Welcome

- Sign-In
- Restrooms
- Acronyms - Refer to handout
- Break
- Q&A
Training Goal

- Introduce new concepts of the Model BMP Design Manual by working through an example project

Training will **not** address:
- Policies
- Local Jurisdictional Procedures
- Alternative Compliance Program
Training Format

- Provide Manual References (see placeholder below)
- Introduce Concepts and Criteria
- Example Project
  - Real design for past project
  - What if scenarios for added information

Model BMP Design Manual Reference (Chapter/Appendix _._)
Training Outline

- Introduction of the Model BMP Design Manual
- Applicability of Storm Water Requirements
- Site Investigation, Feasibility, and Site Layout
- Break
- Pollutant Control Design
- Hydromodification Management Design
- Maintenance Requirements
Model BMP Design Manual
Introduction

Jayne Janda-Timba, P.E., ToR, QSD, QSP
Laura Henry, P.E.
Rick Engineering Company
Project Team

- Copermittees Sub-Workgroup
  - Sumer Hasenin, P.E., Chair
- Rick Engineering Company
  - Jayne Janda-Timba, P.E.
  - Laura Henry, P.E.
- Geosyntec Consultants
  - Trevor Alsop, P.E.
  - Aaron Poresky, P.E.
  - Venkat Gummadi, P.E.
Model BMP Design Manual

- Provides regional procedures for compliance with 2013 MS4 Permit
- Replaces Model SUSMP (2007 MS4 Permit)
- Applies to New Development and Redevelopment Projects
- Applies to Private and Public Projects
Regional Model intended to be customized by each of the 21 Copermittees in San Diego County

Posted to Project Clean Water: June 27, 2015

Effective Date: December 24, 2015*

* November 18, 2015 RWQCB board hearing may provide an extension to the effective date.
Model to Local Manual

- All jurisdictions must adopt and post a local BMP Design Manual
- Local manuals use the model manual as the template and complete the gray boxes that require local information
  - Local watershed information and requirements
  - Local programs and processes (e.g., local permitting processes)
  - Local preferences (e.g., submittal formats)
Model BMP Design Manual - Appendices

A. Submittal Templates
B. Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods
C. Geotechnical and Groundwater Investigation Requirements
D. Approved Infiltration Rate Assessment Methods for Selection and Design of Storm Water BMPs
E. BMP Design Fact Sheets
F. Biofiltration Standard and Checklist

G. Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

H. Guidance for Investigating Potential Critical Coarse Sediment Yield Areas

I. Forms and Checklists
Development Planning Requirements

- BMP Requirements for ALL Development Projects (Source Control and Site Design)
- Priority Development Projects (PDPs)
  - Definitions of PDPs
  - PDP Exemptions – Green Streets
  - Storm Water Pollutant Control Requirements
  - Hydromodification Management Requirements
  - Offsite Alternative Compliance Option (not covered in this training)
Standard Project vs. PDP

**Standard Project**
- Standard Source Control
- Standard Low-Impact Development (Site Design)

**Priority Development Project**
- Source Control & Site Design
- Pollutant Control
- Hydromodification Management (HM)

Analyses
Determine if HM Applies

Chapter 1 and 2
## Changes to PDP Categories

<table>
<thead>
<tr>
<th>Land Use</th>
<th>2007 Permit [Total Project Area]</th>
<th>2013 Permit [Total Impervious Area]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>10 dwelling units</td>
<td>≥10,000 sf</td>
</tr>
<tr>
<td>Commercial</td>
<td>1 acre</td>
<td>≥10,000 sf</td>
</tr>
<tr>
<td>Industrial</td>
<td>1 acre</td>
<td>≥10,000 sf</td>
</tr>
<tr>
<td>Public Improvements</td>
<td>1 acre</td>
<td>≥10,000 sf</td>
</tr>
<tr>
<td>Parking</td>
<td>≥5,000 sf OR ≥15 Parking Spaces</td>
<td>≥5,000 sf</td>
</tr>
</tbody>
</table>
Site Design BMPs

- PDP classification in the 2013 Permit is based on impervious area created and/or replaced.
- Incorporate site design BMPs such as permeable surfaces (with no liners) to minimize the impervious area created and/or replaced by the project.
Changes to Pollutant Control Requirements

- Significant changes to the hierarchy of treatment (pollutant control) requirements
  - 2007 MS4 Permit
    - Treat and release runoff
    - Infiltration or bioretention preferred
    - Filtration and/or extended detention also accepted
Changes to Pollutant Control Requirements

- Significant changes to the hierarchy of treatment (pollutant control) requirements
  - 2013 MS4 Permit
    - **Retain** onsite 85th percentile runoff (infiltrate, evaporate, evapotranspire, harvest and use)
    - **Biofiltration** if infeasible to retain runoff onsite
    - **Flow-thru treatment control BMPs AND mitigate (offsite)** for the design capture volume not retained onsite, if infeasible to retain or use biofiltration
Changes to Hydromodification Management Requirements

- Changes to applicability / exemption criteria
- Requirement to control to “pre-development” condition instead of “pre-project” condition
- New requirement to protect critical coarse sediment yield areas
What is NOT Changing

- Flow control performance standard (range of flow rates to be controlled)
  - 0.1, 0.3, or 0.5Q2 to Q10
- Methods to determine lower flow threshold
  - SCCWRP Channel Screening Tools
- San Diego 2011 Final HMP is not being updated
  - 2011 HMP components are incorporated into the Model BMP Design Manual with modifications as necessary
Designing for “Pre-Development”

- Pre-development condition runoff means runoff conditions from the project footprint based on:
  - Infiltration characteristics of the underlying soil
  - Existing grade
  - No impervious area
Coarse Sediment Protection

- A critical coarse sediment yield area is an area that has been identified as an active or potential source of coarse sediment to downstream channel reaches.
- Potential critical coarse sediment yield areas for each watershed management area are delineated in the associated WMAA.
- ArcGIS shapefile and Google Earth kmz files are available for download from project clean water:
Coarse Sediment Protection

- Model BMP Manual allows for:
  - Site specific analysis to refine the map and/or
  - Implement project-specific onsite measures so that there is no net impact to the receiving waters
Questions
Example Project Set Up

Determination of Applicable Storm Water Requirements

Trevor Alsop, P.E.
Venkat Gummadi, P.E.
Geosyntec Consultants
Example Project

### Project Characteristics

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Area</td>
<td>3.1 Acres</td>
</tr>
<tr>
<td>Disturbed Area</td>
<td>3.1 Acres</td>
</tr>
<tr>
<td>Proposed Impervious Area</td>
<td>2.0 Acres</td>
</tr>
<tr>
<td>Proposed Pervious Area</td>
<td>1.1 Acres</td>
</tr>
<tr>
<td>Proposed Land Use</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
</tr>
<tr>
<td>Parking Lot</td>
<td></td>
</tr>
</tbody>
</table>
Existing Land Cover

Undeveloped

- Previously graded, not built out.
- Vegetated cover.
- No existing natural hydrologic features

Current Status
Identifying Requirements

Is Project a Development Project?
- YES
- NO

Is Project a Priority Development Project?
- YES
- NO

Is Hydromodification Management Applicable?
- YES
- NO

Not a Development Project
Standard Project
PDP with Only Pollutant Control Requirements
PDP with Pollutant Control and Hydromodification Management Requirements
Is project a development project?

<table>
<thead>
<tr>
<th>Step</th>
<th>Answer</th>
<th>Progression</th>
</tr>
</thead>
</table>
| Step 1: Is the project a "development project"?  
See Section 1.3 of the manual for guidance. | ☑ Yes | Go to Step 2. |

☐ No  
Stop.  
Permanent BMP requirements do not apply. No SWQMP will be required.  
Provide discussion below.

Discussion / justification if the project is not a "development project" (e.g., the project includes only interior remodels within an existing building):

➢ Routine Maintenance
➢ Interior Remodels
➢ Additional local guidance may be available

TABLE I-2. Applicability of Permanent, Post-Construction Storm Water Requirements

Do permanent storm water requirements apply to your project?

Requirements DO NOT apply to:
- Replacement of impervious surfaces that are part of a routine maintenance activity, such as:
  - Replacing roof material on an existing building
  - Rebuilding a structure to original design after damage from earthquake, fire or similar disasters
  - Restoring pavement or other surface materials affected by trenches from utility work
  - Resurfacing existing roads and parking lots, including slurry, overlay and restriping
  - Routine replacement of damaged pavement, including full depth replacement, if the sole purpose is to repair the damage
  - Constructing new sidewalk, pedestrian ramps or bike lanes on existing roads (within existing street right-of-way)
  - Restoring a historic building to its original historic design

Repair or improvements to an existing building or structure that do not alter the size:
- Plumbing, electrical and HVAC work
- Interior alterations including major interior remodels and tenant build-out within an existing commercial building
- Exterior alterations that do not change the general dimensions and structural framing of the building (does not include building additions or projects where the existing building is demolished)
Identifying Requirements

1. Is Project a Development Project?
   - NO → Not a Development Project
   - YES → Is Project a Priority Development Project?
     - NO → Standard Project
     - YES → Is Hydromodification Management Applicable?
       - YES → PDP with Pollutant Control and Hydromodification Management Requirements
       - NO → PDP with Only Pollutant Control Requirements
**Is project a PDP?**

**Step 2:** Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions?
To answer this item, see Section 1.4 of the BMP Design Manual *in its entirety* for guidance, AND complete Form I-2, Project Type Determination.

<table>
<thead>
<tr>
<th>Standard Project</th>
<th>PDP</th>
<th>Exception to PDP definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>✅</td>
<td>☐</td>
</tr>
</tbody>
</table>

- **Stop.**
  - Only Standard Project requirements apply, including Standard Project SWQMP.

- **Stop.**
  - Standard and PDP requirements apply, including PDP SWQMP.
  - Go to Step 3.

- **Stop.**
  - Standard Project requirements apply, and any additional requirements specific to the type of project. Provide discussion and list any additional requirements below. Prepare Standard Project SWQMP.

---

**Project Type Determination Checklist**

**Form I-2**

<table>
<thead>
<tr>
<th>Project Information</th>
</tr>
</thead>
</table>

Project Name: _________________________________

Permit Application Number: _______________________

**Project Type Determination: Standard Project or PDP**

The project is (select one):  ☐ New Development  ☐ Redevelopment

The total proposed newly created or replaced impervious area is: ________ ft² (_______) acres

Is the project in any of the following categories, (a) through (f)?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>New development projects that create 10,000 square feet or more of impervious surfaces (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>☐</td>
<td>Near helps prevent soil erosion and sedimentation into water bodies.</td>
</tr>
</tbody>
</table>

---

**Form I-1 and I-2**
Identifying Requirements

Flowchart:

1. Is Project a Development Project?
   - Yes
   - No
     - Is Project a Priority Development Project?
       - Yes
       - No
         - Is Hydromodification Management Applicable?
           - Yes
           - No
             - Not a Development Project
             - Standard Project
             - PDP with Only Pollutant Control Requirements
             - PDP with Pollutant Control and Hydromodification Management Requirements
Hydromodification Applicability

- Use Figure 1-2 and associated node information to determine applicability of hydromodification management.
Downstream Receiving Waters

- Pacific Ocean
- San Dieguito Lagoon
- San Dieguito River
- Unnamed Tributary
- Storm Drain
- Project Location
**Does Hydromodification Management Apply?**

- All PDPs are subject to pollutant control; some PDPs require hydromodification control

<table>
<thead>
<tr>
<th>Step 4 (PDPs only). Do hydromodification control requirements apply?</th>
<th>YES</th>
<th>PDP structural BMPs required for pollutant control (Chapter 5) and hydromodification control (Chapter 6). Go to Step 5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Stop. PDP structural BMPs required for pollutant control (Chapter 5) only. Provide brief discussion of exemption to hydromodification control below.</td>
<td></td>
</tr>
</tbody>
</table>

Discussion / justification if hydromodification control requirements do **not** apply:
Identifying Requirements

Is Project a Development Project?

