532) | 0.465 (0.351-0.622) | 0.524 (0.384-0.721) | 0.604 (0.425-0.866) | 0.666 (0.453-0.989) |
| 15-min | 0.135 (0.112-0.165) | 0.195 (0.161-0.238) | 0.273 (0.225-0.335) | 0.338 (0.276-0.418) | 0.425 (0.336-0.544) | 0.493 (0.381-0.644) | 0.562 (0.424-0.752) | 0.633 (0.465-0.872) | 0.730 (0.514-1.05) | 0.805 (0.548-1.20) |
| 30-min | 0.203 (0.167-0.248) | 0.292 (0.241-0.357) | 0.410 (0.337-0.503) | 0.506 (0.413-0.626) | 0.637 (0.504-0.815) | 0.739 (0.572-0.965) | 0.843 (0.636-1.13) | 0.949 (0.697-1.31) | 1.10 (0.771-1.57) | 1.21 (0.821-1.79) |
| 60-min | 0.271 (0.224-0.332) | 0.391 (0.323-0.479) | 0.549 (0.452-0.674) | 0.678 (0.554-0.839) | 0.854 (0.675-1.09) | 0.990 (0.766-1.29) | 1.13 (0.852-1.51) | 1.27 (0.934-1.75) | 1.47 (1.03-2.10) | 1.62 (1.10-2.40) |
| 2-hr | 0.381 (0.315-0.465) | 0.518 (0.428-0.634) | 0.704 (0.580-0.864) | 0.861 (0.703-1.07) | 1.08 (0.855-1.39) | 1.26 (0.974-1.65) | 1.44 (1.09-1.93) | 1.64 (1.20-2.26) | 1.91 (1.35-2.74) | 2.13 (1.45-3.17) |
| 3-hr | 0.478 (0.395-0.584) | 0.638 (0.527-0.781) | 0.860 (0.708-1.05) | 1.05 (0.857-1.30) | 1.32 (1.04-1.69) | 1.54 (1.19-2.01) | 1.77 (1.34-2.37) | 2.02 (1.49-2.78) | 2.38 (1.67-3.41) | 2.67 (1.81-3.96) |
| 6-hr | 0.653 (0.540-0.798) | 0.865 (0.714-1.06) | 1.16 (0.957-1.43) | 1.42 (1.16-1.76) | 1.80 (1.42-2.30) | 2.11 (1.63-2.76) | 2.45 (1.85-3.27) | 2.81 (2.07-3.87) | 3.34 (2.36-4.80) | 3.78 (2.58-5.62) |
| 12-hr | 0.814 (0.673-0.995) | 1.12 (0.925-1.37) | 1.55 (1.28-1.90) | 1.93 (1.57-2.38) | 2.47 (1.95-3.16) | 2.93 (2.26-3.82) | 3.41 (2.58-4.57) | 3.95 (2.90-5.43) | 4.72 (3.32-6.77) | 5.36 (3.65-7.96) |
| 24-hr | 1.11 (0.985-1.28) | 1.60 (1.41-1.84) | 2.28 (2.01-2.63) | 2.87 (2.51-3.34) | 3.72 (3.16-4.48) | 4.43 (3.68-5.45) | 5.19 (4.20-6.54) | 6.02 (4.74-7.80) | 7.23 (5.46-9.75) | 8.23 (6.01-11.5) |
| 2-day | 1.20 (1.06-1.38) | 1.71 (1.51-1.97) | 2.43 (2.15-2.81) | 3.07 (2.69-3.57) | 3.99 (3.39-4.81) | 4.76 (3.95-5.86) | 5.60 (4.53-7.05) | 6.51 (5.13-8.44) | 7.85 (5.93-10.6) | 8.97 (6.55-12.5) |
| 3-day | 1.27 (1.13-1.47) | 1.81 (1.60-2.08) | 2.57 (2.27-2.97) | 3.24 (2.83-3.77) | 4.21 (3.57-5.07) | 5.02 (4.17-6.18) | 5.91 (4.78-7.44) | 6.88 (5.42-8.91) | 8.30 (6.28-11.2) | 9.50 (6.94-13.3) |
| 4-day | 1.37 (1.22-1.58) | 1.94 (1.72-2.23) | 2.75 (2.43-3.17) | 3.45 (3.02-4.02) | 4.49 (3.80-5.41) | 5.35 (4.44-6.58) | 6.29 (5.09-7.92) | 7.32 (5.76-9.48) | 8.83 (6.67-11.9) | 10.1 (7.38-14.1) |
| 7-day | 1.48 (1.32-1.71) | 2.08 (1.84-2.40) | 2.93 (2.59-3.38) | 3.67 (3.21-4.27) | 4.74 (4.02-5.71) | 5.63 (4.67-6.92) | 6.59 (5.34-8.30) | 7.63 (6.01-9.89) | 9.16 (6.92-12.4) | 10.4 (7.61-14.6) |
| 10-day | 1.59 (1.41-1.83) | 2.21 (1.96-2.55) | 3.10 (2.74-3.58) | 3.87 (3.39-4.51) | 5.00 (4.23-6.02) | 5.92 (4.91-7.28) | 6.91 (5.60-8.70) | 7.99 (6.29-10.3) | 9.55 (7.22-12.9) | 10.8 (7.92-15.1) |
| 20-day | 1.91 (1.70-2.20) | 2.65 (2.35-3.06) | 3.70 (3.27-4.28) | 4.62 (4.04-5.38) | 5.95 (5.04-7.16) | 7.04 (5.84-8.65) | 8.20 (6.64-10.3) | 9.47 (7.46-12.3) | 11.3 (8.52-15.2) | 12.8 (9.32-17.8) |
| 30-day | 2.23 (1.98-2.57) | 3.07 (2.72-3.54) | 4.27 (3.77-4.94) | 5.32 (4.66-6.20) | 6.85 (5.80-8.24) | 8.10 (6.72-9.95) | 9.43 (7.64-11.9) | 10.9 (8.56-14.1) | 12.9 (9.77-17.5) | 14.6 (10.7-20.4) |
| 45-day | 2.62 (2.32-3.01) | 3.56 (3.16-4.11) | 4.92 (4.34-5.68) | 6.10 (5.34-7.11) | 7.84 (6.64-9.43) | 9.26 (7.69-11.4) | 10.8 (8.74-13.6) | 12.4 (9.79-16.1) | 14.8 (11.2-19.9) | 16.7 (12.2-23.3) |
| 60-day | 2.94 (2.61-3.39) | 3.95 (3.50-4.56) | 5.41 (4.78-6.25) | 6.69 (5.86-7.79) | 8.57 (7.26-10.3) | 10.1 (8.40-12.4) | 11.8 (9.54-14.8) | 13.6 (10.7-17.6) | 16.1 (12.2-21.7) | 18.2 (13.3-25.4) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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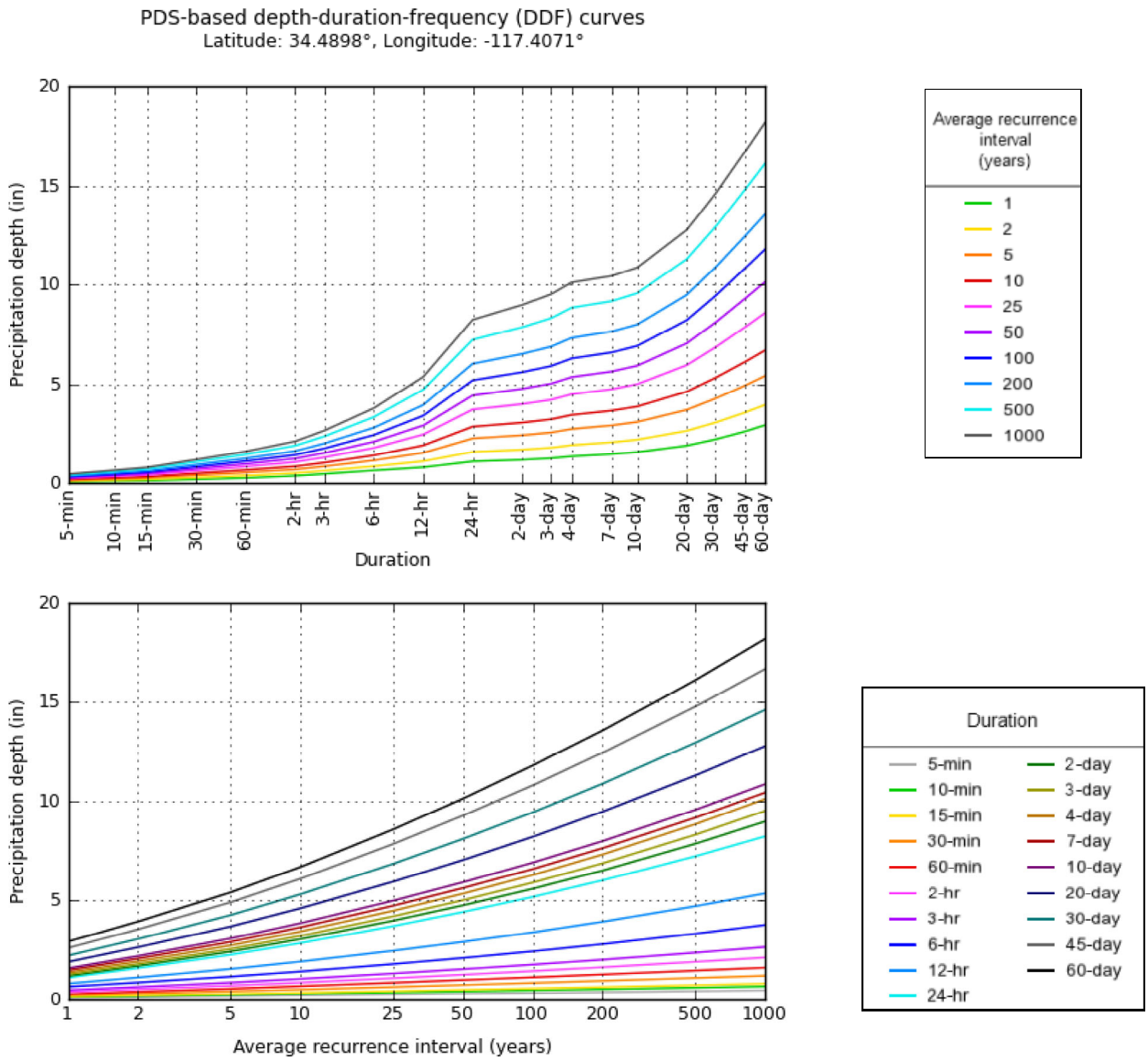
## PF graphical




NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Sat Jun 8 22:55:32 2019

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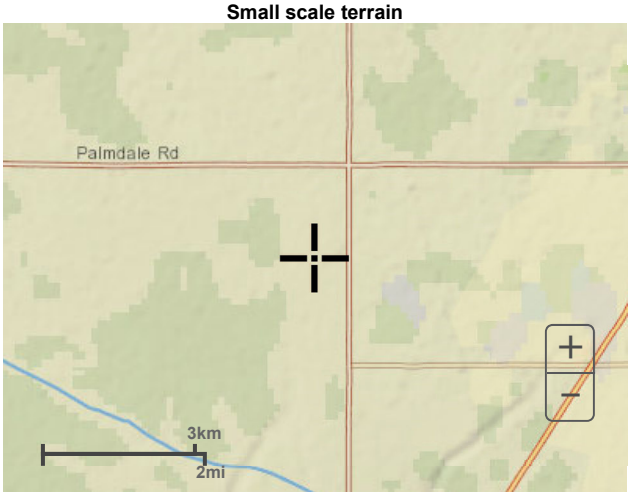
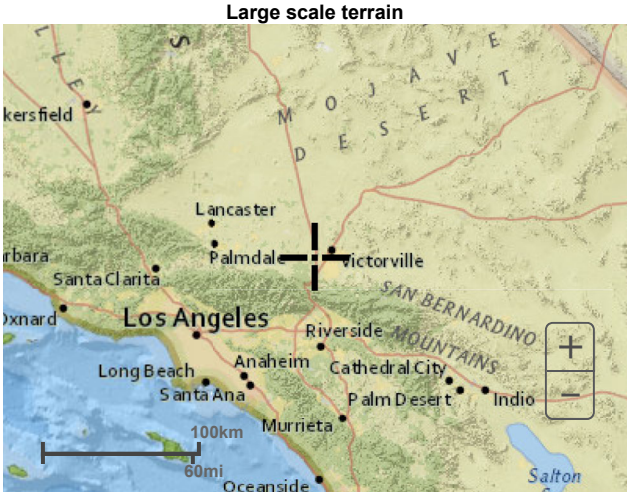
# Maps & aerials

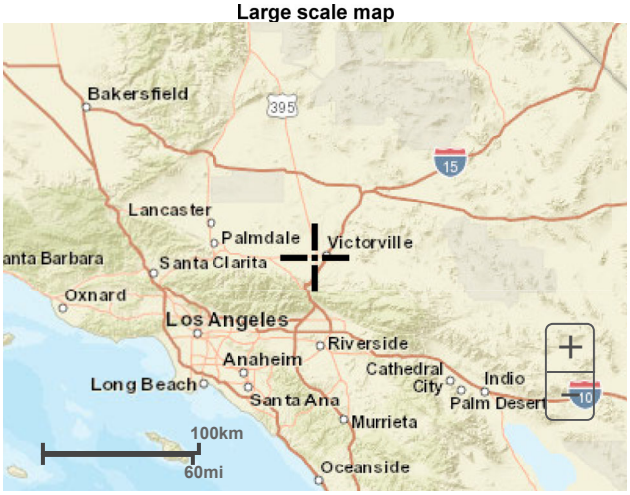
**Small scale terrain**



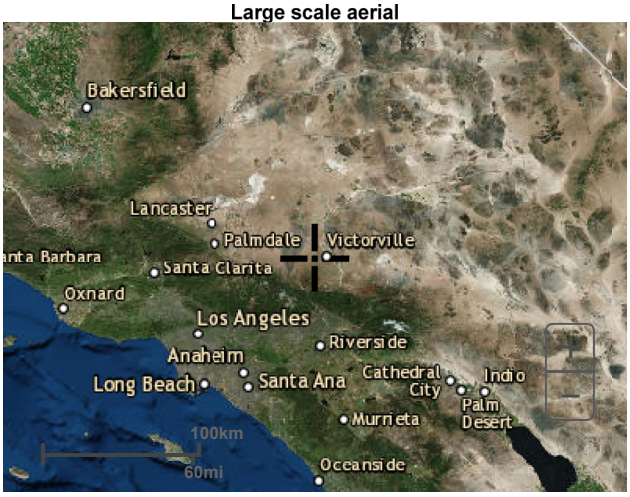

**Large scale terrain**




**Large scale map**



**Large scale aerial**

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov



Disclaimer

## WQMP Project Report

**County of San Bernardino Stormwater Program**

Santa Ana River Watershed Geodatabase

Sunday, June 02, 2019

Note: The information provided in this report and on the Stormwater Geodatabase for the County of San Bernardino Stormwater Program is intended to provide basic guidance in the preparation of the applicant's Water Quality Management Plan (WQMP) and should not be relied upon without independent verification.

| | |
|---|---|
| **Project Site Parcel Number(s):** | 309636107, 309620307, 309620310, 309620304, 309620309, 309620303, 309620302, 309620301, 309620306, 309620308, 309620305 |
| **Project Site Acreage:** | 6.253 |
| **HCOC Exempt Area:** | No |
| **Closest Receiving Waters:** (Applicant to verify based on local drainage facilities and topography.) | **System Number** - See Note<br>**Facility Name** - See Note<br>**Owner** - See Note |
| **Closest channel segment's susceptibility to Hydromodification:** | See Note |
| **Highest downstream hydromodification susceptibility:** | See Note |
| **Is this drainage segment subject to TMDLs?** | See Note |
| **Are there downstream drainage segments subject to TMDLs?** | See Note |
| **Is this drainage segment a 303d listed stream?** | See Note |
| **Are there 303d listed streams downstream?** | See Note |
| **Are there unlined downstream waterbodies?** | See Note |
| **Project Site Onsite Soil Group(s):** | A |
| **Environmentally Sensitive Areas within 200':** | DESERT TORTOISE HABITAT CAT 2 |
| **Groundwater Depth (FT):** | No data available |
| **Parcels with potential septic tanks within 1000':** | No |
| **Known Groundwater Contamination Plumes within 1000':** | No |
| **Studies and Reports Related to Project Site:** | |

Note: No drainage facilities located within 2 miles of site.

# SECTION 6.3
# Operation and Maintenance Plan

# Stormwater BMP Operation & Maintenance Plan

## I. Inspection Log

# Site Inspection Log

| | |
|---|---|
| Maintenance Engineer/Company: | |
| Date: | |
| Reason for Inspection: | |

| Inspection Item | A | M | U | N/A | Corrective Action Required |
|---|---|---|---|---|---|
| I. Landscaping | | | | | |
| Are grounds in good condition, clean and free of debris? | | | | | |
| Are lawn areas mowed and trimmed? | | | | | |
| Are plant beds and/or planter boxes well maintained? | | | | | |
| Are shrubs trimmed and maintained? | | | | | |
| Are dead trees or shrubs evident? | | | | | |
| Are lawn sprinkler systems operable? | | | | | |
| Are areas around trash receptacles clean? | | | | | |
| Do a sufficient quantity of receptacles exist? | | | | | |
| II. Hardscape | | | | | |
| Are sidewalks and trails in good condition, clean, and free of debris? | | | | | |
| III. Storm Drain System | | | | | |
| Are all stencils in good condition, visible and legible? | | | | | |
| Are all drains clean and free of obstructions? | | | | | |
| IV. FLOGARD INSERTS | | | | | |
| Is the BMP in good condition, clean and free of debris? | | | | | |
| Is the BMP free of sediment accumulation? | | | | | |
| Is the BMP free of standing water | | | | | |
| V. Stormtech Chambers | | | | | |
| Is the inlet manhole in good condition, clean and free of debris?<br>Is the outlet manhole in good condition, clean and free of debris? | | | | | |
| Is the BMP free of sediment accumulation? | | | | | |
| Is the BMP free of standing water? | | | | | |

Comments:

A Acceptable M Marginal U Unacceptable N/A Not Applicable

# II. Updates, Revisions, Errata

| Revision No. | Date | Brief Description of Revision, include section and page number | Prepared and Approved By: |
|---|---|---|---|
| | | | Name:<br>Title: |
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| | | | Name:<br>Title: |

# III. Introduction

The project will construct a middle school (SIC Code 821) on the existing vacant lot. Project includes buildings, hardscape, standard parking including a loading zone for students and landscaped areas. Outdoor activities would include typical school activities such as sports and playground area. The site will drain to bioretention basins to capture and treat site runoff.

Responsibility for Maintenance and Funding

# A. General

## 1) Responsible Party during Construction

Identify the parties responsible for maintenance during construction phase of BMPs identified and source controls specified.

| | | | |
|---|---|---|---|
| Developer's Name | Desert Trails Prepatory Academy | | |
| Address | 14530 Bellflower St. | | |
| | City: Adelanto | State: CA | Zip: 92301 |
| Email Address | | | |
| Phone Number | 760-530-7680 | | |
| Engineer of Work | John Johnson, PE, Kolibrien Corp. | | |
| Engineer's Phone Number | (951) 252-1034 | | |

## 2) Responsible Party for Ongoing Maintenance

Owner Responsible for Negotiating and Executing Contracts Responsible for Maintenance

| | | | |
|---|---|---|---|
| Owner's Name | Debra Tarver | | |
| Address | 14530 Bellflower St. | | |
| | City: Adelanto | State: CA | Zip: 92301 |
| Email Address | | | |
| Phone Number | 760-530-7680 | | |

Supervisor Responsible for Responding to problems with Stormwater BMPs

| | | | |
|---|---|---|---|
| Supervisor's Name | TBD | | |
| Address | | | |
| | City: | State: | Zip: |
| Email Address | | | |
| Phone Number | | | |

3) Employees or Contractors Responsible for conducting Stormwater BMP Operation and Maintenance

| **Employees** | |
|---|---|
| Name | TBD |
| Title | |
| Phone | |
| Email | |
| **Contractors** | |
| Company | TBD |
| Employee | |
| Title | |
| Phone | |
| Email | |

4) Funding

Funding for installation, operation, and maintenance of all stormwater BMPs will be the responsibility of the property owner. Funding for stormwater facility maintenance shall be paid for from ordinary incomes generated from the apartment complex. Any future owners will be required to maintain BMPs as per manufacturer's specifications.

Budget for Maintenance will be determined by property owner/management.

## B. Training

Training of employees responsible for BMP maintenance procedures will be provided by the owner and the type of training will be at the discretion of the owner. Any contractors will be trained by their respective company and this will not be the property owner's responsibility.

## C. Records

Insert maintenance records here.

# Storm Water BMP Maintenance Log

| Maintenance Engineer/ Company | Maintenance Type | Date | Comments |
|---|---|---|---|
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## D. Safety

Insert Company's Safety Training Documentation here.

# Employee Training Log

Training Type: _____

_____

Instructor: _____ Date: _____

Company: _____

## Attendees

| Name | Signature | Name | Signature |
|---|---|---|---|
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# IV. Summary of Drainage Management Areas and Stormwater BMPs

## A. Drainage Areas

This site includes landscaping that is considered self-treating or buffering; these areas will not require specialized O&M or inspections, but will require typical landscape maintenance.

The site has three drainage areas, which drains to bioretention basins. The site uses curb and gutter to convey runoff to the basins.

B. Structural Post-Construction BMPs

# V. Stormwater BMP Design Documentation

These BMPs will be "As Built" by a licensed civil/geotechnical engineer registered in the state of California and submitted to the Co-Permittee.