- YES
- NO

Is Project a Priority Development Project?

- YES
- NO

Is Hydromodification Management Applicable?

- YES
- NO

Not a Development Project -> Standard Project -> PDP with Only Pollutant Control Requirements -> PDP with Pollutant Control and Hydromodification Management Requirements
Coarse Sediment Protection

Potential Critical Coarse Sediment Yield Areas
San Dieguito Watershed - HU 905.00, 346 mi²

Exhibit Date: Sept. 8, 2014
Coarse Sediment Protection

Appendix H
Coarse Sediment Protection

Appendix H
### Does Coarse Sediment Requirement Apply?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ NO</td>
<td>Management measures not required for protection of critical coarse sediment yield areas. Provide brief discussion below. Stop.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I; Form I-1

The following requirements apply to the project (document using Form I-1):

- Source Control and Site Design Requirements
- Storm Water Pollutant Control Requirements
- Hydromodification Management Requirements

- Coarse sediment requirements do not apply
Questions
Site Investigation, Feasibility, and Site Layout

Aaron Poresky, P.E.
Geosyntec Consultants
Project Planning and Design

BMP Manual Planning and Design Steps

• **Step 1**: Coordinate Between Disciplines

• **Step 2**: Gather Site Information
  - Site characteristics
  - Information to determine feasibility

• **Step 3**: Develop Conceptual Site Layout and Strategies
  - Source control and site design BMPs
  - Pollutant control and HM requirements
  - Evaluate structural BMPs

• **Step 4**: Develop Complete Design
<table>
<thead>
<tr>
<th>Performance Criteria and Applicability (Ch. 1 and 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine Pollutant Control Requirements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conceptual Design (Ch. 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Investigation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Detailed/Complete Design (Ch. 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Capture Volume (DCV)</td>
</tr>
</tbody>
</table>
Key Criteria for Site Investigation and Feasibility Screening

- Is storm water quality being considered at the early phases of site investigation and layout?
- Is appropriate information presented to justify site design and BMP selection decisions (i.e., feasibility)?
- Has adequate effort been made to identify and create opportunities for higher priority BMP types?
Gather Site Information

Key Questions:

- What are the existing conditions?
- What are the proposed attributes of the project feature?
- What are the opportunities and constraints that influence BMP selection and design?
- What BMPs types are potentially applicable and feasible?

Objective:

- Provide information to justify decisions
- Provide the basis for a design that efficiently meets pollutant treatment and hydromodification requirements
- Avoid pitfalls and minimize surprises
Site Investigation Elements

Design Requirements and Setting
- Physical site information
- Proposed uses
- Special requirements
- Watershed information
- Discharge information

Design Limitations and Opportunities (Feasibility)
- Potential impacts/affects
- Constraints
- Opportunities

Design Inputs
- Site drainage plan
- BMP locations
- Infiltration/harvesting rates and quantities
Design Requirements and Setting

- **Form I-3A: Site Information Checklist (Standard)**
  - APN
  - Hydrologic Unit
  - Area
  - Existing Conditions (drainage, land use/cover, Soils)
  - Proposed Conditions

- **Form I-3B: Site Information Checklist (PDP)**
  - Depth to Ground Water
  - Receiving Water /Pollutants of Concern
  - Critical Coarse Sediment Yield Areas
  - HMP Points of Compliance (POCs)
  - Low Flow Threshold
Feasibility Considerations

Physical Limitations
- Soil infiltration rate
- Limiting soil horizons
- High, mounded groundwater

Risk of Impacts
- Groundwater and/or soil contamination
- Groundwater source protection
- Groundwater mounding
- Geotechnical, setbacks
- I&I and ephemeral streams

Site Constraints
- Elevation
- Utility Conflicts
- Physical Constraints
Feasibility Tiers

Would infiltration of the full design volume be feasible?

Yes

Full Infiltration Condition:
Select BMPs that provide full infiltration

No

Would infiltration of water in any appreciable amount be feasible?

Yes

Partial Infiltration Condition:
Select BMPs that provide opportunity for partial infiltration; desirable

No

No Infiltration Condition:
Do not use infiltration BMPs
Site Feasibility/Screening

Key Considerations

• Geotechnical constraints
  ➢ Soil and geotechnical conditions
  ➢ Settlement and volume change
  ➢ Slope stability
  ➢ Utilities
  ➢ Groundwater mounding
  ➢ Retaining walls and foundations

• Groundwater
  ➢ Soil/GW contamination
  ➢ Water table elevation
  ➢ Wellhead protection
  ➢ Water balance (stream flow/ water rights)

Assess and document applicable conditions and recommendations per Appendix C and D
Feasibility at Planning and Design Levels

Planning Level Feasibility Screening
• What types of constraints apply?
• What BMP types are potentially feasible?
• Where are the constraints within the site?

Site Layout, Conceptual BMP Selection and Design

Design Level Investigation
• Based on the selected BMPs, what information do I need to know to confirm feasibility and provide final calculations?

Preliminary report or first part of overall report
Final report or second part of overall report
Example Project - Location

Figure G.1-1

San Dieguito Watershed: 905

Nearest Station: Poway

Project Location
Receiving Water Information

- Route of runoff from the project site to the Pacific Ocean

- Sources of Information
  - Water Quality Improvement Plan
  - 303 (d) List
  - MS4 maps
  - Watershed Management Area Analysis
## Project Site Pollutants

### General Pollutant Categories

<table>
<thead>
<tr>
<th>Priority Project Categories</th>
<th>Sediment</th>
<th>Nutrients</th>
<th>Heavy Metals</th>
<th>Organic Compounds</th>
<th>Trash &amp; Debris</th>
<th>Oxygen Demanding Substances</th>
<th>Oil &amp; Grease</th>
<th>Bacteria &amp; Viruses</th>
<th>Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detached Residential Development</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attached Residential Development</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Development &gt; one acre</td>
<td>P(1)</td>
<td>P(1)</td>
<td>X</td>
<td>P(2)</td>
<td>X</td>
<td>P(5)</td>
<td>X</td>
<td>P(3)</td>
<td>P(5)</td>
</tr>
<tr>
<td>Heavy Industry</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive Repair Shops</td>
<td></td>
<td>X</td>
<td>X(4)(5)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Restaurants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hillside Development &gt; 5,000 ft²</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking Lots</td>
<td>P(1)</td>
<td>P(1)</td>
<td>X</td>
<td></td>
<td></td>
<td>P(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail Gasoline Outlets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streets, Highways &amp; Freeways</td>
<td>X</td>
<td>P(1)</td>
<td>X</td>
<td>X(4)</td>
<td>X</td>
<td>P(5)</td>
<td>X</td>
<td></td>
<td>P(1)</td>
</tr>
</tbody>
</table>

- **X** = anticipated
- **P** = potential

1. A potential pollutant if landscaping exists onsite.
2. A potential pollutant if the project includes uncovered parking areas.
3. A potential pollutant if land use involves food or animal waste products.
4. Including petroleum hydrocarbons.
5. Including solvents.

---

- **WQIP Highest priority water quality condition:** Bacteria along the Pacific Ocean at the San Dieguito Lagoon Mouth

- **303(d) Listed Waters:** Pacific Ocean Shoreline, San Dieguito HU, at San Dieguito Lagoon Mouth at San Dieguito River Beach
**Existing Conditions**

### Project Parcels

<table>
<thead>
<tr>
<th>APN</th>
<th>123-456-789</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Parcel Area</td>
<td>3.1 Acres</td>
</tr>
</tbody>
</table>
Existing Conditions

Drainage Patterns

SD System 1

SD System 2
Proposed Conditions

<table>
<thead>
<tr>
<th>Project Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Area</td>
<td>3.1 Acres</td>
</tr>
<tr>
<td>Disturbed Area</td>
<td>3.1 Acres</td>
</tr>
<tr>
<td>Proposed Impervious Area</td>
<td>2.0 Acres</td>
</tr>
<tr>
<td>Proposed Pervious Area</td>
<td>1.1 Acres</td>
</tr>
</tbody>
</table>

 Proposition: 3.1 Acres
 Disturbed Area: 3.1 Acres
 Proposed Impervious Area: 2.0 Acres
 Proposed Pervious Area: 1.1 Acres
**Existing Land Cover**

**Undeveloped**

- Previously graded, not built out.
- Vegetated cover.
- No existing natural hydrologic features

**Current Status**
Geotechnical Investigation

- **Planning Level**
  - Determine planning level opportunities and restrictions
    - Infiltration properties, steep slopes, geotechnical hazards

- **Sources of Information**
  - Appendix C feasibility screening exhibits
  - NRCS web soil survey
  - SanGIS
  - Site-specific geotechnical assessment

*Planning level information is intended to inform site design and layout at the initial stages of design. Refer to Appendix C and D for design level feasibility requirements (covered later)*
Hydrologic Soils Group: D

- Generally poor soils for infiltration confirmed from previous bore logs
- Previously compacted

*GIS layers will be available through SanGIS.

Further investigation would be required for a larger site or where mapped soils are less conclusive.
Groundwater Investigation

• Planning Level
  ➢ Determine planning level opportunities and restrictions
    ❖ Water table, contamination, wells

• Sources of Information
  ➢ Appendix C feasibility screening exhibits
  ➢ California GeoTracker website
  ➢ SanGIS

*Planning level information is intended to inform site design and layout at the initial stages of design. Refer to Appendix C and D for design level feasibility requirements (covered later).
Approximate Depth to Groundwater

- Depth to GW
  - Online sources: GeoTracker
  - Practical sources: Detailed geotechnical report
Preliminary Feasibility Summary

Would infiltration of the full design volume be feasible?
- Yes: Full Infiltration Condition: Select BMPs that provide full infiltration
- No: Partial Infiltration Condition: Select BMPs that provide opportunity for partial infiltration; desirable

Would infiltration of water in any appreciable amount be feasible?
- Yes: Partial Infiltration Condition: Select BMPs that provide opportunity for partial infiltration; desirable
- No: No Infiltration Condition: Do not use infiltration BMPs

No Infiltration Condition: Do not use infiltration BMPs
Example Project Information Summary:

- **Watershed:** San Dieguito 905
- **Area:** 3.1 acres
- **Existing Condition:** Graded/grass cover
- **NRCS Soil Type:** D
- **Groundwater:** >20 feet
- **Pollutant of Concern:** Bacteria & Viruses
- **No natural hydrologic features or other site restrictions.**
What If: Multiple Constraints

- Concentrate buildings/parking lots
- Type D Soils
- Type B Soils
- Capture area for offsite remediation well

Avoid infiltration

Maintain pervious areas, consider infiltration
Pollutant Control Design

Performance Criteria and Applicability (Ch. 1 and Ch. 2)
- Determine Pollutant Control Requirements
- Determine HMP Requirements

Conceptual Design (Ch. 3)
- Site Investigation
- Feasibility/Screening
- Site Layout

Detailed/Complete Design (Ch. 5)
- Design Capture Volume (DCV)
- Select Appropriate BMPs
- Size and Design BMPs
Site Layout

• **Relevant Criteria:**
  - Are all developed portions of the site treated?
  - Are all applicable site design and source control BMPs incorporated?
  - Has adequate effort been made to identify and create opportunities for higher priority BMP types?

• **Approach:**
  - Use overlay of constraints and opportunities to influence site layout
  - Develop general drainage plan, delineate initial Drainage Management Areas (DMAs)
  - Consider applicable BMP types and approximate sizes in site layout iterations
  - Identify areas for site design and source control BMPs
DMAs are the framework for storm water management.