# VI. Maintenance Schedule or Matrix

## A. Maintenance Schedule

| BMP | Responsible Party | Maintenance Activity | Inspection/Maintenance Frequency |
|---|---|---|---|
| **Self-Treating Areas** | | | |
| Landscape Maintenance | Property Owner | Inspect landscape areas for litter and debris daily. Weekly preform landscape area inspections and preform required landscape maintenance activities when it is needed. These maintenance activities include irrigating, weeding, applying fertilizers and pesticides in minimum required quantities, remulching, trimming vegetation, raking leaves, removing detritus, and replacing diseased or dead plants. | Continuous, as needed |
| **Source Control BMPs {Structural and Nonstructural)** | | | |
| Education for Property Owner | Property Owner | Education program as it would apply to future tenants and maintenance staff. The owner shall prepare manual{s) for tenants and maintenance staff. | Continuous. Provide regular training to field employees regarding all the BMPs proposed in this document. |
| Activity Restriction | Property Owner | No sidewalk or driveway washing. | Continuous |
| Common Area Landscape Maintenance | Property Owner | Manage landscaping in accordance with: the City Regulations, and with management guidelines for use of fertilizers and pesticides and with the County of Riverside. | Monthly during regular maintenance. |
| BMP Maintenance | Property Owner | The maintenance staff and tenants will be instructed in environmental procedures regarding contamination and cleanup. | Per established maintenance BMP schedule. |
| Common Area Litter Control/ Refuse | Property Owner | A contract for trash management and litter control and landscaped maintenance will be made with outside contractors as necessary. | Daily, during regular maintenance. Litter patrol and emptying trash receptacles. |
| Employee Training | Property Owner | Educational materials. | When maintenance staff are hired or for new tenants, and once every six months. |

| | | | |
|---|---|---|---|
| Common catch basin Inspection | Property Owner | Inspect inlet for debris and clean with required. See O&M info on FLOGARD Filters from Manufacturer. | Monthly, after rain events and prior to October 1st each year. |
| Private Street Sweeping | Property Owner | Post "No Littering" signs and enforce anti-litter laws. A contract for street sweeping and litter control will be mad with outside contractors as necessary. The contractor will clean out and cover litter receptacles frequently to prevent spillage. The contractor will routinely sweep, shovel, and dispose of litter in the trash. The contractor will use dry cleaning methods to prevent the discharge of pollutants into the stormwater conveyance system. A contract for oil and petroleum hydrocarbons removal will be made with cleaning services contractor. | Sweep private alleys and parking lots weekly and prior to the storm season. Remove oil and petroleum hydrocarbons if any at the drive-way once every 6 months. |
| Storm Drain System Stenciling and Signage | Property Owner | Inspect for re-stenciling needs and re-stencil as necessary. | Once every 6 months. |
| Efficient Irrigation System | Property Owner | Verify that the runoff minimizing landscape design continues to function by checking that water sensors are functioning properly, that irrigation heads are adjusted properly to eliminate overspray to landscape areas, and to verify that irrigation timing and cycle lengths are adjusted in accordance with water demands, given time of day or night time temperatures. | Once a week with maintenance activities. |

B. Service Agreement Information

RECORDING REQUESTED BY

**City of Victorville: Engineering Division**

AND WHEN RECORDED MAIL DOCUMENT TO:

NAME **City Clerk: c/o _____**

STREET ADDRESS

CITY, STATE & ZIP CODE

SPACE ABOVE FOR RECORDER'S USE ONLY

# COVENANT AND AGREEMENT REGARDING WATER QUALITY MANAGEMENT PLAN AND STORMWATER BEST MANAGEMENT PRACTICES TRANSFER, ACCESS AND MAINTENANCE

Title of Document

**Document exempt from recording fees pursuant to Cal. Gov. Code 6103 & 27383**

# THIS AREA FOR RECORDER'S USE ONLY

THIS COVER SHEET ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION

**Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance**

**OWNER NAME:** Desert Trails Prepatory Academy

**PROPERTY ADDRESS:** 14530 Bellflower Street

Adelanto, CA 92301

**APN:** 3096-361-07

**THIS AGREEMENT** is made and entered into in

CITY OF VICTORVILLE COUNTY OF SAN BERNARDINO, California, this _____ day of

_____, by and between

Desert Trails Prepatory Academy, hereinafter

referred to as Owner, and the CITY OF VICTORVILLE a political subdivision of the State of California, hereinafter referred to as "the City";

**WHEREAS,** the Owner owns real property ("Property") in the State of California, County of San Bernardino, located at [STREET ADDRESS] within the City of Victorville, more commonly referred to as San Bernardino County Tax Assessor Parcel No. [APN Number] specifically described in Exhibit "A" and depicted in Exhibit "B", each of which is attached hereto and incorporated herein by this reference; and

**WHEREAS,** at the time of initial approval of the development project known as

Desert Trails Prepatory Academy within the Property described herein, the City required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff; and

**WHEREAS**, the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, dated _____, on file with the City and incorporated herein by this reference, hereinafter referred to as "WQMP", to minimize pollutants in stormwater and urban runoff and to minimize other adverse impacts of stormwater and urban runoff; and

**WHEREAS,** said WQMP has been certified by the Owner and reviewed and approved by the City; and

**WHEREAS,** the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of all BMPs in the WQMP and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs.

**NOW THEREFORE**, it is mutually stipulated and agreed as follows:

1. Owner shall comply with the WQMP.

2. All maintenance or replacement of any BMPs specified within the approved WQMP is the sole responsibility of the Owner in accordance with the terms of this Agreement.

3. Owner hereby provides the City's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by the City, no advance notice, for the purpose of inspection, sampling, testing of the BMPs, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 5 below. The City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property. Denial of access to any premises or facility that contains WQMP features is a breach of this Agreement and may also be a violation of the Clean Water Act, the California Water Code, and/or the City's NPDES Permit Implementation regulations. If there is reasonable cause to believe that an illicit discharge or breach of this Agreement is occurring on the premises then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction in addition to other enforcement actions. Owner recognizes that the City may perform routine and regular inspections, as well as emergency inspections, of the BMPs. Owner or Owner's successors or assigns shall pay City for all costs incurred by City in the inspection, sampling, testing of the BMPs within thirty (30) calendar days of City invoice.

4. Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination, testing construction or reconstruction.

5. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) business days of being given written notice by the City, the City is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense against the Property and/or to the Owner or Owner's successors or assigns, including administrative costs, attorney's fees and interest thereon at the maximum rate authorized by the City Code from the date of the notice of expense until paid in full. Owner or Owner's successors or assigns shall pay City within thirty (30) calendar days of City invoice.

6. The City may require the owner to post security in form and for a time period satisfactory to the City to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under the Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the surety (ies) to perform the obligations of this Agreement.

7. The City agrees, from time to time, within ten (10) business days after request of Owner, to execute and deliver to Owner, or Owner's designee, an estoppel certificate requested by Owner, stating that this Agreement is in full force and effect, and that Owner is not in default hereunder with regard to any maintenance or payment obligations (or specifying in detail the nature of Owner's default). Owner shall pay all costs and expenses incurred by the City in its investigation of whether to issue an estoppel certificate within thirty (30) calendar days after receipt of a City invoice and prior to the City's issuance of such certificate. Where the City cannot issue an estoppel certificate, Owner shall pay the City within thirty (30) calendar days of receipt of a City invoice.

8. Owner shall not change any BMPs identified in the WQMP without an amendment to this Agreement approved by authorized representatives of both the City and the Owner.

9. City and Owner shall comply with all applicable laws, ordinances, rules, regulations, court orders and government agency orders now or hereinafter in effect in carrying out the terms of this Agreement. If a provision of this Agreement is terminated or held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall remain in full effect.

10. In addition to any remedy available to City under this Agreement, if Owner violates any term of this Agreement and does not cure the violation within the time already provided in this Agreement, or, if not provided, within thirty (30) calendar days, or within such time authorized by the City if said cure reasonably requires more than the subject time, the City may bring an action at law or in equity in a court of competent jurisdiction to enforce compliance by the Owner with the terms of this Agreement. In such action, the City may recover any damages to which the City may be entitled for the violation, enjoin the violation by temporary or permanent injunction without the necessity of proving actual damages or the inadequacy of otherwise available legal remedies, or obtain other equitable relief, including, but not limited to, the restoration of the Property and/or the BMPs identified in the WQMP to the condition in which it/they existed prior to any such violation or injury.

11. This Agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.

12. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to hold the City harmless and pay all costs incurred by the City in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.

13. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.

14. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of

this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

15. Time is of the essence in the performance of this Agreement.

16. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

17. Owner agrees to indemnify, defend (with counsel reasonably approved by the City) and hold harmless the City and its authorized officers, employees, agents and volunteers from any and all claims, actions, losses, damages, and/or liability arising out of this Agreement from any cause whatsoever, including the acts, errors or omissions of any person and for any costs or expenses incurred by the City on account of any claim except where such indemnification is prohibited by law. This indemnification provision shall apply regardless of the existence or degree of fault of indemnitees. The Owner's indemnification obligation applies to the City's "active" as well as "passive" negligence but does not apply to the City's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782, or to any claims, actions, losses, damages, and/or liabilities, to the extent caused by the acts or omissions of any third party contractors undertaking any work (other than field inspections) or other maintenance on the Property on behalf of the City under this Agreement.

[REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK]

**IF TO CITY:**

City of Victorville

**IF TO OWNER:**

Desert Trails Prepatory Academy

Victorville, CA

**IN WITNESS THEREOF,** the parties hereto have affixed their signatures as of the date first written above.

**OWNER:**
Signature: _____

Name: _____

Title: _____

Date: _____

**OWNER:**

Signature: _____

Name: _____

Title: _____

Date: _____

**FOR:** Maintenance Agreement, dated _____, for the project known as

Desert Trails Prepatory Academy

(APN)__ 3096-361-07,

As described in the WQMP dated _____.

**NOTARIES ON FOLLOWING PAGE(S)**

A notary acknowledgement for each signature is required for recordation.

ACCEPTED BY:

Director of Development Services or designee

Date: _____

Attachment: Notary Acknowledgement

**ATTACHMENT 1**

**(Notary Acknowledgement)**

**ATTACHMENT 1, Page 2**

**(Notary Acknowledgement)**

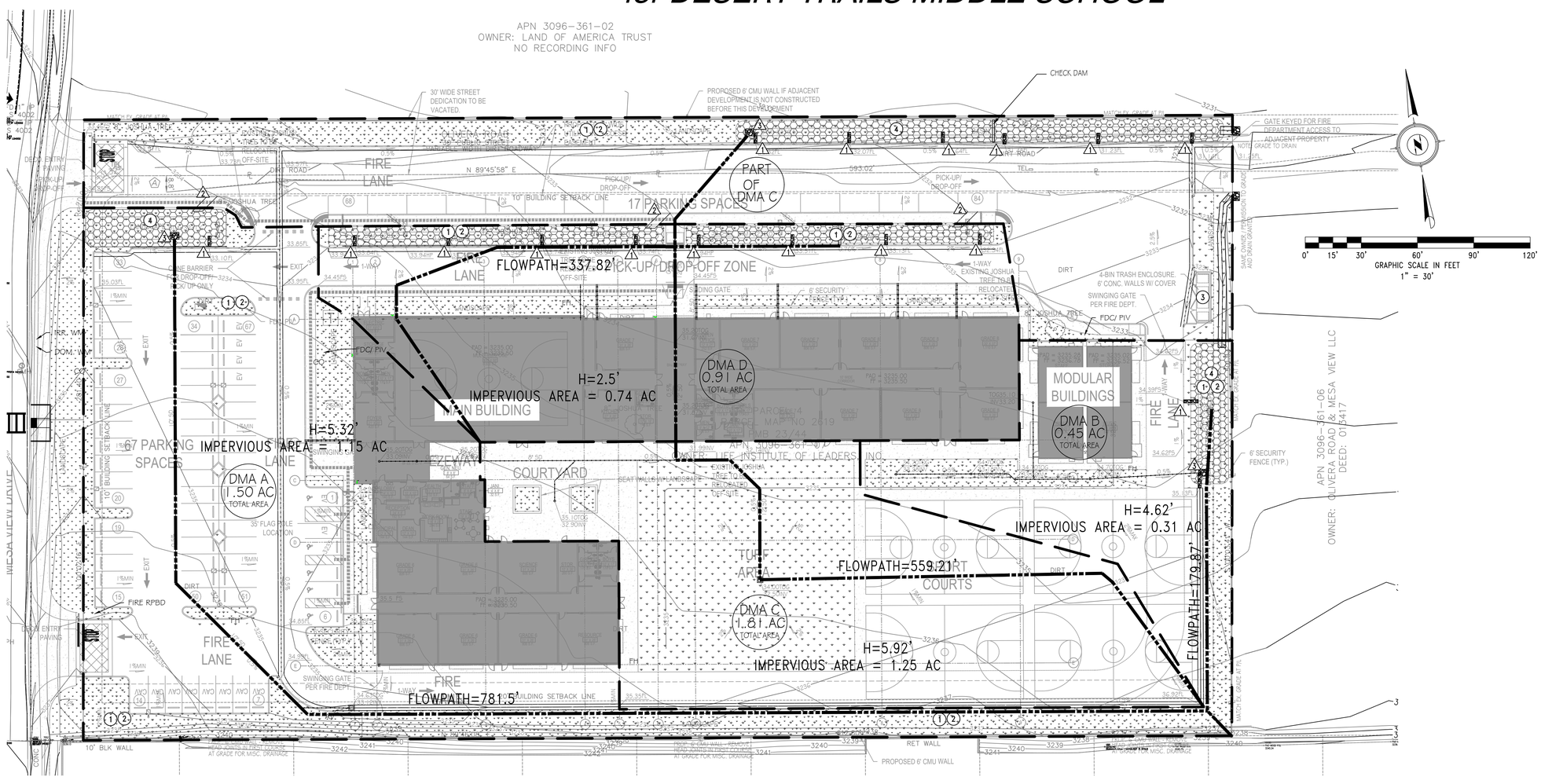
**EXHIBIT A**

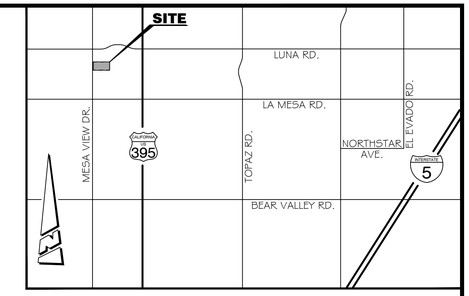
**(Legal Description)**

**EXHIBIT B**

**(Map/illustration)**

# LID BMP SITE MAP
## for DESERT TRAILS MIDDLE SCHOOL




VICINITY MAP
NOT TO SCALE

## SITE ADDRESS:

MESA VIEW DRIVE, VICTORVILLE, CA 92392
SOUTH OF PEPPERWOOD STREET, NORTH OF FOREST PARK LANE, EAST OF MESA VIEW DRIVE

## ASSESSOR'S PARCEL NO.:

3096-361-07

## FLOOD ZONE DESIGNATION:

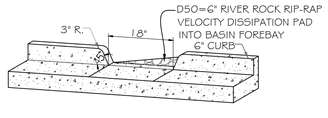
THIS PROPERTY IS IN FLOODWAY AREA ZONE X, AS IS SHOWN ON FLOOD INSURANCE RATE MAPS FOR THE COUNTY OF SAN BERNARDINO, CALIFORNIA, SHOWN ON COMMUNITY PANEL NUMBER 06071C6475H.

## ON-SITE DISTURBED AREA:

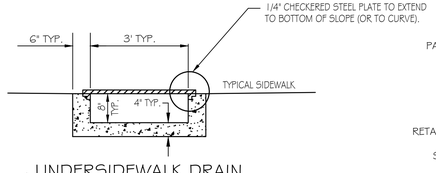
4.66 ACRES

## LEGEND:

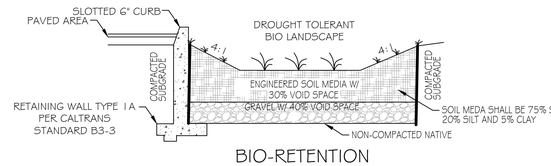
- DX X / X.XX AC / XXXXXXXXXXXX — AREA ID, AREA IN ACRES, DESCRIPTION
- DA 1
- DMA 1
- FLOW LINE
- DRAINAGE FLOW DIRECTION
- PROP. BLDG PERIMETER
- BOUNDARY LINE
- RIGHT OF WAY
- CENTERLINE
- FLOW LINE
- FENCE LINE
- DRAINAGE MANAGEMENT AREA
- (XXX) EX. CONTOUR
- [XXX] PROP. CONTOUR
- EX. PALM TREE
- EX. TREE
- EX. FIRE HYDRANT
- LANDSCAPING
- P.C.C. CONCRETE SURFACE
- PAINT HANDICAP/CROSSWALK
- PAINT DIRECTION ARROW
- PAINT PARKING STALL



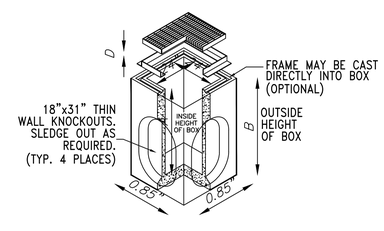

1 BIO-RETENTION INLET
N.T.S



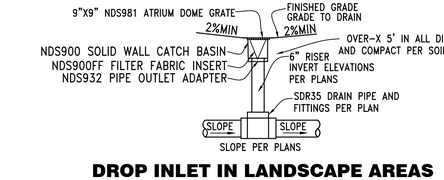

2 UNDERSIDEWALK DRAIN CROSS SECTION
N.T.S.



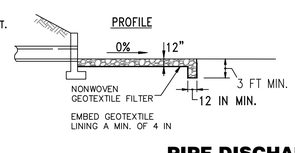

BIO-RETENTION
N.T.S

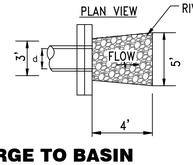



**24" X 24" JENSEN PRECAST DROP INLET IN TURF AREA**
NOT TO SCALE

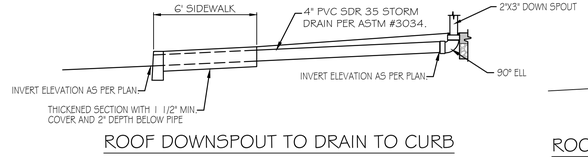



**DROP INLET IN LANDSCAPE AREAS**
NOT TO SCALE

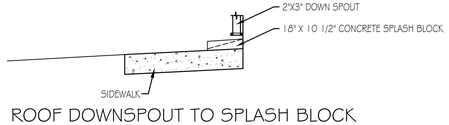



3 **PIPE DISCHARGE TO BASIN**
NOT TO SCALE




ROOF DOWNSPOUT TO DRAIN TO CURB
NTS




ROOF DOWNSPOUT TO SPLASH BLOCK
NTS

## BMP NOTES

1. 5D-10 DROUGHT TOLERANT LANDSCAPING AREA PER LANDSCAPE ARCHITECTURE PLANS USED TO MAXIMIZE PERVIOUS AREAS AND TREAT RUNNOFF WHERE POSSIBLE.
2. 5D-12 MINIMIZE NON-STORMWATER SITE RUNOFF THROUGH EFFICIENT IRRIGATION SYSTEM DESIGN AND CONTROLLERS
3. 5D-32 PROVIDE SOLID ROOFS OVER TRASH ENCLOSURE.
4. TC-32 BIORETENTION BASIN

REGISTERED PROFESSIONAL ENGINEER
JOHN H. JOHNSON
No. 83934
Exp. 9/30/19
CIVIL
STATE OF CALIFORNIA

JOHN H. JOHNSON R.C.E. 83934 DATE
MY REGISTRATION EXPIRES ON 09/30/2019

KOLIBRIEN®
LAND SURVEYING - CIVIL ENGINEERING - STRUCTURAL ENGINEERING

SHEET 1 OF 1

File: L02001

# SECTION 6.4
# Other Supporting Documentation

BMP Education Material
Hydromod Docs
Geotechnical Report

# 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.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

### *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

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.

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.

# Efficient Irrigation SD-12

**Design Objectives**

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

## Description

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

## Approach

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

## Suitable Applications

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

## Design Considerations

### *Designing New Installations*

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

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

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

### *Redeveloping Existing Installations*

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

## Other Resources

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

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

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

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

# Trash Storage Areas SD-32

**Design Objectives**

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

## 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.

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- 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.

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.

# Bioretention TC-32

## Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

## Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

## Targeted Constituents

| | | |
|---|---|---|
| ☑ | Sediment | ■ |
| ☑ | Nutrients | ▲ |
| ☑ | Trash | ■ |
| ☑ | Metals | ■ |
| ☑ | Bacteria | ■ |
| ☑ | Oil and Grease | ■ |
| ☑ | Organics | ■ |

**Legend** ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

## California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

## Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

## Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

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be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

## Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 $ft^2$ of bioretention area should be included.
- Cover area with about 3 inches of mulch.

### *Construction/Inspection Considerations*

Bioretention area should not be established until contributing watershed is stabilized.

## Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately

aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

**Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)**

| Pollutant | Removal Rate |
|---|---|
| Total Phosphorus | 70-83% |
| Metals (Cu, Zn, Pb) | 93-98% |
| TKN | 68-80% |
| Total Suspended Solids | 90% |
| Organics | 90% |
| Bacteria | 90% |

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

## Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

## Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

## Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural

soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

## Cost

### *Construction Cost*

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock, ). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

### *Maintenance Cost*

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

## References and Sources of Additional Information

Coffman, L.S., R. Goo and R. Frederick, 1999: Low impact development: an innovative alternative approach to stormwater management. Proceedings of the 26th Annual Water Resources Planning and Management Conference ASCE, June 6-9, Tempe, Arizona.