Defined by proposed drainage patterns and BMPs to which they drain.

DMAs determine required treatment volumes.
Source Control and Site Design BMPs

**Source Control BMPs**: an activity that reduces the potential for storm water runoff to come into contact with pollutants.

**Site Design BMPs**: reduce the rate and volume of storm water runoff and associated pollutant loads.

Source Control and Site Design BMPs are required for ALL development projects and fulfill the pollutant control requirements for STANDARD Projects.
Source Control Concepts

- Avoid and reduce pollutants in storm water runoff
- Can be either activities or structural elements
- All development projects are required to implement source control BMPs
Source Control BMPs

- SC-1: Prevent illicit discharges to the MS4
- SC-2: Identify the storm drain system using stenciling or signage
- SC-3: Protect outdoor material storage areas from rainfall, run-on, runoff, and wind dispersal
- SC-4: Protect materials stored in outdoor work areas from rainfall, run-on, runoff, and wind dispersal
- SC-5: Protect trash storage areas from rainfall, run-on, runoff, and wind dispersal
- SC-6: Additional jurisdictional BMPs
# Source Control BMPs SC-1 through SC-6

- Select “Yes” if implemented, discussion not required.
  - **SC-1 Example:** “Yes”

- Select “N/A” if the BMP is not applicable to the project site because site design does not include the features addressed by the BMP. Justification optional.
  - **SC-4 Example:** “N/A” “The site does not propose any outdoor work areas, no materials will be stored outdoors.”

- Select “No” if the BMP is applicable to the project but is not feasible to implement. Justification required.
  - **SC-5 Example:** “No” “Trash storage areas cannot be protected from rainfall according to SC-5. A room cannot be provided over the trash enclosure due to proximity to overhead utility lines. Trash containers will be provided with lids.”
Site Design Concepts

- Site layout considerations:
  - Preserve natural hydrologic features and drainage patterns
  - Concentrate development, preferably on less permeable soils
  - Locate BMPs near source
  - Locate pervious areas down gradient from buildings to allow for dispersion
  - Identify parts of the project that could be drained via overland vegetated conveyance rather than piped connections
  - Minimize impervious area
Site Design BMPs

- SD-1: Maintain natural drainage pathways and hydrologic features
- SD-2: Conserve natural areas, soils, and vegetation
- SD-3: Minimize impervious area
- SD-4: Minimize soil compaction
- SD-5: Disperse impervious area
- SD-6: Collect runoff
- SD-7: Landscape with drought tolerant species
- SD-8: Harvest and use precipitation
### Documenting Site Design BMPs

**Site Design BMPs SD-1 through SD-8**

- Select “Yes” if implemented, discussion not required.
  - SD-1 Example: “Yes”

- Select “No” if the BMP is applicable to the project but is not feasible to implement. Justification required.
  - SD-5 Example: “No” “Site layout and grading constraints do not allow for the dispersion of impervious areas.”

- Select “N/A” if the BMP is not applicable to the project site because site design does not include the features addressed by the BMP. Justification optional.
  - SD-2# Example: “N/A” “The site has no natural areas to conserve.”

---

| Site Design BMP Checklist for All Development Projects (Standard Projects and PDPs) |
|---------------------------------|---|
| **Project Name** | Example Project |
| Permit Application Number | 123456789 |
| **Site Design BMPs** | |
| All development projects must implement site design BMPs SD-1 through SD-8 where applicable and feasible. See Chapter 4 and Appendix E of the manual for information on implementing site design BMPs shown in this checklist. |
| Review each category below pursuant to the following: |
| 1. “Yes” means the project will implement the site design BMP as described in Chapter 4 and/or Appendix E of the manual. Discussion / justification is not required. |
| 2. “No” means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. |
| 3. “N/A” means the BMP is not applicable to the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification is optional. |

<table>
<thead>
<tr>
<th>Site Design Requirement</th>
<th>Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD-1 Shoreline Erosion Mitigation and Sediment Processes</td>
<td>Yes</td>
</tr>
<tr>
<td>SD-2 Natural Areas, Soils, and Vegetation</td>
<td>Yes</td>
</tr>
<tr>
<td>SD-3 Stormwater Impervious Area</td>
<td>Yes</td>
</tr>
<tr>
<td>SD-4 Managed Stormwater detention</td>
<td>Yes</td>
</tr>
</tbody>
</table>

---

Appendix I: Forms and Checklists
Questions
Design Capture Volume Calculation

Venkat Gummadi, P.E.
Geosyntec Consultants
Pollutant Control Design

Performance Criteria and Applicability (Ch. 1 and 2)
- Determine Pollutant Control Requirements
- Determine HMP Requirements

Conceptual Design (Ch. 3)
- Site Investigation
- Feasibility/Screening
- Site Layout

Detailed/Complete Design (Ch. 5)
- Design Capture Volume (DCV)
- Select Appropriate BMPs
- Size and Design BMPs
Pollutant Control Concepts

1. Site BMPs and delineate DMAs
2. Calculate DCV
3. Reduce DCV by accounting for site design BMPs
4. Select and confirm feasible pollutant treatment BMPs from hierarchy
5. Provide required size
The Design Capture Volume (DCV) is the volume of storm water runoff resulting from the 85\textsuperscript{th} percentile, 24-hr storm event.

\[ DCV = C \times d \times A \times 43,560 \, \text{sf/ac} \times \frac{1}{12} \, \text{in/ft} \]

\[ DCV = 3,630 \times C \times d \times A \]

Where:

- DCV = Design Capture Volume in cubic feet
- C = Runoff factor (unitless); refer to section B.1.1
- d = 85\textsuperscript{th} percentile, 24-hr storm event rainfall depth (inches), refer to section B.1.3
- A = Tributary area (acres)
Rainfall Depth (d)

San Diego County
85th Percentile Isopluvials

Project Location:
d=0.54in

Figure B.1-1: 85th Percentile 24-hour Isopluvial Map
Example DMA

BMP Manual Training
Example Project: Biofiltration Sizing

Biofiltration Sizing Example

Basic Input Data
Rainfall Gauge: Poway
DMA Area: 1.54 acres
% Impervious: 64%
Runoff Factor: 0.61
D (in): 0.54
DCV: 1,847 ft³

Table B.1-1: Runoff factors for surfaces draining to BMPs - Pollutant Control BMPs

<table>
<thead>
<tr>
<th>Surface</th>
<th>Runoff Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>0.90</td>
</tr>
<tr>
<td>Concrete or Asphalt</td>
<td>0.90</td>
</tr>
<tr>
<td>Unit Pervious (grouted)</td>
<td>0.90</td>
</tr>
<tr>
<td>Decomposed Granite</td>
<td>0.30</td>
</tr>
<tr>
<td>Golden_graldia</td>
<td>0.90</td>
</tr>
<tr>
<td>Amended, Mulched Soils or Landscape</td>
<td>0.10</td>
</tr>
<tr>
<td>Compacted Soil (e.g., unpaved parking)</td>
<td>0.30</td>
</tr>
</tbody>
</table>
**Design Capture Volume**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Worksheet B-2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>85th percentile 24-hr storm depth from Figure B.1-1</td>
<td>( d = 0.54 ) inches</td>
</tr>
<tr>
<td>2</td>
<td>Area tributary to BMP (s)</td>
<td>( A = 1.54 ) acres</td>
</tr>
<tr>
<td>3</td>
<td>Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)</td>
<td>( C = 0.61 ) unitless</td>
</tr>
<tr>
<td>4</td>
<td>Street trees volume reduction</td>
<td>( TCV = 0 ) cubic-feet</td>
</tr>
<tr>
<td>5</td>
<td>Rain barrels volume reduction</td>
<td>( RCV = 0 ) cubic-feet</td>
</tr>
<tr>
<td>6</td>
<td>Calculate DCV =</td>
<td>DCV = 1,850 cubic-feet</td>
</tr>
</tbody>
</table>

**Calculations:**

Area weighted runoff factor: 
\[
\frac{(0.99 \text{ acres} \times 0.9) + (0.55 \text{ acres} \times 0.1)}{1.54 \text{ acres}} = 0.61
\]

DCV = \( (3630 \times 0.61 \times 0.54 \times 1.54) - 0 - 0 = 1,850 \text{ cubic feet} \)
1. **Adjustment of Impervious Runoff Factor:** When one of the following site design BMPs is implemented the runoff factor of 0.9 for impervious surfaces should be adjusted using the factors provided in Section B.2.1.

- SD-5: Impervious area dispersion
- SD-6A: Green roofs
- SD-6B: Permeable pavement

2. **Adjustment to DCV:** When the following site design BMPs are implemented the anticipated volume reduction from these BMPs (Section B.2.2) shall be deducted from the DCV.

- SD-1: Street trees
- SD-8: Rain barrels

3. **Exclusion of DMAs:** Self-mitigating, De Minimis, and Self-retaining DMAs may be excluded from DCV calculations if they meet certain requirements.
DCV Reduction: Example

SD-5 Impervious Area Dispersion
SD-6B Pervious Parking Lot

Potential DCV Reductions
- Runoff Coefficient Reduction
- Site Design Reduction
- Adjusted DCV
Runoff Factor DCV Reduction

- Impervious area dispersion
  - Reduction factors range by soil type and disconnection ratio
- Green roofs (SD-6A): Runoff factor = 0.1
- Permeable pavement (SD-6B): Runoff factor = 0.1

Runoff factors for pervious areas can be reduced to 0.1 through the use of soil amendments.
### Runoff Factor DCV Reduction

**Example:** Impervious area dispersion (SD-5)

- 1 acre of impervious area draining to 0.5 acres of landscaping with Type D soils.
- Impervious to Pervious ratio equals 2:1
- Adjustment factor allowed for Impervious area = 0.93
- Resultant runoff factor for Impervious area = 0.93 x 0.9 = 0.84
- For our project this would decrease DCV by 118 cubic feet per acre impervious area dispersed.

<table>
<thead>
<tr>
<th>Pervious area hydrologic soil group</th>
<th>Ratio = Impervious area/Pervious area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;=1</td>
</tr>
<tr>
<td>A</td>
<td>0.00</td>
</tr>
<tr>
<td>B</td>
<td>0.00</td>
</tr>
<tr>
<td>C</td>
<td>0.34</td>
</tr>
<tr>
<td>D</td>
<td>0.86</td>
</tr>
</tbody>
</table>
Site Design DCV Reduction

• Street trees (SD-1):
  ➢ Reduction based on # of trees and mature tree canopy diameter.

• Rain barrels (SD-8):
  ◦ Reduction allowed for full rain barrel volume if:
    ➢ Each rain barrel <100 gallons
    ➢ Total rain barrel volume <0.25 DCV
    ➢ Landscape area > 30% project footprint
Worksheet B.2-1

<table>
<thead>
<tr>
<th>Design Capture Volume</th>
<th>Worksheet B-2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 85th percentile 24-hr storm depth from Figure B.1-1</td>
<td>d= 0.54 inches</td>
</tr>
<tr>
<td>2 Area tributary to BMP (s)</td>
<td>A= 1.54 acres</td>
</tr>
<tr>
<td>3 Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)</td>
<td>C= 0.57 unitless</td>
</tr>
<tr>
<td>4 Street trees volume reduction</td>
<td>TCV= 500 cubic-feet</td>
</tr>
<tr>
<td>5 Rain barrels volume reduction</td>
<td>RCV= 67 cubic-feet</td>
</tr>
<tr>
<td>Calculate DCV = (3630 x C x d x A) – TCV - RCV</td>
<td>DCV= 1,153 cubic-feet</td>
</tr>
</tbody>
</table>

Area weighted runoff factor: \( \frac{(0.99 \text{ acres} \times 0.84) + (0.55 \text{ acres} \times 0.1)}{1.54 \text{ acres}} = 0.57 \)

TCV = (5 fifteen foot diameter trees) \( \times \left( 100 \frac{ft^3}{tree} \right) = 500 \text{ cubic feet} \)

RCV = (5 one hundred gallon barrels) \( \times \left( \frac{1ft^3}{7.48 \text{ gallons}} \right) = 67 \text{ cubic feet} \)

DCV = (3630 x 0.57 x 0.54 x 1.54) – 500 – 67 = 1,153 cubic feet

37.5% Reduction
DMA Exclusion DCV Reduction

- Self Mitigating DMAs
  - Natural or landscaped areas that drain directly offsite or to the public storm drain system.