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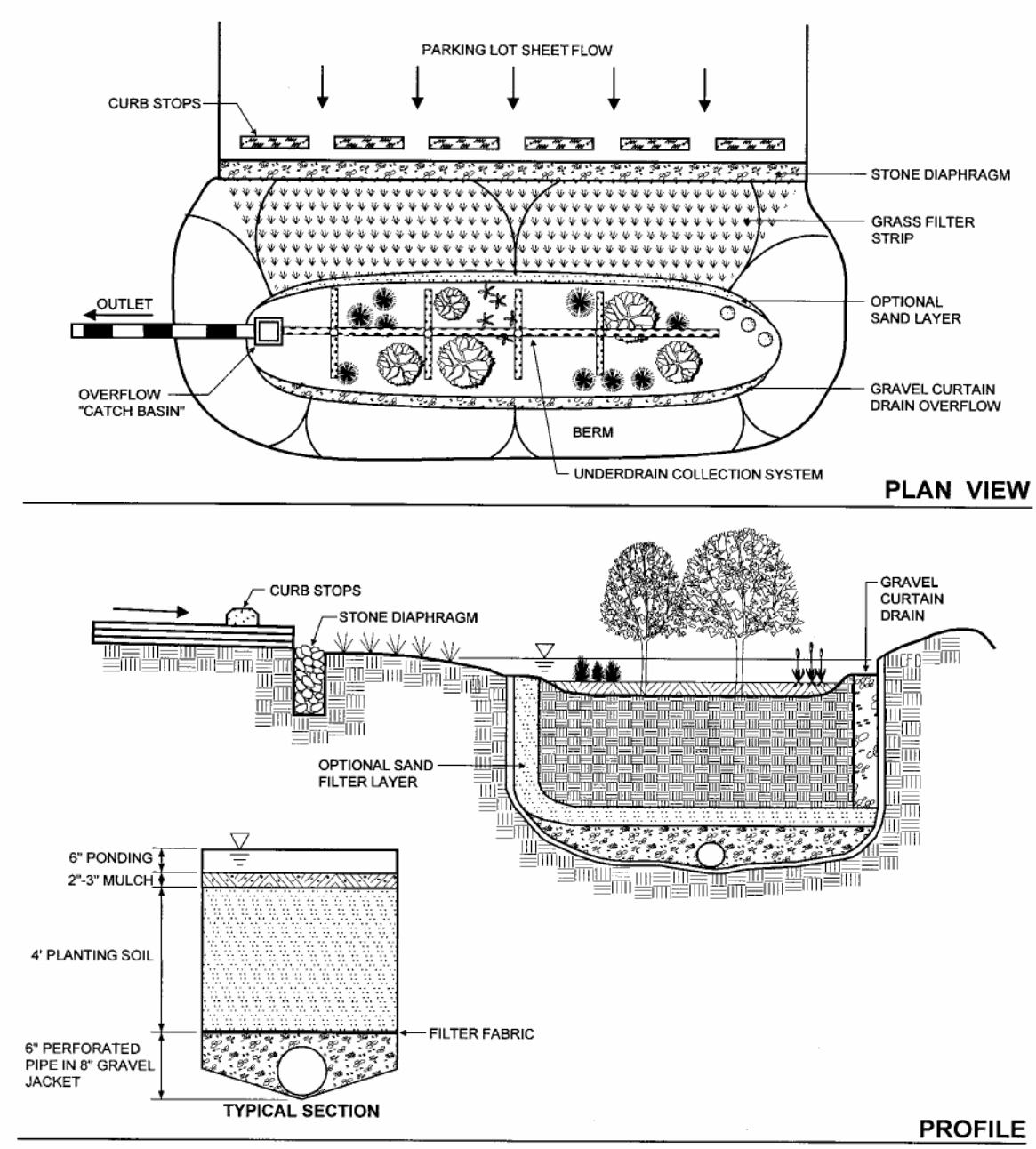
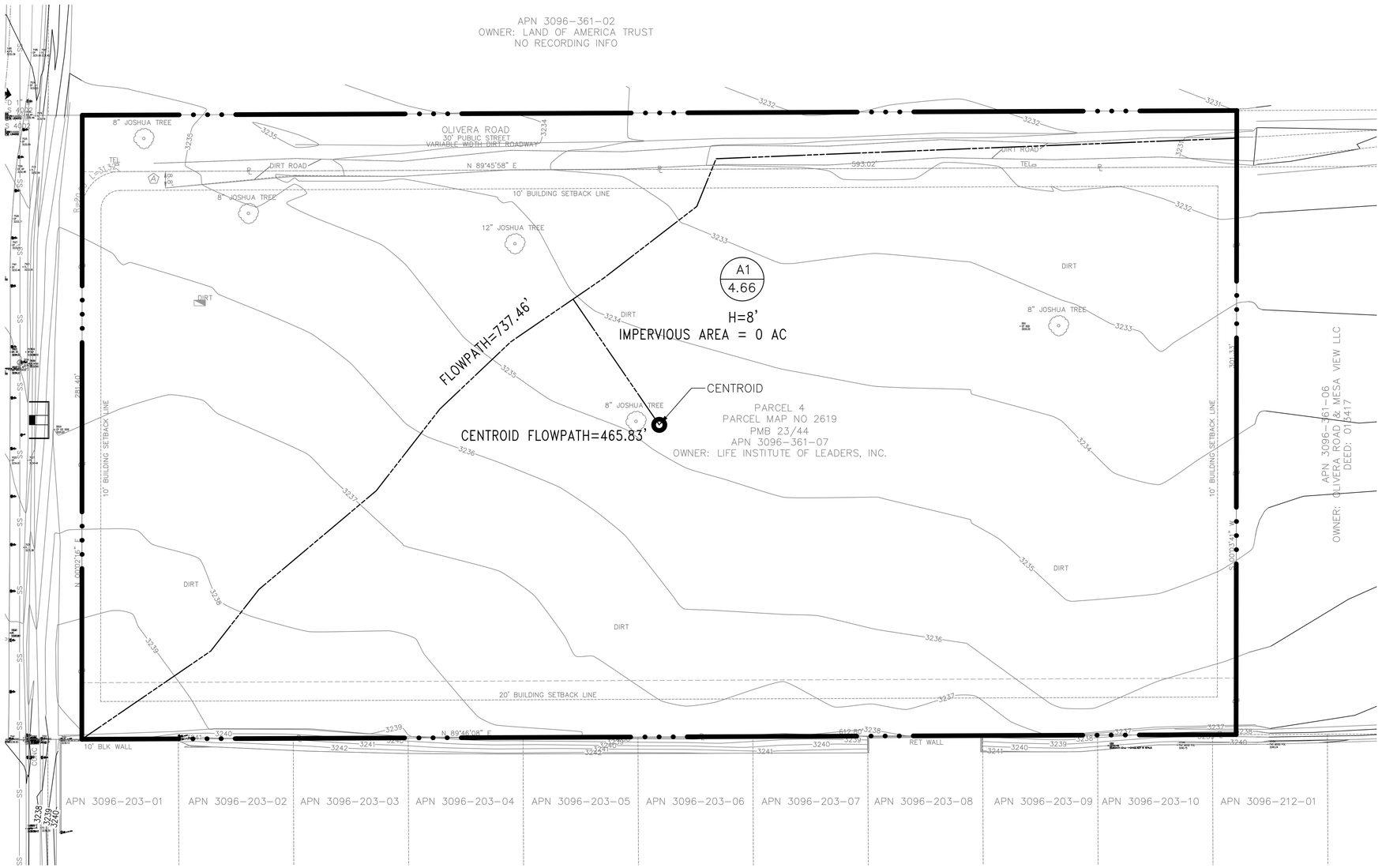
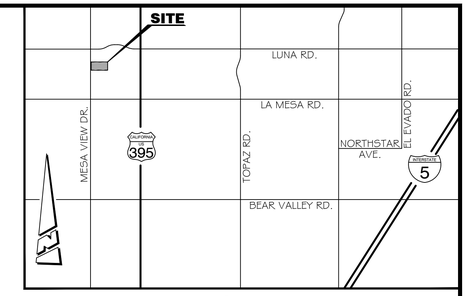



**Schematic of a Bioretention Facility (MDE, 2000)**

# EXISTING CONDITION HYDROMOD MAP
## for DESERT TRAILS MIDDLE SCHOOL




VICINITY MAP
NOT TO SCALE

## SITE ADDRESS:
MESA VIEW DRIVE, VICTORVILLE, CA 92392
SOUTH OF PEPPERWOOD STREET, NORTH OF FOREST PARK LANE, EAST OF MESA VIEW DRIVE

## ASSESSOR'S PARCEL NO.:
3096-361-07

## FLOOD ZONE DESIGNATION:
THIS PROPERTY IS IN FLOODWAY AREA ZONE X, AS IS SHOWN ON FLOOD INSURANCE RATE MAPS FOR THE COUNTY OF SAN BERNARDINO, CALIFORNIA, SHOWN ON COMMUNITY PANEL NUMBER 06071C6475H.

## ON-SITE DISTURBED AREA:
4.66 ACRES

## LEGEND:
- DX X / X.XX AC / XXXXXXXXXXXX — AREA ID / AREA IN ACRES / DESCRIPTION
- DA 1
- DMA 1
- FLOW LINE
- DRAINAGE FLOW DIRECTION
- PROP. BLDG PERIMETER
- BOUNDARY LINE
- RIGHT OF WAY
- CENTERLINE
- FLOW LINE
- FENCE LINE
- DRAINAGE MANAGEMENT AREA
- (XXX) EX. CONTOUR
- [XXX] PROP. CONTOUR
- EX. PALM TREE
- EX. TREE
- EX. FIRE HYDRANT
- EX. BUILDING
- P.C.C. CONCRETE SURFACE
- PAINT HANDICAP/CROSSWALK
- PAINT DIRECTION ARROW
- PAINT PARKING STALL

0' 15' 30' 60' 90' 120'
GRAPHIC SCALE IN FEET
1" = 30'

REGISTERED PROFESSIONAL ENGINEER
JOHN H. JOHNSON
No. 83934
Exp. 9/30/19
CIVIL
STATE OF CALIFORNIA

JOHN H. JOHNSON R.C.E. 83934 DATE
MY REGISTRATION EXPIRES ON 09/30/2019

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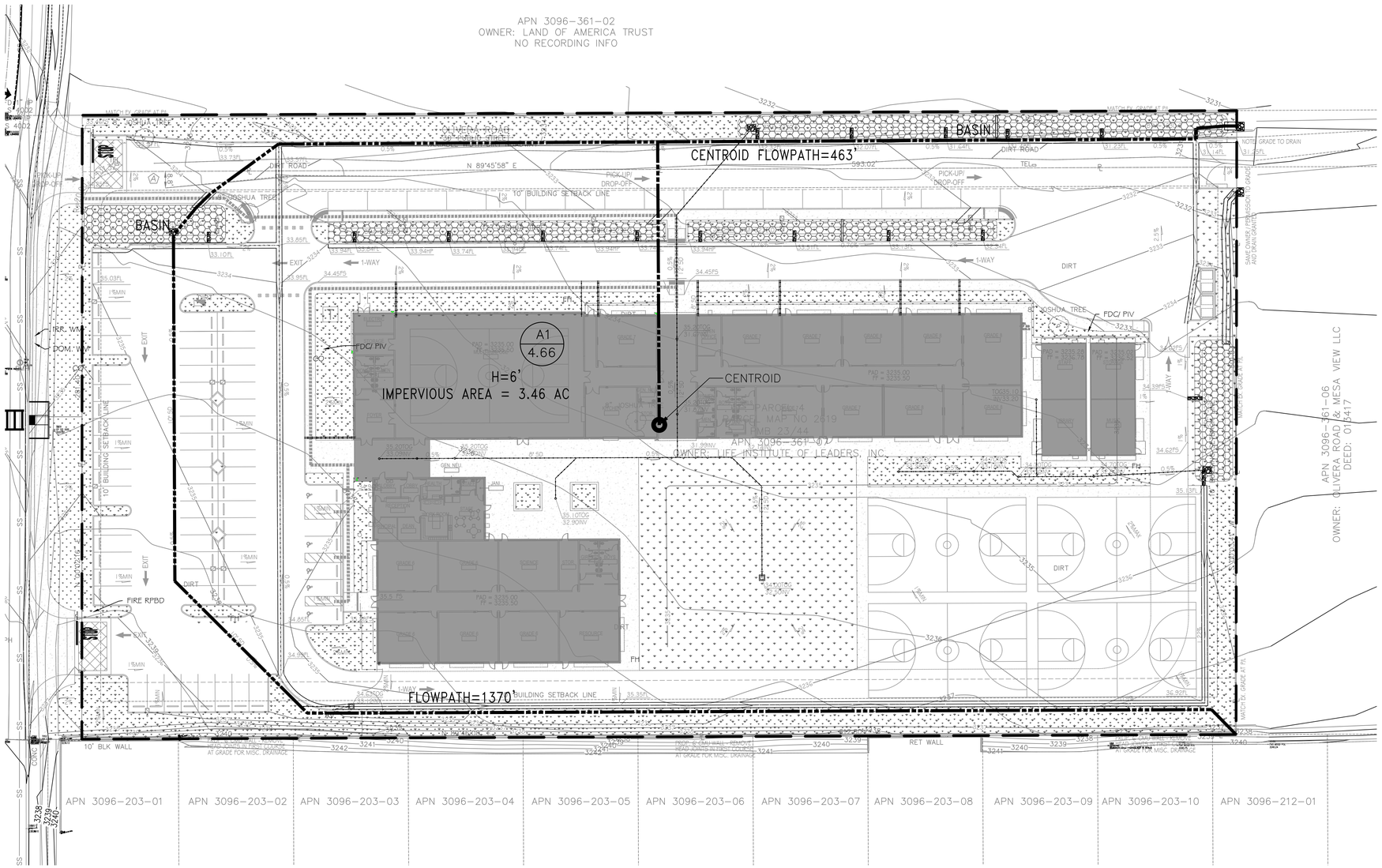
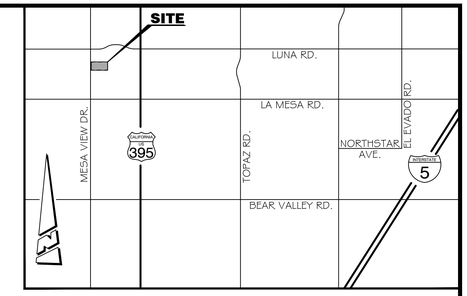
SHEET 1 OF 1

File: L02001

# PROPOSED CONDITION HYDROMOD MAP
## for DESERT TRAILS MIDDLE SCHOOL




VICINITY MAP
NOT TO SCALE

### SITE ADDRESS:
MESA VIEW DRIVE, VICTORVILLE, CA 92392
SOUTH OF PEPPERWOOD STREET, NORTH OF FOREST PARK LANE, EAST OF MESA VIEW DRIVE

### ASSESSOR'S PARCEL NO.:
3096-361-07

### FLOOD ZONE DESIGNATION:
THIS PROPERTY IS IN FLOODWAY AREA ZONE X, AS IS SHOWN ON FLOOD INSURANCE RATE MAPS FOR THE COUNTY OF SAN BERNARDINO, CALIFORNIA, SHOWN ON COMMUNITY PANEL NUMBER 06071C6475H.

### ON-SITE DISTURBED AREA:
4.66 ACRES

### LEGEND:
- DX X / X.XX AC / XXXXXXXXXX — AREA ID / AREA IN ACRES / DESCRIPTION
- DA 1
- DMA 1
- FLOW LINE
- DRAINAGE FLOW DIRECTION
- PROP. BLDG PERIMETER
- BOUNDARY LINE
- RIGHT OF WAY
- CENTERLINE
- FLOW LINE
- FENCE LINE
- DRAINAGE MANAGEMENT AREA
- (XXX) EX. CONTOUR
- [XXX] PROP. CONTOUR
- EX. PALM TREE
- EX. TREE
- EX. FIRE HYDRANT
- EX. BUILDING
- P.C.C. CONCRETE SURFACE
- PAINT HANDICAP/CROSSWALK
- PAINT DIRECTION ARROW
- PAINT PARKING STALL

0' 15' 30' 60' 90' 120'
GRAPHIC SCALE IN FEET
1" = 30'

REGISTERED PROFESSIONAL ENGINEER
JOHN H. JOHNSON
No. 83934
Exp. 9/30/19
CIVIL
STATE OF CALIFORNIA

JOHN H. JOHNSON R.C.E. 83934 DATE
MY REGISTRATION EXPIRES ON 09/30/2019

KOLIBRIEN®
LAND SURVEYING - CIVIL ENGINEERING - STRUCTURAL ENGINEERING

SHEET 1 OF 1

File: L02001

# Appendix E
# Soils Report

John R. Byerly
INCORPORATED

May 21, 2019

Desert Trails Preparatory Academy
14350 Bellflower Street
Adelanto, California 92301

Rpt. No.: 5856
File No.: S-14158

Attention: Debra Tarver, CEO

Project: Desert Trails Preparatory Academy Middle School, East Side of Mesa View Drive, North of Forest Park Lane, Victorville, California

Subject: Infiltration Rate Study for Storm Water Disposal

References:
(a) San Bernardino County Stormwater Program, Technical Guidance Document for Water Quality Management Plans (WQMP), June 7, 2013

(b) e-mail re: Desert Trails Preparatory Academy Middle School, John Johnson, Kolibrien, February 19, 2019 with attached Annotated Percolation Test Location Plan

(c) Preliminary Soils Investigation, Desert Trails Preparatory Academy Middle School, John R. Byerly, Inc., Rpt. No. 5854, May 23, 2019

Ladies and Gentlemen:

We understand that further development of the new middle school will include the construction of infiltration systems for storm water disposal. The referenced annotated percolation test location plan identifies three areas in which infiltration systems will be constructed. An investigation of the percolation characteristics of the subsoils underlying these areas was performed by this firm during February of 2019. The purpose of our percolation investigation was to assist in the determination of suitable infiltration rate for design of the proposed infiltration systems.

## PROJECT DESCRIPTION

For the preparation of this report, we reviewed the referenced San Bernardino County's Technical Guidance Document for Water Quality Management Plans (Reference a), the referenced preliminary soils investigation report (Reference c), and the referenced annotated percolation test location plan (Reference b). We understand that a new middle school is proposed and will consist of three buildings separated by two breezeways and with a combined footprint area of about

35,440 square feet. We also understand that the buildings will be of concrete tilt-up or concrete block masonry construction incorporating concrete slab-on-grade floors. A parking lot, student pick-up/drop-off drive, fire lane, hardscape, and turf field areas will also be developed. As part of the development, infiltration systems are planned to dispose of storm water runoff. We have been informed by the project civil engineer that the bottom of each infiltration system will be 4 feet below the presently existing ground surface. The site configuration is illustrated on Enclosure 1.

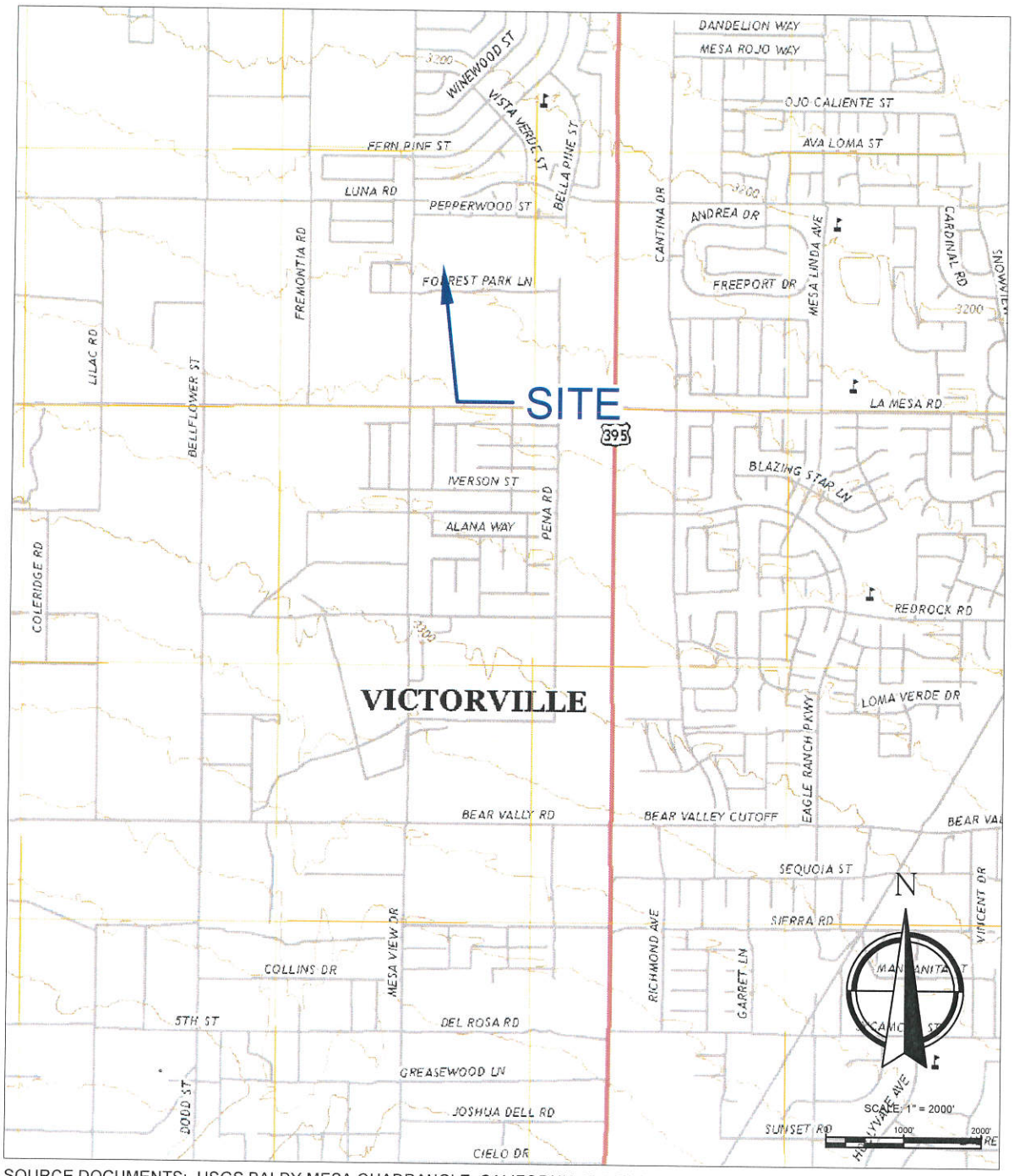
## REVIEW OF GEOTECHNICAL REPORT

A preliminary soils investigation was performed for the new middle school by our firm as described in Reference (c). The subsurface explorations consisted of eight test borings drilled with a four-wheel drive truck-mounted flight-auger to depths of up to 51.5 feet below the existing ground surface. Also, six shallow borings were drilled to a depth of 6 feet in the vicinity of the new parking lot, driveways, fire lane, hardcourt, and ball field areas. Artificial fill was not encountered in our explorations. The upper natural soils encountered in these explorations generally consisted of loose to dense sands and silty sands with varying amounts of gravel. The deeper soils consisted of dense to very dense sands and silty sands with varying amounts of gravel. Ground water was not encountered in these explorations. Some of the test borings were placed in close proximity (less than 100 feet) of the areas proposed for the storm water disposal systems. Laboratory testing included maximum density, gradation, sand equivalent, "R" value, and chemical tests. This report presented grading and foundation design recommendations. Recommendations are also provided for the design of asphalt concrete and portland cement concrete pavement for vehicle drive and parking areas, and for portland cement concrete pavement to receive only pedestrian traffic.

## SITE CONDITIONS

The 4.31-acre site is located on the east side of Mesa View Drive and north of Forest Park Lane in the city of Victorville. An Index Map showing the general vicinity of the site is presented on the following page. The coordinates of the site are latitude 34.4898° N and longitude 117.4071° W

# INDEX MAP




SOURCE DOCUMENTS: USGS BALDY MESA QUADRANGLE, CALIFORNIA, 7.5 MINUTE SERIES, 2018

TOWNSHIP AND RANGE: SECTION 28, T5N, R5W

LATITUDE: 34.4898° N

LONGITUDE: 117.4071° W

John R. Byerly INCORPORATED

Rpt. No.: 5856
File No.: S-14158

utilizing the North American Datum 1983 (NAD 1983). The area proposed for the new middle school is currently vacant. The ground surface throughout the property is covered with a light to moderate growth of weeds and sagebrush. Single-family residences occupy the properties to the south and west across Mesa View Drive. The remaining surrounding properties are vacant. The area topography is generally flat, and the site slopes downward to the northeast at an average gradient of less than 1½ percent.