- De Minimis DMAs
  - Areas that are very small, and therefore are not considered to be significant contributors of pollutants, and are considered not practicable to drain to a BMP. (Ex. Retaining walls at external boundary of a project).

- Self-retaining DMAs
  - Areas that are designed with site design BMPs to retain runoff to a level equivalent to pervious land.
Self Mitigating DMAs

- Natural or landscaped areas that drain directly offsite or to the public storm drain.
- DMA implements source control and site design BMPs
- DMA meets all requirements of section 5.2.1
De Minimis DMAs

- Very small areas that are not significant contributors of pollutants, and are not practicable to drain to a BMP.

- Examples:
  - Driveway apron connecting to existing street
  - Portion of sidewalk
  - Retaining wall at external project boundary

- De Minimis DMAs must be approved on case-by-base basis.
Self-Retaining DMAs

- Areas that are designed to retain runoff to a level equivalent of pervious land.
- Example: a DMA is considered self-retaining if the impervious to pervious ratio is:
  - 2:1 when the pervious area is composed of HSG A
  - 1:1 when the pervious area is composed of HSG B
Questions
Break

• When we come back...
  ◦ BMP Selection (design-phase feasibility)
  ◦ Biofiltration Design
  ◦ Flow-thru BMPs
Pollutant Control Design

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Geosyntec Consultants
Pollutant Control Design

Performance Criteria and Applicability (Ch. 1 and 2)
- Determine Pollutant Control Requirements
- Determine HMP Requirements

Conceptual Design (Ch. 3)
- Site Investigation
- Feasibility/Screening
- Site Layout

Detailed/Complete Design (Ch. 5)
- Determine Treatment Volume (DCV)
- Select Appropriate BMPs
- Size and Design BMPs
Storm Water Pollutant Control

Regulatory BMP Hierarchy

Retention
- Harvest and Use, Infiltration Basin, Bioretention, Permeable Pavement

Partial Retention
- Biofiltration with Partial Retention

Biofiltration
- Biofiltration, including Nutrient Sensitive and Proprietary design variations

Flow-thru
- Vegetated Swales, Media/Sand Filters, Dry Extended Detention Basins, Proprietary

Plus Alternative Compliance
Select Appropriate BMPs

Determine Treatment Control Category

1. Finalize BMP locations and conduct more detailed feasibility investigation at these locations, as needed
2. Complete harvest and use feasibility checklist
3. Complete retention feasibility checklists
4. Identify type of pollutant control to be implemented
Storm Water Pollutant Control

Pollutant control BMPs must be sized and sited based on the characteristics of the DMAs draining to them.

Step 1A: Can DMA be Excluded

Step 1B: Calculate DCV

Step 2: Determine Harvest and Use Feasibility

Step 3A&B: Determine Infiltration Feasibility Category and Select BMP(s) from Category

Step 3C: Size Pollutant Treatment BMPs

Step 4: Implement Infiltration/Biofiltration BMPs

Yes: Exclude DMA from Calculations

No: Potentially Feasible

Not Feasible

Remaining Volume not Reliably Used

Implement Harvest and Use BMPs
Harvest and Use Feasibility

- Harvest and Use BMPs allow captured runoff to be used on-site (reducing the DCV) if there is sufficient demand.

- Possible sources of demand:
  - Toilet/Urinal Flushing
  - Irrigation
  - Vehicle Washing
  - Evaporative Cooling
  - Dilution (recycled water)
  - Industrial processes
1. Is there reliable demand for harvested water during the wet season?

2. Anticipated average wet season demand of 36 hour period is 57.3 cubic feet.

3. DCV = 3,768 cubic feet* (from B-21).
   a) Demand ≥ DCV : HU is feasible.
   b) 0.25*DCV < Demand < DCV : HU may be feasible.
   c) Demand < 0.25*DCV : HU is not feasible

*Harvest and use should be evaluated at the scale of the entire project.

Demand < 0.25*DCV

Conclusion: HU is Not Feasible
Infiltration Feasibility Conditions

Site Design / Project Type

Conditions at BMP Location

Watershed Characteristics

Would infiltration of the full design volume be feasible?

Yes

No

Would infiltration of water in any appreciable amount be feasible?

Yes

No

Infiltration Screening Conditions

Full Infiltration Condition:
Select BMPs that provide full infiltration

Partial Infiltration Condition:
Select BMPs that provide opportunity for partial infiltration; desirable

No Infiltration Condition:
Do not use infiltration BMPs

BMPs

Infiltration BMP Category
Infiltration Basin
Bioretention
Permeable Pavement

Partial Retention BMP Category
Biofiltration with Partial Retention

Harvest and Use Category if feasible, then
Biofiltration Category if feasible, then
Flow-thru Treatment Control Category

Inputs
Screening Steps
Results
Infiltration Feasibility to Pollutant Treatment Design

Factors affecting Feasibility and Desirability
- Geotechnical considerations
- Infiltration rate
- Groundwater quality
- Water balance impacts

Guidance/Requirements for Investigation and Design
- Geotechnical investigation: Appendix C
- Groundwater investigation: Appendix C
- Infiltration rate assessment: Appendix D

Documentation of Infiltration and Feasibility Screening
- Form I-8
Full Infiltration Feasibility

1. Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour?

- Appendix C.2.1: Soil and geologic conditions
- Appendix D: Design infiltration rate
- Supporting information
  - Geotechnical report
  - Worksheets D.5-1 and D.5-2
Infiltration Rate Assessment

Design Phase Questions:

• What infiltration rates should be used to design BMPs?
  ➢ Desktop analysis and data correlation-D.3.1
  ➢ Surface and shallow excavation methods-D.3.2
  ➢ Deeper subsurface tests-D.3.3
  ➢ Specific considerations-D.4

• What factor of safety should be applied?
  ➢ Site suitability considerations
  ➢ Design related considerations
  ➢ Documentation-Worksheets D.5-1
2. Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level?

- Appendix C.2
  - C.2.1 – Soil and geologic conditions
  - C.2.2 – Settlement and volume change
  - C.2.3 – Slope stability
  - C.2.4 – Utility considerations
  - C.2.5 – Groundwater mounding
  - C.2.6 – Retaining walls and foundations
  - C.2.7 – Other factors

- Supporting information
  - Geotechnical report
3. Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level?

• Appendix C.3
  - C.3.1 - Soil and groundwater contamination
  - C.3.2 - Separation to seasonal high groundwater
  - C.3.3 – Wellhead protection
  - C.3.4 – Contamination risks from land use activities
  - C.3.5 – Consultation with applicable groundwater agencies

• Supporting information
  - Geotechnical report
  - Groundwater investigation
4. Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters?

- Appendix C.3
  - C.3.6 - Water balance impacts on stream flow
- Supporting information
  - Hydrogeologic data survey
    - Piezometer measurements, boring logs, regional GW maps
    - Downstream receiving water characteristics
Full Infiltration Feasibility

Part 1 Result:
If: Answers to all questions 1 through 4 are **YES**
  - **Full Infiltration category**
If: Answers to any question, 1 through 4, is **NO**
  - **Partial or No Infiltration category**

Full infiltration category BMPs
- INF-1: Infiltration basin
- INF-2: Bioretention
- INF-3: Permeable pavement
Partial/No Infiltration Feasibility

5. Do soil and geologic conditions allow for infiltration in any appreciable rate or volume?

- Appendix C.2.1: Soil and geologic conditions
- Appendix D: Design infiltration rate

- Supporting information
  - Geotechnical report
  - Worksheets D.5-1
Partial/No Infiltration Feasibility

6. Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level?

• Appendix C.2
  ➢ C.2.1 – Soil and geologic conditions
  ➢ C.2.2 – Settlement and volume change
  ➢ C.2.3 – Slope stability
  ➢ C.2.4 – Utility considerations
  ➢ C.2.5 – Groundwater mounding
  ➢ C.2.6 – Retaining walls and foundations
  ➢ C.2.7 – Other factors

• Supporting information
  ➢ Geotechnical report
Partial/No Infiltration Feasibility

7. Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)?

- Appendix C.3
  - C.3.1 - Soil and groundwater contamination
  - C.3.2 - Separation to seasonal high groundwater
  - C.3.3 – Wellhead protection
  - C.3.4 – Contamination risks from land use activities
  - C.3.5 – Consultation with applicable groundwater agencies

- Supporting information
  - Geotechnical report
  - Groundwater investigation
8. Can infiltration be allowed without violating downstream water rights?

- Appendix C.3
  - C.3.7 – Downstream water rights

- Supporting information
  - Site specific evaluation
Infiltration Feasibility

Part 2 Result:
If: answers to all questions 5 through 8 are **YES**
   - **Partial Infiltration** category
If: Answers to any question, 5 through 8, is **NO**
   - **No infiltration** category

Partial infiltration category BMPs
- PR-1: Biofiltration with partial retention
- Site design BMPs incorporating infiltration

No infiltration category BMPs
- BF-1 through BF-3: Biofiltration BMPs
- FT-1 through FT-5: Flow-thru BMPs
Infiltration Feasibility

Example Project:
- Compacted type D Soils
- Infiltration Rate $<< 0.5$ in/hr
- Geotech recommendations: observe setbacks from foundations, slopes, utilities
- No water balance concerns
- No water rights concerns

Result: Partial Infiltration Category
Example Project: Partial Infiltration

Required Documentation

- Geotechnical report
- Groundwater investigation
- Form I-8
- Geotechnical engineer recommendation for allowable infiltration rate in partial infiltration design
What if: Full Infiltration Category

- Observed infiltration rate
  - Field investigation
- Combined safety factor
  - Determine score for suitability related considerations (Table D.5-1)
  - Determine score for design related considerations (Table D.5-2)
- Design infiltration rate
**Example: Full Infiltration Category**

Suitability Assessment Related Considerations for Infiltration Facility Safety Factors

<table>
<thead>
<tr>
<th>Consideration</th>
<th>High Concern – 3 points</th>
<th>Medium Concern – 2 points</th>
<th>Low Concern – 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment methods</td>
<td>Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates</td>
<td>Use of well permeameter or borehole methods with accompanying continuous boring log</td>
<td>Direct measurement with localized (i.e., small-scale) infiltration testing methods at relatively high resolution¹ or Use of extensive test pit infiltration measurement methods²</td>
</tr>
<tr>
<td>(see explanation below)</td>
<td>Use of well permeameter or borehole methods without accompanying continuous boring log</td>
<td>Direct measurement of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Relatively sparse testing with direct infiltration methods</td>
<td>Moderate spatial resolution</td>
<td></td>
</tr>
<tr>
<td>Texture Class</td>
<td>Silty and clayey soils with significant fines</td>
<td>Loamy soils</td>
<td>Granular to slightly loamy soils</td>
</tr>
<tr>
<td>Site soil variability</td>
<td>Highly variable soils indicated from site assessment, or Unknown variability</td>
<td>Soil borings/test pits indicate moderately homogeneous soils</td>
<td>Soil borings/test pits indicate relatively homogeneous soils</td>
</tr>
<tr>
<td>Depth to groundwater/</td>
<td>&lt;5 ft below facility bottom</td>
<td>5-15 ft below facility bottom</td>
<td>&gt;15 below facility bottom</td>
</tr>
<tr>
<td>impervious layer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table D.5-1**

---

¹: High spatial resolution
²: Low spatial resolution
## Example: Full Infiltration Category

**Design Related Considerations for Infiltration Facility Safety Factors**

<table>
<thead>
<tr>
<th>Consideration</th>
<th>High Concern – 3 points</th>
<th>Medium Concern – 2 points</th>
<th>Low Concern – 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of pretreatment/expected influent sediment loads</td>
<td>Limited pretreatment using gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, road sanding, or any other areas expected to produce high sediment, trash, or debris loads.</td>
<td>Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be moderate (e.g., low traffic, mild slopes, stabilized pervious areas, etc.). Performance of pretreatment consistent with “pretreatment BMP performance criteria” (50% TSS removal) in Appendix B.6.</td>
<td>Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops/non-sanded road surfaces. Performance of pretreatment consistent with “flow-thru treatment control BMP performance criteria” (i.e., 80% TSS removal) in Appendix B.6.</td>
</tr>
<tr>
<td>Redundancy/ resiliency</td>
<td>No “backup” system is provided; the system design does not allow infiltration rates to be restored relatively easily with maintenance.</td>
<td>The system has a backup pathway for treated water to discharge if clogging occurs OR infiltration rates can be restored via maintenance.</td>
<td>The system has a backup pathway for treated water to discharge if clogging occurs and infiltration rates can be relatively easily restored via maintenance.</td>
</tr>
<tr>
<td>Compaction during construction</td>
<td>Construction of facility on a compacted site or increased probability of unintended/indirect compaction.</td>
<td>Medium probability of unintended/indirect compaction.</td>
<td>Equipment traffic is effectively restricted from infiltration areas during construction and there is low probability of unintended/indirect compaction.</td>
</tr>
</tbody>
</table>

*Table D.5-2*
### Design Infiltration Rate

#### Factor of Safety and Design Infiltration Rate Worksheet

<table>
<thead>
<tr>
<th>Factor Category</th>
<th>Factor Description</th>
<th>Assigned Weight (w)</th>
<th>Factor Value (v)</th>
<th>Product (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Soils assessment methods</td>
<td>0.25</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>A</td>
<td>Predominant soil texture</td>
<td>0.25</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>A</td>
<td>Site soil variability</td>
<td>0.25</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>A</td>
<td>Depth to groundwater / impervious layer</td>
<td>0.25</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>B</td>
<td>Level of pretreatment/expected sediment loads</td>
<td>0.5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Redundancy/resiliency</td>
<td>0.25</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>B</td>
<td>Compaction during construction</td>
<td>0.25</td>
<td>1</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**Suitability Assessment Safety Factor, \( S_A = \Sigma p \):** 1.5

**Design Safety Factor, \( S_B = \Sigma p \):** 2.6

**Combined Safety Factor, \( S_{total} = S_A \times S_B \):** 2.6

**Observed Infiltration Rate, inch/hr, \( K_{observed} \):** 1.5

**Corrected for test-specific bias:**

**Design Infiltration Rate, in/hr, \( K_{design} = \frac{K_{observed}}{S_{total}} \):** **0.58**

- Design infiltration rate = 0.58 in/hr
- Design infiltration rate > 0.5 in/hr
- Feasibility Criteria 1 is met
- Full infiltration category is potentially feasible
- Complete Form I-8
## Pollutant Control Design

### Performance Criteria and Applicability (Ch. 1 and 2)

- Determine Pollutant Control Requirements
- Determine HMP Requirements

### Conceptual Design (Ch. 3)

- Site Investigation
- Feasibility/Screening
- Site Layout

### Detailed/Complete Design (Ch. 5)

- Determine Treatment Volume (DCV)
- Select Appropriate BMPs
- Size and Design BMPs
Training Topics

- Develop Complete Design
  - Standard Biofiltration Design
    - Partial Infiltration (Section 5.5.2)
    - What If: No Infiltration (Section 5.5.3)
  - Proprietary Biofiltration Pathways
  - Selection of Flow-thru BMPs (Section 5.5.4)
Infiltration/Biofiltration Continuum

- Decreasing infiltration rate
- Underdrain closer to bottom
- Less rock storage
- Less volume reduction

Partial Retention

INF-1

PR-1

BF-1

Clear suitability for infiltration

Zero infiltration allowable

INF-1         PR-1    BF-1
## PR and BF Options

<table>
<thead>
<tr>
<th>Partial Retention BMPs</th>
<th>Defining Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR-1: Biofiltration w/partial retention</td>
<td>Partial infiltration of DCV</td>
</tr>
<tr>
<td></td>
<td>Aggregate storage layer</td>
</tr>
<tr>
<td></td>
<td>Elevated underdrain</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biofiltration BMPs</th>
<th>Defining Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF-1: Biofiltration</td>
<td>No infiltration</td>
</tr>
<tr>
<td>BF-2: Nutrient Sensitive Media Design</td>
<td>Specialized media to minimize nutrient export</td>
</tr>
<tr>
<td>BF-3: Proprietary Biofiltration Systems</td>
<td>Proprietary device meeting Appendix F criteria</td>
</tr>
</tbody>
</table>

Refer to Chapter 5.5 for general BMP information and Appendix E for design information.
Biofiltration Siting and Design

PR and BF Sources

- Chapter 5.5 – General information
- Appendix B – Sizing
- Appendix E.11-E.14 – Fact Sheets
- Appendix F – Standards and Checklist

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

Chapter 5.5.3, Appendix B.5
Biofiltration Criteria

Biofiltration BMPs must meet the following criteria:

1. Be selected according to BMP and retention hierarchy
2. Sized using acceptable sizing methods
3. Maximize feasible infiltration and evapotranspiration
4. Maximize pollutant retention/control/sequestration, and minimize washout
5. Promote biological activity to support/maintain treatment
6. Be designed to prevent internal erosion, scour, and channeling
7. Include O&M and planning considerations to maintain effectiveness
Biofiltration Sizing

Biofiltration BMPs shall be sized by one of the following methods:

- **Option 1:** Treat 1.5 times the portion of the DCV not reliably retained onsite, OR

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

- **Minimum Sizing Factor:** Biofiltration BMP surface area must be a minimum of 3% of the runoff-adjusted tributary area (i.e. contributing area x adjusted runoff factor)

Appendix B.5
Biofiltration Sizing Criteria

DCV$_{bf}$ (DCV not retained)

Option 1

Option 2

Treat $1.5 \times$ DCV$_{bf}$

Storage Vol. = 0.75 DCV$_{bf}$

Static Storage $\geq 0.75$ remaining DCV

Pre-filter detention + pores

Retained

Retained

Option 1

Option 2
Example Project

BMP Manual Training
Example Project: Biofiltration Sizing

Biofiltration Sizing Example

Basic Input Data
Rainfall Gauge: Poway
DMA Area: 1.54 acres
% Impervious: 64%
Runoff Factor: 0.61
d (in): 0.54
DCV: 1,847 ft³

Partial Infiltration Condition
## Biofiltration Calculations

**Worksheet B.5-1**

### Partial Retention

- **Base Calculations**
- **Option 2 Sizing**
- **Option 1 Sizing**
- **BMP Footprint Factor Check**
- **Design Parameters**

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Formula/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial Retention</td>
<td>Formula: (1)</td>
</tr>
<tr>
<td>Base Calculations</td>
<td>Formula: (2)</td>
</tr>
<tr>
<td>Option 2 Sizing</td>
<td>Formula: (3)</td>
</tr>
<tr>
<td>Option 1 Sizing</td>
<td>Formula: (4)</td>
</tr>
<tr>
<td>BMP Footprint</td>
<td>Formula: (5)</td>
</tr>
<tr>
<td>Design Parameters</td>
<td>Formula: (6)</td>
</tr>
</tbody>
</table>

### BMP Parameters

- **11. Surface Area:** [Surface Area x 12 in = inches maximum] 120 inches
- **12. BMP Thickness:** [BMP Thickness x 12 in = inches maximum] 24 inches
- **13. Aggregate Storage Above Undisturbed Level:** [Aggregate Storage Above Undisturbed Level x 12 in = inches maximum] 12 inches
- **14. Media Available Space:** [Media Available Space x 12 in = inches maximum] 0.2 inches

### Baseline Calculations

- **16. Allowable Retention Time for Storm:** 4 hours
- **17. Depth of Filtered Storm:** [Baseline Calculations x 12 in = inches maximum] 30 inches
- **18. Depth of Sediment Storage:** [Baseline Calculations x 12 in = inches maximum] 21.6 inches

### BMP Parameters

- **20. Required buffer zone:** [Required Buffer Zone x 12] 1,300 cubic feet
- **21. Required Footprint:** [Required Footprint x 12] 100 sq ft

### Option 2 - Storm 0.75 times the DCV

- **22. Required Storage Volume + pump:** [Required Storage Volume + pump x 12] 600 cubic feet
- **23. Required Footprint:** [Required Footprint x 12] 300 sq ft

### Footprint of the BMP

- **24. Area drained to the BMP:** [Area drained to the BMP x 12] 87,000 sq ft
- **25. Maximum BMP Footprint:** [Maximum BMP Footprint x 12] 1,230 sq ft

### Summary

- **Total BMP Footprint:** [Total BMP Footprint x 12] 1,230 sq ft

---

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Partial Retention Calculations

Simple Sizing Method for Biofiltration BMPs

<table>
<thead>
<tr>
<th></th>
<th>Remaining DCV after implementing retention BMPs</th>
<th>Worksheet B.5-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1,850</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cubic-feet</td>
</tr>
</tbody>
</table>

**Partial Retention**

|   | Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible | 0.2 | in/hr. |
| 2 |                                                                 | 36 | hours |
| 3 | Allowable drawdown time for aggregate storage below the underdrain | 7.2 | inches |
| 4 | Depth of runoff that can be infiltrated [Line 2 x Line 3] | 12 | ft² |
| 5 | Aggregate pore space | 0.40 | in/in |
| 6 | Required depth of gravel below the underdrain [Line 4/Line 5] | 18 | inches |
| 7 | Assumed surface area of the biofiltration BMP (min BMP footprint) | 1,230 | sq-ft |
| 8 | Media retained pore space | 0.1 | in/in |
| 9 | Volume retained by BMP [([Line 4 + (Line 12 x Line 8)]/12) x Line 7 | 980 | cubic-feet |
| 10| DCV that requires biofiltration [Line 1 – Line 9] | 870 | cubic-feet |

Runoff depth to be infiltration = (0.2 in/hr) x (36 hr) = 7.2 inches

Required depth of gravel = \( \frac{\text{Runoff depth to be infiltrated}}{\text{Aggregate pore space}} = \frac{7.2 \text{ inches}}{0.4 \text{ in/in}} = 18 \text{ inches} \)

Volume Retained = \( \frac{[\text{Runoff depth} + (M_{Th} \times M_{RPS})]}{12} \times A_{BMP} = \frac{[7.2 \text{ in} + (24 \text{ in} \times 0.1 \text{ in/in})]}{12} \times 1,230 \text{ ft}^3 = 980 \text{ ft}^3 \)

DCV that requires biofiltration = \( V_{DCV} - V_{BMP} = 1,850 \text{ ft}^3 - 980 \text{ ft}^3 = 870 \text{ ft}^3 \)
### BMP Parameters