## FIELD INVESTIGATION

We explored the soils underlying the three areas currently proposed for infiltration systems by means of six test borings excavated with a four-wheel drive truck-mounted flight-auger to depths ranging from about 45.0 inches to 50.0 inches below the existing ground surface. The approximate locations of the field explorations are shown on Enclosure 1. The soils encountered were examined and visually classified by one of our field engineers. A summary of the soil classifications appears as Enclosure 2. The exploration logs show subsurface conditions at the dates and locations indicated, and may not be representative of subsurface conditions at other locations and times. The stratification depths presented on the logs represent the approximate soil type boundaries.

San Bernardino County's Technical Guidance Document for Water Quality Management Plans (Reference a) incorporates Low Impact Development (LID) Best Management Practices (BMPs) to the maximum extent practicable. Table VII.1, Appendix VII of Reference (a) provides required methods of establishing design infiltration rates. We investigated the percolation characteristics of the subsoils in the three areas designated for infiltration systems by a total of six percolation tests, two tests in each designated system area, using the falling-head test method. Percolation testing was performed using the borehole-type method and following test procedures required by Reference (a).

On February 22, 2019, percolation testing was performed at six locations. The weather condition was dry and cool with an average temperature of 48 degrees Fahrenheit. Two inches of clean gravel were placed in the bottoms of the test holes. Perforated plastic cans, 12 inches in height and 6 inches in diameter, were then placed in the test holes to control scour. Clear water was introduced into each test hole, and the soils were allowed to soak and condition overnight prior to determination of the percolation rate. The following day, water was reintroduced into the test holes, and the water was allowed to percolate into the soil. At timed intervals, the level of water was measured and additional water was added to the test holes. The test was continued until steady-state conditions were attained. Enclosure 3 presents the field test data. Percolation rates have been corrected for the contribution of the test hole sidewall.

## SOIL CONDITIONS

Artificial fill was not encountered in our explorations. The underlying natural soils consisted of medium dense silty sands and sands with varying amounts of gravel. The soils encountered in this percolation investigation are generally consistent with the findings of our earlier preliminary soils investigation report (Reference c). Neither bedrock nor ground water was encountered at our exploration locations. Data from the State of California Department of Water Resources indicate that the water well closest to the site (05N05W21J001S) is approximately 1.1 miles to the northeast. At this location, ground water (W.S. Elevation 2791.9) was at a depth of 348.1 feet below the ground surface (G.S. Elevation 3140) during January of 1957. The ground surface elevation of the new middle school site varies from about 449.1 feet to 455.1 feet (G.S. Elevation 3241 to 3247) above the water surface elevation. We have searched the resources at the Western Municipal Water District. No well data applicable to the subject site were found. Due to the great depth to ground water, we conclude that the potential for storm water runoff contamination of ground water at this location is low.

## CONCLUSIONS AND RECOMMENDATIONS

The percolation tests yielded infiltration rates ranging from 0.5 inch per hour to 1.4 inches per hour. The infiltration rates were computed utilizing the percolation rate conversion equation (Porchet Method, aka Inverse Borehole Method) provided by the San Bernardino County's Technical Guidance Document for Water Quality Management Plans (Reference a), which accommodates the contribution of the test hole sidewall to the measured percolation rate. The percolation rate conversion equation is presented below.

$$I_t = \frac{\Delta H \text{ (60 min./hr.) } r}{\Delta t \ (r + 2\ H_{avg})}$$

*Where:* $I_t$ = *tested infiltration rate (in./hr.)*

$\Delta t$ = *time interval (min.)*

$r$ = *test hole radius (in.)*

$\Delta H$ = *change in height over the time interval (in.)*

$H_{avg}$ = *average head height over the time interval (in.)*

The converted percolation rates are presented in the following table.

| Percolation Number | Depth of Test (inches) | Converted Percolation Rate (inch per hour) |
|---|---|---|
| P-1 | 47.0 | 1.1 |
| P-2 | 49.0 | 1.4 |
| P-3 | 48.0 | 0.5 |
| P-4 | 46.0 | 1.1 |
| P-5 | 50.0 | 0.5 |
| P-6 | 45.0 | 0.5 |

A safety factor has not been applied to these design values. We note that the tests conducted in Percolation Test Nos. 3, 5, and 6 yielded slow percolation rates. It is our opinion that the slow infiltration rates are attributable to the fine grained and medium dense nature of the soil that will likely underlie the proposed infiltration system areas. The depth of percolation testing performed during this investigation corresponds to the depth representative of the bottom elevation of the proposed infiltration systems.

We appreciate this opportunity to be of service. Should there be questions, please feel free to contact this office.

Respectfully submitted,

**JOHN R. BYERLY, INC.**

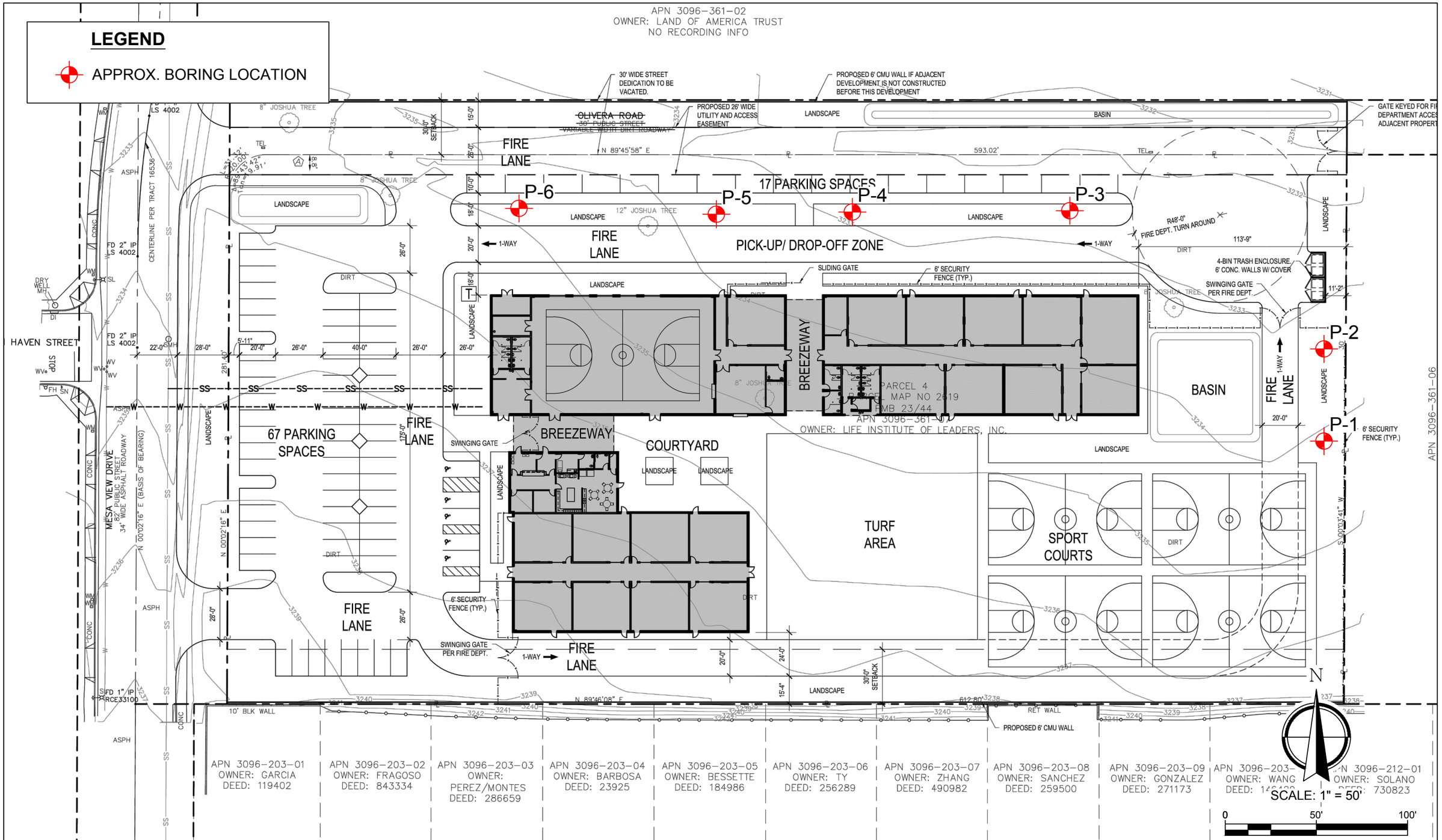
REGISTERED PROFESSIONAL ENGINEER
JOHN R. BYERLY
No. GE000179
Exp. Date 6-30-19
GEOTECHNICAL
STATE OF CALIFORNIA

John R. Byerly, Geotechnical Engineer
President

JRB:MLL:jet

Enclosures: (1) Plot Plan
(2) Exploration Logs
(3) Summary of Field Test Data

Copies: (1) Client
(1) MAA Architects, Inc.
(1) Kolibrien




SOURCE DOCUMENT: SITE PLAN, MAA ARCHITECTS, 05 OCTOBER 2018

| | | | |
|---|---|---|---|
| John R. Byerly INCORPORATED | INFILTRATION RATE STUDY | DESERT TRAILS PREPARATORY ACADEMY MIDDLE SCHOOL<br>MESA VIEW DRIVE<br>VICTORVILLE, CALIFORNIA | Enclosure 1<br>Rpt. No.: 5856<br>File No.: S-14158 |

# P-1

| Depth | Std. Pen. "N" Value | Blows/Ft. | Dry Density (PCF) | Moisture Content (%) | Rel. Compaction (%) | Water Table | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GWT not encountered | SM | Light gray-brown silty fine to coarse sand, dry and medium dense (ORIGINAL GROUND) |
| | | | | | | | SP | Light gray-brown fine to coarse sand with gravel, dry and medium dense |
| 5 | | | | | | | | Total Depth at 4.1 Feet<br>No Free Ground Water Encountered |
| 10 | | | | | | | | |
| 15 | | | | | | | | |
| 20 | | | | | | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |
| 35 | | | | | | | | |

**Boring Date: 2/21/19**
**Surface Elevation:**
**Drilling Method: Four-Wheel Drive Flight-Auger**

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECTS-14158 (Rpt. No. 5856).log Date: 5/22/2019

## LOG OF BORING

# P-2

**Boring Date: 2/21/19**
**Surface Elevation:**
**Drilling Method: Four-Wheel Drive Flight-Auger**

| Depth | Std. Pen. "N" Value | Blows/Ft. | Dry Density (PCF) | Moisture Content (%) | Rel. Compaction (%) | Water Table | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GWT not encountered | SM | Light gray-brown silty fine to coarse sand, dry and medium dense (ORIGINAL GROUND) |
| | | | | | | | SP | Light gray-brown fine to coarse sand with some gravel, dry and medium dense |
| 5 | | | | | | | | Total Depth at 4.3 Feet<br>No Free Ground Water Encountered |
| 10 | | | | | | | | |
| 15 | | | | | | | | |
| 20 | | | | | | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |
| 35 | | | | | | | | |

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECT\S-14158 (Rpt. No. 5856).log Date: 5/22/2019

## LOG OF BORING

**John R. Byerly, Inc.**

**Desert Trails Preparatory Academy Middle School**

Enclosure 2, Page 2
Rpt. No.: 5856
File No.: S-14158

# P-3

| Depth | Std. Pen. "N" Value | Blows/Ft. | Dry Density (PCF) | Moisture Content (%) | Rel. Compaction (%) | Water Table | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GWT not encountered | SM | Brown silty fine to coarse sand, dry and medium dense (ORIGINAL GROUND) |
| | | | | | | | SP | Light gray-brown fine to coarse sand with some silt, dry and medium dense |
| 5 | | | | | | | | Total Depth at 4.2 Feet<br>No Free Ground Water Encountered |
| 10 | | | | | | | | |
| 15 | | | | | | | | |
| 20 | | | | | | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |
| 35 | | | | | | | | |