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Surface Ponding [6 inch minimum, 12 inch maximum]</td>
<td>12</td>
<td>inches</td>
</tr>
<tr>
<td>12</td>
<td>Media Thickness [18 inches minimum]</td>
<td>24</td>
<td>inches</td>
</tr>
<tr>
<td>13</td>
<td>Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area</td>
<td>12</td>
<td>inches</td>
</tr>
<tr>
<td>14</td>
<td>Media available pore space</td>
<td>0.2</td>
<td>in/in</td>
</tr>
<tr>
<td>15</td>
<td>Media filtration rate to be used for sizing</td>
<td>5</td>
<td>in/hr.</td>
</tr>
</tbody>
</table>

---

The diagram illustrates the various components of a BMP (Best Management Practice) system, including:

- **Surface Ponding**
- **Aggregate Storage above underdrain**
- **Media Thickness**
- **Infiltration Storage**
Baseline Calculations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Allowable Routing Time for sizing</td>
</tr>
<tr>
<td>17</td>
<td>Depth filtered during storm [Line 15 x Line 16]</td>
</tr>
<tr>
<td>18</td>
<td>Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]</td>
</tr>
<tr>
<td>19</td>
<td>Total Depth Treated [Line 17 + Line 18]</td>
</tr>
</tbody>
</table>

\[D_\text{storm} = \text{Depth filtered during storm} = (\text{Media filtration rate}) \times (\text{routing time})\]

\[D_\text{storm} = (5 \text{ in/hr}) \times 6 \text{ hr} = 30 \text{ in}\]

\[D_\text{detention} = \text{Depth of detention storage}\]

\[D_\text{detention} = 12 \text{ in} + (24 \text{ in} \times 0.2 \text{ in/in}) + (12 \text{ in} \times 0.4 \text{ in/in}) = 21.6 \text{ in}\]

\[D_\text{total} = \text{total depth treated} = D_\text{storm} + D_\text{det}\]

\[D_\text{total} = 30 \text{ in} + 21.6 \text{ in} = 51.6 \text{ in}\]
Option 1 – Biofilter 1.5 times DCV

<table>
<thead>
<tr>
<th>Option 1 – Biofilter 1.5 times the DCV</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
</tr>
<tr>
<td>21</td>
</tr>
</tbody>
</table>

Req’d biofiltered vol = 1.5 x DCV that requires biofiltration

Req’d biofiltered vol = 1.5 x 870 ft³

Req’d biofiltered vol = 1,300 ft³

Req’d footprint = \( \frac{\text{Req’d biofiltered vol}}{D_{\text{tot}}} \times 12 \)

Req’d footprint = \( \frac{1,300 \text{ ft}^3}{51.6 \text{ in}} \times 12 = 300 \text{ ft}^2 \)
Option 2 – Store 75% of remaining DCV in pores and ponding

Option 2 - Store 0.75 of remaining DCV in pores and ponding

<table>
<thead>
<tr>
<th></th>
<th>Required Storage (surface + pores) Volume [0.75 x Line 10]</th>
<th>650</th>
<th>cubic-feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Required Footprint [Line 22/ Line 18] x 12</td>
<td>360</td>
<td>sq-ft</td>
</tr>
</tbody>
</table>

Req’d storage vol = 0.75 x DCV that requires biofiltration

Req’d storage vol = 0.75 x 870 ft³

Req’d storage vol = 650 ft³

Req’d footprint = $\frac{\text{Req’d storage vol}}{D_{\text{storage}}} \times 12$

Req’d footprint = $\frac{650 \text{ ft}^3}{21.6 \text{ in}} \times 12 = 360 \text{ ft}^2$
### Minimum BMP Size

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Area draining to the BMP</td>
<td>67,060</td>
<td>sq-ft</td>
</tr>
<tr>
<td>25</td>
<td>Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Minimum BMP Footprint [Line 24 x Line 25 x 0.03]</td>
<td>1,230</td>
<td>sq-ft</td>
</tr>
<tr>
<td>27</td>
<td>Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 26)</td>
<td>1,230</td>
<td>sq-ft</td>
</tr>
</tbody>
</table>

\[A_{\text{drain}} = \text{Area draining to the BMP} = 67,059 \text{ ft}^2\]

\[\text{Runoff factor} = 0.61\]

\[\text{Min BMP Footprint} = A_{\text{drain}} \times \text{Runoff factor} \times 0.03\]

\[\text{Min BMP Footprint} = 67,059 \text{ ft}^2 \times 0.61 \times 0.03 = 1,230 \text{ ft}^2\]

\[\text{Footprint of the BMP} = \max[\min(\text{Req'd footprint option 1, option 2}), \text{Min BMP Footprint}]\]

\[\text{Footprint of the BMP} = \max[\min(300 \text{ ft}^2, 360 \text{ ft}^2), 1230 \text{ ft}^2)\]

\[\text{Footprint of the BMP} = \max[300 \text{ ft}^2, 1230 \text{ ft}^2) = 1,230 \text{ ft}^2\]
What if: No Infiltration?

- Skip “Partial Retention” section
  - DCV the requires biofiltration equals the total DCV (i.e. Line 10 = Line 1)
- Change aggregate storage thickness to 0”
- Update baseline calculations
- Update Option 1 sizing
- Update Option 2 sizing
- Determine BMP footprint
<table>
<thead>
<tr>
<th>Baseline Calculations</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Allowable Routing Time for sizing</td>
<td>6</td>
<td>hours</td>
</tr>
<tr>
<td>17 Depth filtered during storm [Line 15 x Line 16]</td>
<td>30</td>
<td>inches</td>
</tr>
<tr>
<td>18 Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]</td>
<td>16.8</td>
<td>inches</td>
</tr>
<tr>
<td>19 Total Depth Treated [Line 17 + Line 18]</td>
<td>46.8</td>
<td>inches</td>
</tr>
</tbody>
</table>

\[D_{\text{storm}} = \text{Depth filtered during storm} = (\text{Media filtration rate}) \times (\text{routing time})\]

\[D_{\text{storm}} = (5 \text{ in/hr}) \times 6 \text{ hr} = 30 \text{ in}\]

\[D_{\text{detention}} = \text{Depth of detention storage}\]

\[D_{\text{detention}} = \text{Sfc ponding} + (M_{\text{th}} \times \text{Media avail pore space}) + (\text{Agg storage} \times \text{Agg pore space})\]

\[D_{\text{detention}} = 12 \text{ in} + (24 \text{ in} \times 0.2 \text{ in/in}) + (0 \text{ in} \times 0.4 \text{ in/in}) = 16.8 \text{ in}\]

\[D_{\text{total}} = \text{total depth treated} = D_{\text{storm}} + D_{\text{det}}\]

\[D_{\text{total}} = 30 \text{ in} + 16.8 \text{ in} = 46.8 \text{ in}\]
Option 1 – Biofilter 1.5 times DCV

<table>
<thead>
<tr>
<th>Option 1 – Biofilter 1.5 times the DCV</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Required biofiltered volume [1.5 x Line 10]</td>
<td>2,770 cubic-feet</td>
</tr>
<tr>
<td>21 Required Footprint [Line 20/ Line 19] x 12</td>
<td>710 sq-ft</td>
</tr>
</tbody>
</table>

Req’d biofiltered vol = 1.5 x DCV that requires biofiltration

Req’d biofiltered vol = 1.5 x 1,850 ft³

Req’d biofiltered vol = 2,770 ft³

Req’d footprint = \( \frac{\text{Req’d biofiltered vol}}{D_{\text{tot}}} \times 12 \)

Req’d footprint = \( \frac{2,770 \text{ ft}^3}{46.8 \text{ in}} \times 12 = 710 \text{ ft}^2 \)
Option 2 – Store 75% of remaining DCV in pores and ponding

<table>
<thead>
<tr>
<th>Option 2 - Store 0.75 of remaining DCV in pores and ponding</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
</tr>
<tr>
<td>23</td>
</tr>
</tbody>
</table>

Req’d storage vol = 0.75 x DCV that requires biofiltration

Req’d storage vol = 0.75 x 1,850 ft³

Req’d storage vol = 1,390 ft³

Req’d footprint = \( \frac{\text{Req’d storage vol}}{D_{\text{Storage}}} \times 12 \)

Req’d footprint = \( \frac{1,390 \text{ ft}^3}{16.8 \text{ in}} \times 12 = 990 \text{ ft}^2 \)
**Minimum BMP Size**

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
<th>Area</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Area draining to the BMP</td>
<td>67,060</td>
<td>sq-ft</td>
</tr>
<tr>
<td>25</td>
<td>Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Minimum BMP Footprint [Line 24 x Line 25 x 0.03]</td>
<td>1,230</td>
<td>sq-ft</td>
</tr>
<tr>
<td>25</td>
<td>Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 26)</td>
<td>1,230</td>
<td>sq-ft</td>
</tr>
</tbody>
</table>

\[
A_{\text{drain}} = \text{Area draining to the BMP} = 67,060 \text{ ft}^2
\]

Runoff factor = 0.61

\[
\text{Min BMP Footprint} = A_{\text{drain}} \times \text{Runoff factor} \times 0.03
\]

\[
\text{Min BMP Footprint} = 67,060 \text{ ft}^2 \times 0.61 \times 0.03 = 1,230 \text{ ft}^2
\]

Footprint of the BMP = \(\max(\min(\text{Req'd footprint option 1, option 2}), \text{Min BMP Footprint})\)

Footprint of the BMP = \(\max(\min(710 \text{ ft}^2, 990 \text{ ft}^2), 1230 \text{ ft}^2)\)

Footprint of the BMP = \(\max(710 \text{ ft}^2, 1230 \text{ ft}^2) = 1,230 \text{ ft}^2\)
# Biofiltration Sizing

## Required Footprint for Various Configurations

<table>
<thead>
<tr>
<th></th>
<th>12” Surface Ponding, 24” Media Thickness</th>
<th>6” Surface Ponding, 18” Media Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1 (1.5*DCV)</td>
<td>710 s.f.</td>
<td>840 s.f.</td>
</tr>
<tr>
<td>Option 2 (Store 0.75*DCV)</td>
<td>990 s.f.</td>
<td>1,740 s.f.</td>
</tr>
<tr>
<td>Minimum footprint (3%)</td>
<td><strong>1,230 s.f.</strong></td>
<td><strong>1,230 s.f.</strong></td>
</tr>
</tbody>
</table>

*Minimum footprint controls but 6” ponding w/18” media layer has a smaller vertical profile.*
Other Biofiltration Sizing Options

- Three percent sizing factor developed as a Countywide standard
  - Reduce likelihood of premature clogging (target of 10 year design life)
  - Maximize volume retention (target of 40% long term volume reduction on average)

- Alternative minimum sizing factors may be acceptable under certain conditions
  - Refer to Appendix F: Biofiltration Standard and Checklist
  - Allows for potential use of alternative and proprietary designs
**Pathways to Proprietary Biofiltration BMPs**

**General**
- TAPE “General Use” Designation that addresses POCs (Table F.1-1)
- Supports robust biological process (typically vegetation)
- Acceptable to local jurisdiction (performance, maintenance cost and effort, local experience, etc.)
- Sizing meets one of the applicable biofiltration sizing methods
- Maintenance agreement/plan in place

**Partial Infiltration**
- Must be supplemented with infiltration storage equal 3% minimum sizing standard, OR
- Achieve 40% long term volume reduction

**No Infiltration**
- Demonstrated lack of space for standard biofiltration
- Should consider reduction of 3% sizing factor first

*Fact Sheet BF-3, Appendix F*
Section Outline

Biofiltration Category

Standard, Nutrient Sensitive, Proprietary

Flow-Thru Category

Vegetates Swales, Media Filters, Sand Filters, Dry Extended Detention Basins, Proprietary
Select Flow-thru BMPs

- Flow-thru BMPs must be implemented when pollutant control standards cannot be met through retention and/or biofiltration.

- Use of flow-thru BMPs requires participation in offsite Alternative Compliance program.

- Step 1: Select the pollutant group for each “most significant pollutant of concern” from Table B.6-2.

- Step 2: Select the flow-thru treatment control BMP based on the grouping from Step 1. This step establishes the pollutant control standard to be met for each grouping.
Example Flow-thru Selection

- Assume retention/biofiltration of DCV is infeasible.
- Assume alternative compliance program exists.

**Step 1:**

- Most significant Pollutant of Concern: Bacteria (From Form I-3B pg. 6)
- Identify Grouping using Table B.6-2

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Coarse Sediment and Trash</th>
<th>Suspended Sediment and Particulate-bound Pollutants(^1)</th>
<th>Soluble-form Dominated Pollutants(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Nutrients</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Heavy Metals</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Organic Compounds</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Trash &amp; Debris</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen Demanding</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pesticides</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Example Flow-thru Selection

Pollutant Grouping: Suspended Sediment and Particulate-Bound Pollutants

- Pollutants in this category can be addressed to Medium or High effectiveness by effectively removing suspended sediments and associated particulate-bound pollutants.

Select Flow-thru treatment BMPs that meet High or Medium removal designation, AND meet all performance standards.
Example Flow-thru Selection

Step 2:

- Identify performance standards for pollutant grouping.
- Select Non-Proprietary BMPs
- Select Proprietary BMPs

Performance Standards:

<table>
<thead>
<tr>
<th>Influent Range</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 100 mg/L TSS</td>
<td>Effluent goal ≤ 20 mg/L TSS</td>
</tr>
<tr>
<td>100 – 200 mg/L TSS</td>
<td>≥ 80% TSS removal</td>
</tr>
<tr>
<td>&gt;200 mg/L TSS</td>
<td>&gt; 80% TSS removal</td>
</tr>
</tbody>
</table>

Table B.6-4 identifies the categories of non-proprietary BMPs that are considered to meet the pollutant treatment performance standard if designed to contemporary design standards. BMP types with an “High” ranking should be considered before those with an “Medium” ranking.
### Step 2: Select Non-Proprietary BMPs

<table>
<thead>
<tr>
<th>List of Acceptable Flow-Thru Treatment Control BMPs</th>
<th>Statistical Analysis of International Stormwater BMP Database</th>
<th>Evaluation of Conformance to Performance Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count In/Out</td>
<td>TSS Mean Influent, mg/L</td>
</tr>
<tr>
<td>Vegetated Filter Strip</td>
<td>361/282</td>
<td>69</td>
</tr>
<tr>
<td>Vegetated Swale</td>
<td>399/346</td>
<td>45</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>321/346</td>
<td>125</td>
</tr>
<tr>
<td>Sand Filter/Media Bed Filter</td>
<td>381/358</td>
<td>95</td>
</tr>
<tr>
<td>Lined Porous Pavement⁴</td>
<td>356/220</td>
<td>229</td>
</tr>
<tr>
<td>Wet Pond</td>
<td>923/933</td>
<td>119</td>
</tr>
</tbody>
</table>

| Table B.6-4 |
Example Flow-thru Selection

Step 2: Select Proprietary BMPs

Proprietary BMPs can be used if they meet each of the following conditions:

1. BMP meets the applicable performance standard as certified through third-party, field scale evaluation (ex. TAPE: General Use).

2. BMP is designed and maintained in a manner consistent with conditions of its certification.

3. BMP is acceptable at the discretion of approving authority
   - Maintenance cost and effort, local experience, performance data, etc.
Example Project Summary

Harvest and Use Feasibility: Not feasible
Infiltration Feasibility: No infiltration category
Pollutant of Concern: Bacteria
DCV (Example BMP): 1,850 cubic feet
DCV (Total Site): 3,770 cubic feet
Pollutant Control Category: Biofiltration BMPs
Applicable Sizing Standard: Minimum 3% Footprint
Biofiltration BMP footprint (Example DMA): 1,230 square feet
Biofiltration BMP footprint (Total Site): 2,510 square feet
Appropriate Flow-thru BMPs: Sand filter/Media bed filter, porous pavement, Proprietary
Questions
Example Project Hydromodification Management

Laura Henry, P.E.
Nobu Murakami, P.E.
Rick Engineering Company

project clean water

RICK Engineering Company
Geosyntec consultants
APWA
AMERICAN PUBLIC WORKS ASSOCIATION
Hydromodification Management

- Components of hydromodification management
  - Protection of critical coarse sediment yield areas
    - Land planning practices implemented at site layout
  - Flow control for post-project runoff from the project site
    - Structural BMPs for flow control that provide storage volume and outflow control
    - Retention, biofiltration or detention
    - Control a range of flows from critical channel flow up to upper threshold of geomorphically significant flows
Hydromodification Management

- Flow control devices must be designed based on continuous simulation hydrologic modeling
- Acceptable methods
  - SWMM
  - SDHM
  - HSPF
  - Sizing factors
- Guidance of BMP Design Manual Appendix G
Hydromodification Management

- Hydromodification management design for example project
  - A biofiltration design was prepared using SWMM computer program
  - Previously prepared design was presented during June 2015 SWMM training
  - June 2015 slides available at Project Clean Water

Note: SDHM training is planned for early 2016
Example Project Site

- Existing condition of the site
  - Site is undeveloped but is surrounded by existing streets
Example Project Site

- Existing drainage patterns

Example Project Study Area

Basin A
Example Project Site

- Pre-development condition of the site

Basin A

Basin B

Basin C

Basin D
Example Project Site

- Rain gauge selection (Poway gauge)
Example Project Site

- Pre-development model was executed to determine range of flows to control
Example Project Site

- Pre-development range of flows to control

<table>
<thead>
<tr>
<th>Rank</th>
<th>Start Date</th>
<th>Event Duration (hours)</th>
<th>Event Peak (CFS)</th>
<th>Exceedance Frequency (percent)</th>
<th>Return Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>3/4/1983</td>
<td>11</td>
<td>1.019</td>
<td>0.34</td>
<td>47</td>
</tr>
<tr>
<td>10</td>
<td>2/18/1980</td>
<td>77</td>
<td>1.014</td>
<td>0.68</td>
<td>23.5</td>
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<tr>
<td>11</td>
<td>1/25/1995</td>
<td>11</td>
<td>0.908</td>
<td>1.02</td>
<td>15.67</td>
</tr>
<tr>
<td>12</td>
<td>1/9/1978</td>
<td>29</td>
<td>0.883</td>
<td>1.37</td>
<td>11.75</td>
</tr>
<tr>
<td>5</td>
<td>3/17/1982</td>
<td>21</td>
<td>0.883</td>
<td>1.71</td>
<td>9.4</td>
</tr>
<tr>
<td>14</td>
<td>12/31/2004</td>
<td>19</td>
<td>0.839</td>
<td>2.05</td>
<td>7.83</td>
</tr>
<tr>
<td>17</td>
<td>11/5/1987</td>
<td>2</td>
<td>0.804</td>
<td>2.39</td>
<td>6.71</td>
</tr>
<tr>
<td>16</td>
<td>2/3/1998</td>
<td>16</td>
<td>0.752</td>
<td>2.73</td>
<td>5.88</td>
</tr>
<tr>
<td>17</td>
<td>12/18/1978</td>
<td>37</td>
<td>0.735</td>
<td>3.07</td>
<td>5.22</td>
</tr>
<tr>
<td>18</td>
<td>11/19/1982</td>
<td>22</td>
<td>0.733</td>
<td>3.41</td>
<td>4.7</td>
</tr>
<tr>
<td>19</td>
<td>2/3/1998</td>
<td>7</td>
<td>0.727</td>
<td>3.75</td>
<td>4.27</td>
</tr>
<tr>
<td>20</td>
<td>12/18/1978</td>
<td>3</td>
<td>0.71</td>
<td>4.1</td>
<td>3.92</td>
</tr>
<tr>
<td>21</td>
<td>11/12/1976</td>
<td>2</td>
<td>0.693</td>
<td>4.44</td>
<td>3.62</td>
</tr>
<tr>
<td>22</td>
<td>2/28/1970</td>
<td>3</td>
<td>0.691</td>
<td>4.78</td>
<td>3.36</td>
</tr>
<tr>
<td>23</td>
<td>2/14/1998</td>
<td>5</td>
<td>0.652</td>
<td>5.12</td>
<td>3.13</td>
</tr>
<tr>
<td>24</td>
<td>1/6/1974</td>
<td>33</td>
<td>0.631</td>
<td>5.46</td>
<td>1.94</td>
</tr>
<tr>
<td>25</td>
<td>3/1/1983</td>
<td>42</td>
<td>0.623</td>
<td>5.8</td>
<td>1.76</td>
</tr>
<tr>
<td>26</td>
<td>2/5/1983</td>
<td>5</td>
<td>0.617</td>
<td>6.14</td>
<td>2.61</td>
</tr>
</tbody>
</table>

10-year Q: 0.883 cfs
5-year Q: 0.734 cfs
2-year Q: 0.570 cfs

Lower Flow Threshold: 10%

0.1xQ2 (Pre): 0.057 cfs
Example Project Site

- Iterative design process executed to find final solution

Diagram:

1. Run Simulation
2. Generate Runoff Time Series
3. Extract Runoff Time Series
4. Calculate Peak Flow Statistics
5. Calculate Flow Durations
6. Assess Results, Adjust Design
Example Project Site

- Working solution biofiltration design
Hydromodification Management

- Summary of previously prepared biofiltration design for hydromodification management:
  - Bottom area 1,533 square feet
  - 24 inches total surface depth includes overflow conveyance and freeboard
  - 12 inch tall riser (SDRSD D-29 Type “I” Grated Catch Basin) with 1.5-inch orifice at 3 inches above surface
  - 24 inches soil media
  - 12 inches gravel
  - Underdrain with 0.75-inch control orifice
Example Project Site

- Example project cross section

12 inches ponding depth (below crest of overflow structure)

24 inches soil media

12 inches gravel

Overflow Structure

Mid-Flow Restrictor

Perforated Pipe Underdrain

Low-Flow Restrictor

Outflow

12 inches additional depth for conveyance of large storm events, and freeboard
# Hydromodification Management

- Comparing hydromodification management results to pollutant control results

<table>
<thead>
<tr>
<th></th>
<th>Pollutant Control Result</th>
<th>Hydromodification Management Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area measured at bottom of ponding (square feet)</td>
<td>1,230</td>
<td>1,533</td>
</tr>
<tr>
<td>Total ponding depth including freeboard (feet)</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Depth of bioretention soil media (feet)</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Depth of gravel layer (feet)</td>
<td>n/a</td>
<td>1</td>
</tr>
<tr>
<td>Underdrain control orifice (inches)</td>
<td>n/a</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Hydromodification Management

- Overall the design for hydromodification management has a larger area, cross section, and total volume than the design for pollutant control.
- But does it still meet the pollutant control performance standards?
- Two differences:
  - The riser includes a mid-flow orifice 3 inches above the surface.
  - A low flow orifice controls the outflow.
Hydromodification Management

- Revised data for Worksheet B.5-1
  - Surface area = 1,533 ft$^2$
  - Ponding depth = 3 inches
  - Media thickness = 24 inches
  - Aggregate storage above underdrain = 12 inches
  - Media filtration rate (controlled by the underdrain control orifice) = 0.8 inches/hour

  Approximate orifice flow = 0.03 cfs
  \[
  \frac{(0.03 \text{ cfs} \times 3,600 \text{ s/hour} \times 12 \text{ in/foot})}{1,533 \text{ ft}^2} = 0.8 \text{ in/hour}
  \]
Hydromodification Management