**Boring Date: 2/21/19**
**Surface Elevation:**
**Drilling Method: Four-Wheel Drive Flight-Auger**

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECT\S-14158 (Rpt. No. 5856).log Date: 5/22/2019

## LOG OF BORING

**John R. Byerly, Inc.**

**Desert Trails Preparatory Academy Middle School**

Enclosure 2, Page 3
Rpt. No.: 5856
File No.: S-14158

# P-4

| Depth | Std. Pen. "N" Value | Blows/Ft. | Dry Density (PCF) | Moisture Content (%) | Rel. Compaction (%) | Water Table | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GWT not encountered | SM | Brown silty fine to coarse sand, dry and medium dense (ORIGINAL GROUND) |
| | | | | | | | SP | Light gray-brown fine to coarse sand with some gravel, dry and medium dense |
| 5 | | | | | | | | Total Depth at 4.0 Feet<br>No Free Ground Water Encountered |
| 10 | | | | | | | | |
| 15 | | | | | | | | |
| 20 | | | | | | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |
| 35 | | | | | | | | |

**Boring Date: 2/21/19**
**Surface Elevation:**
**Drilling Method: Four-Wheel Drive Flight-Auger**

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECTS-14158 (Rpt. No. 5856).log Date: 5/22/2019

## LOG OF BORING

| | | |
|---|---|---|
| ***John R. Byerly, Inc.*** | **Desert Trails Preparatory Academy Middle School** | **Enclosure 2, Page 4**<br>**Rpt. No.: 5856**<br>**File No.: S-14158** |

# P-5

| Depth | Std. Pen. "N" Value | Blows/Ft. | Dry Density (PCF) | Moisture Content (%) | Rel. Compaction (%) | Water Table | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GWT not encountered | SM | Gray-brown silty fine to coarse sand, dry and medium dense (ORIGINAL GROUND) |
| | | | | | | | SP | Light gray-brown fine to coarse sand, dry and medium dense |
| 5 | | | | | | | | Total Depth at 4.3 Feet<br>No Free Ground Water Encountered |
| 10 | | | | | | | | |
| 15 | | | | | | | | |
| 20 | | | | | | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |
| 35 | | | | | | | | |

**Boring Date: 2/21/19**
**Surface Elevation:**
**Drilling Method: Four-Wheel Drive Flight-Auger**

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECTS-14158 (Rpt. No. 5856).log Date: 5/22/2019

## LOG OF BORING

# P-6

| Depth | Std. Pen. "N" Value | Blows/Ft. | Dry Density (PCF) | Moisture Content (%) | Rel. Compaction (%) | Water Table | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GWT not encountered | SM | Gray-brown silty fine to coarse sand, dry and medium dense |
| | | | | | | | SP | Light gray-brown fine to coarse sand, dry and medium dense |
| 5 | | | | | | | | Total Depth at 3.8 Feet<br>No Free Ground Water Encountered |
| 10 | | | | | | | | |
| 15 | | | | | | | | |
| 20 | | | | | | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |
| 35 | | | | | | | | |

**Boring Date: 2/21/19**
**Surface Elevation:**
**Drilling Method: Four-Wheel Drive Flight-Auger**

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECTS-14158 (Rpt. No. 5856).log Date: 5/22/2019

## LOG OF BORING

**John R. Byerly, Inc.**

**Desert Trails Preparatory Academy Middle School**

# JOHN R. BYERLY, INC.

## PERCOLATION TEST DATA SHEET

Job: Desert Trails Preparatory Academy Middle School S-14158 Date: 2-22-19 By: Eric Johnson Remarks:

Perc. No. 1 Dia. (in.) 8.0
Depth of Test 47.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 6:26 | 35.0 | 2.4 |
| 6:56 | 41.5 | |
| 6:57 | 35.0 | 1.6 |
| 7:27 | 39.75 | |
| 7:28 | 35.0 | 1.4 |
| 7:58 | 39.25 | |
| 7:59 | 35.0 | 1.4 |
| 8:29 | 39.25 | |
| 8:30 | 35.0 | 1.3 |
| 9:00 | 39.0 | |
| 9:01 | 35.0 | 1.3 |
| 9:31 | 39.0 | |
| 9:32 | 35.0 | 1.2 |
| 10:02 | 38.75 | |
| 10:03 | 35.0 | 1.2 |
| 10:33 | 38.75 | |
| 10:34 | 35.0 | 1.2 |
| 11:04 | 38.75 | |
| 11:05 | 35.0 | 1.1 |
| 11:35 | 38.5 | |

Perc. No. 1 Dia. (in.) 8.0
Depth of Test 47.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 11:36 | 35.0 | 1.1 |
| 12:06 | 38.5 | |
| 12:07 | 35.0 | 1.1 |
| 12:37 | 38.5 | |

Perc. No. 2 Dia. (in.) 8.0
Depth of Test 49.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 6:28 | 37.0 | 2.8 |
| 6:58 | 44.25 | |
| 6:59 | 37.0 | 2.3 |
| 7:29 | 43.25 | |
| 7:30 | 37.0 | 2.1 |
| 8:00 | 42.75 | |
| 8:01 | 37.0 | 1.9 |
| 8:31 | 42.25 | |
| 8:32 | 37.0 | 1.7 |
| 9:02 | 42.0 | |
| 9:03 | 37.0 | 1.6 |
| 9:33 | 41.75 | |
| 9:34 | 37.0 | 1.6 |
| 10:04 | 41.75 | |
| 10:05 | 37.0 | 1.5 |
| 10:35 | 41.5 | |
| 10:36 | 37.0 | 1.5 |
| 11:06 | 41.5 | |
| 11:07 | 37.0 | 1.4 |
| 11:37 | 41.25 | |

Perc. No. 2 Dia. (in.) 8.0
Depth of Test 49.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 11:38 | 37.0 | 1.4 |
| 12:08 | 41.25 | |
| 12:09 | 37.0 | 1.4 |
| 12:39 | 41.25 | |

* Rate has been corrected for contribution of boring sidewall

# JOHN R. BYERLY, INC.

## PERCOLATION TEST DATA SHEET

Job: Desert Trails Preparatory Academy Middle School S-14158 Date: 2-22-19 By: Eric Johnson Remarks:

Perc. No. 3 Dia. (in.) 8.0
Depth of Test 48.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 6:31 | 36.0 | 1.4 |
| 7:01 | 40.25 | |
| 7:02 | 36.0 | 1.2 |
| 7:32 | 39.75 | |
| 7:33 | 36.0 | 1.0 |
| 8:03 | 39.0 | |
| 8:04 | 36.0 | 0.9 |
| 8:34 | 38.75 | |
| 8:35 | 36.0 | 0.8 |
| 9:05 | 38.5 | |
| 9:06 | 36.0 | 0.7 |
| 9:36 | 38.25 | |
| 9:37 | 36.0 | 0.7 |
| 10:07 | 38.25 | |
| 10:08 | 36.0 | 0.6 |
| 10:38 | 38.0 | |
| 10:39 | 36.0 | 0.6 |
| 11:09 | 38.0 | |
| 11:10 | 36.0 | 0.5 |
| 11:40 | 37.75 | |

Perc. No. 3 Dia. (in.) 8.0
Depth of Test 48.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 11:41 | 36.0 | 0.5 |
| 12:11 | 37.75 | |
| 12:12 | 36.0 | 0.5 |
| 12:42 | 37.75 | |

Perc. No. 4 Dia. (in.) 8.0
Depth of Test 46.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 6:33 | 34.0 | 2.4 |
| 7:03 | 40.5 | |
| 7:04 | 34.0 | 2.0 |
| 7:34 | 39.5 | |
| 7:35 | 34.0 | 1.7 |
| 8:05 | 39.0 | |
| 8:06 | 34.0 | 1.6 |
| 8:36 | 38.75 | |
| 8:37 | 34.0 | 1.5 |
| 9:07 | 38.5 | |
| 9:08 | 34.0 | 1.4 |
| 9:38 | 38.25 | |
| 9:39 | 34.0 | 1.3 |
| 10:09 | 38.0 | |
| 10:10 | 34.0 | 1.2 |
| 10:40 | 37.75 | |
| 10:41 | 34.0 | 1.2 |
| 11:11 | 37.75 | |
| 11:12 | 34.0 | 1.1 |
| 11:42 | 37.5 | |

Perc. No. 4 Dia. (in.) 8.0
Depth of Test 46.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 11:43 | 34.0 | 1.1 |
| 12:13 | 37.5 | |
| 12:14 | 34.0 | 1.1 |
| 12:44 | 37.5 | |

* Rate has been corrected for contribution of boring sidewall

# JOHN R. BYERLY, INC.

## PERCOLATION TEST DATA SHEET

Job: Desert Trails Preparatory Academy Middle School S-14158 Date: 2-22-19 By: Eric Johnson Remarks:

Perc. No. 5 Dia. (in.) 8.0
Depth of Test 50.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 6:35 | 38.0 | 1.4 |
| 7:05 | 42.25 | |
| 7:06 | 38.0 | 1.1 |
| 7:36 | 41.25 | |
| 7:37 | 38.0 | 0.9 |
| 8:07 | 40.75 | |
| 8:08 | 38.0 | 0.8 |
| 8:38 | 40.5 | |
| 8:39 | 38.0 | 0.7 |
| 9:09 | 40.25 | |
| 9:10 | 38.0 | 0.7 |
| 9:40 | 40.25 | |
| 9:41 | 38.0 | 0.6 |
| 10:11 | 40.0 | |
| 10:12 | 38.0 | 0.6 |
| 10:42 | 40.0 | |
| 10:43 | 38.0 | 0.5 |
| 11:13 | 39.75 | |
| 11:14 | 38.0 | 0.5 |
| 11:44 | 39.5 | |

Perc. No. 5 Dia. (in.) 8.0
Depth of Test 50.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 11:45 | 38.0 | 0.5 |
| 12:15 | 39.5 | |
| 12:16 | 38.0 | 0.5 |
| 12:46 | 39.5 | |

Perc. No. 6 Dia. (in.) 8.0
Depth of Test 45.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 6:37 | 33.0 | 1.3 |
| 7:07 | 37.0 | |
| 7:08 | 33.0 | 1.1 |
| 7:38 | 36.25 | |
| 7:39 | 33.0 | 1.0 |
| 8:09 | 36.0 | |
| 8:10 | 33.0 | 0.9 |
| 8:40 | 35.75 | |
| 8:41 | 33.0 | 0.8 |
| 9:11 | 35.5 | |
| 9:12 | 33.0 | 0.7 |
| 9:42 | 35.25 | |
| 9:43 | 33.0 | 0.6 |
| 10:13 | 35.0 | |
| 10:14 | 33.0 | 0.5 |
| 10:44 | 34.75 | |
| 10:45 | 33.0 | 0.5 |
| 11:15 | 34.75 | |
| 11:16 | 33.0 | 0.5 |
| 11:46 | 34.5 | |

Perc. No. 6 Dia. (in.) 8.0
Depth of Test 45.0 in.

| Time Read | Read. (in.) | * Rate (in/hr) |
|---|---|---|
| 11:47 | 33.0 | 0.5 |
| 12:17 | 34.5 | |
| 12:18 | 33.0 | 0.5 |
| 12:48 | 34.5 | |

* Rate has been corrected for contribution of boring sidewall