- Pollutant control check (1 of 3)
  - Worksheet B.5-1 with new surface area data entered

### Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs

<table>
<thead>
<tr>
<th>Simple Sizing Method for Biofiltration BMPs</th>
<th>Worksheet B.5-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remaining DCV after implementing retention BMPs</td>
<td>1,850</td>
</tr>
<tr>
<td>Partial Retention</td>
<td></td>
</tr>
<tr>
<td>2 Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible</td>
<td>0</td>
</tr>
<tr>
<td>3 Allowable drawdown time for aggregate storage below the underdrain</td>
<td>36 hours</td>
</tr>
<tr>
<td>4 Depth of runoff that can be infiltrated [Line 2 x Line 3]</td>
<td>0 inches</td>
</tr>
<tr>
<td>5 Aggregate pore space</td>
<td>0.40 in/in</td>
</tr>
<tr>
<td>6 Required depth of gravel below the underdrain [Line 4/ Line 5]</td>
<td>0 inches</td>
</tr>
<tr>
<td>7 Assumed surface area of the biofiltration BMP</td>
<td><strong>1,533</strong> sq-ft</td>
</tr>
<tr>
<td>8 Media retained pore space</td>
<td>0.1 in/in</td>
</tr>
<tr>
<td>9 Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7</td>
<td>307 cubic-feet</td>
</tr>
<tr>
<td>10 DCV that requires biofiltration [Line 1 – Line 9]</td>
<td>1,543 cubic-feet</td>
</tr>
</tbody>
</table>


Hydromodification Management

- Pollutant control check (2 of 3)
  - Worksheet B.5-1 with new cross section and outflow data entered

<table>
<thead>
<tr>
<th>BMP Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Surface Ponding [6 inch minimum, 12 inch maximum]</td>
<td>3</td>
</tr>
<tr>
<td>12 Media Thickness [18 inches minimum]</td>
<td>24</td>
</tr>
<tr>
<td>13 Aggregate Storage above underdrain invert (12 inches typical) – use 0 inch for sizing if the aggregate is not over the entire bottom surface area</td>
<td>12</td>
</tr>
<tr>
<td>14 Media available pore space</td>
<td>0.2</td>
</tr>
<tr>
<td>15 Media filtration rate to be used for sizing</td>
<td>0.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline Calculations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Allowable Routing Time for sizing</td>
<td>6</td>
</tr>
<tr>
<td>17 Depth filtered during storm [Line 15 x Line 16]</td>
<td>4.8</td>
</tr>
<tr>
<td>18 Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]</td>
<td>12.6</td>
</tr>
<tr>
<td>19 Total Depth Treated [Line 17 + Line 18]</td>
<td>17.4</td>
</tr>
</tbody>
</table>
### Hydromodification Management

- Pollutant control check (3 of 3)
  - The minimum footprint for pollutant control is still 1,230 ft² with the new cross section and surface area
  - 1,533 ft² provided exceeds 1,230 ft² required

<table>
<thead>
<tr>
<th>Option 1 – Biofilter 1.5 times the DCV</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Required biofiltered volume [1.5 x Line 10]</td>
<td>2,315 cubic-feet</td>
</tr>
<tr>
<td>21 Required Footprint [Line 20/ Line 19] x 12</td>
<td>1,596 sq-ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 2 - Store 0.75 of remaining DCV in pores and ponding</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>22 Required Storage (surface + pores) Volume [0.75 x Line 10]</td>
<td>1,157 cubic-feet</td>
</tr>
<tr>
<td>23 Required Footprint [Line 22/ Line 18] x 12</td>
<td>1,102 sq-ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Footprint of the BMP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Area draining to the BMP</td>
<td>67,060 sq-ft</td>
</tr>
<tr>
<td>25 Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)</td>
<td>0.61</td>
</tr>
<tr>
<td>26 Minimum BMP Footprint [Line 24 x Line 25 x 0.03]</td>
<td>1,230 sq-ft</td>
</tr>
<tr>
<td>25 Footprint of the BMP = Maximum(1,230, 1,230)</td>
<td>1,230 sq-ft</td>
</tr>
</tbody>
</table>
Hydromodification Management

- Drawdown check

- Model BMP Design Manual and Final HMP are flexible about calculation methods
  - Use Excel, hand calculation, HEC-1

- Drawdown requirements:
  - Hydromodification management: 96 hours
  - Pollutant control: depends on BMP
  - Biofiltration: drain surface in 24 hours or less
Hydromodification Management

- Drawdown check
- Biofiltration and other surface storage BMPs - drain from the crest of the overflow structure to the surface
# Hydromodification Management

- Example project drawdown outflow

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Notes for Drawdown Calculations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Depth Above Surface (inches)</td>
<td>Depth Above Surface (feet)</td>
<td>Head on Low Flow Orifice (feet)</td>
<td>0.75-inch Low Flow Orifice Outflow (cfs)</td>
<td>Head on Mid Flow Orifice (feet)</td>
<td>1.5-inch Mid Flow Orifice Outflow (cfs)</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0.000</td>
<td>2.969</td>
<td>0.025</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>0.250</td>
<td>3.219</td>
<td>0.027</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>0.500</td>
<td>3.469</td>
<td>0.028</td>
<td>0.438</td>
<td>0.039</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>0.750</td>
<td>3.719</td>
<td>0.028</td>
<td>0.688</td>
<td>0.049</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>1.000</td>
<td>3.969</td>
<td>0.029</td>
<td>0.938</td>
<td>0.057</td>
</tr>
</tbody>
</table>
Hydromodification Management

- Example project drawdown volume

<table>
<thead>
<tr>
<th></th>
<th>Depth Above Surface (feet)</th>
<th>Area (ft²)</th>
<th>Volume (ft³)</th>
<th>Volume (acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>0</td>
<td>1533</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>2345</td>
<td>1939</td>
<td>0.045</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hydromodification Management

- HEC-1 input for drawdown calculations

### DRAWDOWN.HC1 - WordPad

<table>
<thead>
<tr>
<th>ID</th>
<th>EXAMPLE PROJECT FOR NOVEMBER 2015 BMP DESIGN MANUAL TRAINING</th>
</tr>
</thead>
<tbody>
<tr>
<td>FN</td>
<td>DRAWDOWN.HC1</td>
</tr>
<tr>
<td>ID</td>
<td>DRAWDOWN CALCULATION</td>
</tr>
<tr>
<td>ID</td>
<td>STARTING ELEVATION 1.0 FOOT (TOP OF RISER)</td>
</tr>
</tbody>
</table>

*FREE

| IT | 15 01JAN90 1200 300 |
| IQ | 2 2 |
| KK | BIOFILTRATION BASIN |
| KM | VOLUME AND FLOW CURVES FOR BIOFILTRATION BASIN |
| KO | 0 0 0 0 21 |
| RS | 1 ELEV 1.0 |
| SV | 0.00 0.045 |
| SE | 0.00 1.00 |
| SQ | 0.025 0.027 0.067 0.077 0.087 |
| SE | 0.00 0.25 0.50 0.75 1.0 |
| ZZ | |
Hydromodification Management

- Tabular HEC-1 output shows stage dropped to 0.0 feet in 45 time steps (11.25 hours)
Conclusion for example project
- Meets hydromodification management performance standards
- Meets pollutant control performance standards
- Accessible for inspection and maintenance via street
Questions
Maintenance Requirements

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Operation and Maintenance

- Structural BMPs require on-going maintenance into perpetuity
- Pollutants/overgrown vegetation must be removed in order to maintain BMP function
- Copermittees must confirm structural BMPs are maintained – required by MS4 Permit
Operation and Maintenance

- Goals of the Model BMP Design Manual maintenance section:
  - Consider maintenance from the start of project planning
  - Incorporate design features to facilitate maintenance
## Schedule for Developing O&M Plan and Agreement

<table>
<thead>
<tr>
<th>Step</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine ownership, responsible party, and funding mechanism</td>
<td>Prior to first submittal – discuss at pre-application meeting</td>
</tr>
<tr>
<td>Identify expected maintenance actions</td>
<td>First submittal – identify in SWQMP</td>
</tr>
<tr>
<td>Develop detailed O&amp;M Plan</td>
<td>As required by [City Engineer], prior to issuance of permit to construct</td>
</tr>
<tr>
<td>Update/finalize O&amp;M Plan post-construction</td>
<td>As required by [City Engineer], upon completion of construction</td>
</tr>
<tr>
<td>Prepare draft O&amp;M Agreement</td>
<td>As required by [City Engineer]</td>
</tr>
<tr>
<td>Execute and record O&amp;M Agreement</td>
<td>As required by [City Engineer]</td>
</tr>
</tbody>
</table>
Operation and Maintenance

- Designing structural BMPs to facilitate maintenance and control maintenance costs (see Section 7.6):
  - Considerations for placement of vegetated BMPs
  - Measures to facilitate collection of trapped pollutants
  - Measures to access the structural BMP
  - Measures to facilitate inspection
Civil engineer is responsible to determine applicable maintenance actions and design BMP to facilitate maintenance

Include maintenance information on plans
Operation and Maintenance

• BMPs are grouped based on common maintenance actions

  ◦ Vegetated infiltration or filtration BMPs
  ◦ Non-vegetated infiltration BMPs
  ◦ Non-vegetated filtration BMPs
  ◦ Detention BMPs
Operation and Maintenance

- Maintenance actions are provided for each group
- Civil engineer is responsible to review the maintenance actions in Chapter 7 and design BMP features to facilitate maintenance

<table>
<thead>
<tr>
<th>Typical Maintenance Indicator(s) for Vegetated BMPs</th>
<th>Maintenance Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulation of sediment, litter, or debris</td>
<td>Remove and properly dispose of accumulated materials, without damage to the vegetation.</td>
</tr>
<tr>
<td>Poor vegetation establishment</td>
<td>Re-seed, re-plant, or re-establish vegetation per original plans.</td>
</tr>
<tr>
<td>Overgrown vegetation</td>
<td>Mow or trim as appropriate, but not less than the design height of the vegetation per original plans when applicable (e.g. a vegetated swale may require a minimum vegetation height).</td>
</tr>
<tr>
<td>Erosion due to concentrated irrigation flow</td>
<td>Repair/re-seed/re-plant eroded areas and adjust the irrigation system.</td>
</tr>
</tbody>
</table>
Example Biofiltration BMP:

- Required maintenance actions?
Operation and Maintenance

- Typical Maintenance Indicators for Vegetated BMPs (e.g., biofiltration)
  - Accumulation of sediment, litter, or debris
  - Poor vegetation establishment
  - Overgrown vegetation
  - Erosion due to concentrated irrigation flow
  - Erosion due to concentrated storm water runoff flow
  - Standing water
  - Obstructed inlet or outlet structure
  - Damage to structural components such as weirs, inlet or outlet structures
Operation and Maintenance

- Example Biofiltration BMP:
  - What equipment will be needed for maintenance?
  - How will it access the BMP?
Operation and Maintenance

- Checklist for Construction Plans
  - Maintenance access points
  - Features that facilitate inspection (observation ports, cleanouts, silt posts, etc.)
  - Maintenance thresholds specific to the BMP (e.g., silt level that triggers removal of silt)
  - Recommended equipment to perform maintenance
  - When applicable, required training or certification (e.g., confined space entry)
  - When applicable, manufacturer and part number for proprietary parts
Operation and Maintenance

- Maintenance frequency
  - Minimum reporting is annual*, but actual maintenance frequency depends on the site conditions
    *minimum reporting may vary by jurisdiction
  - Maintain every time maintenance threshold for removal of materials is met
  - Routine maintenance will help avoid more costly rehabilitative maintenance
  - Inspect monthly and during rain events until a suitable inspection/maintenance schedule can be determined based on site conditions
Questions