STORM WATER TRAINING
LOW IMPACT DEVELOPMENT (LID)

DECEMBER 11, 2019
INTRODUCTION
REGIONAL LID MANUAL TRAINING

AGENDA
1:00 PM  Introduction  Colleen Hunt
1:15 PM  Regulations  Brendan Thompson
1:30 PM  LID Manual 101  Heaven Moore
2:30 PM  BREAK
2:45 PM  Example Exercise  Yoash Tilles
3:30 PM  Q&A Panel  Panelist
4:30 PM  END
ACRONYMS & DEFINITIONS
• **IMPERVIOUS SURFACE**: For the purposes of this Manual, impervious area is defined as areas that have been modified such that storm water percolation into underlying soils is reduced or prohibited. Typical examples of surfaces include concrete, asphalt, and roof tops.
  - Gravel placed as part of the proposed project is considered to be impervious unless documentation is provided to verify that it is pervious.
  - Existing gravel on a project site prior to the proposed project is considered to be pervious unless documentation is provided that demonstrates that it is impervious.
REGULATORY BACKGROUND

BRENDAN THOMPSON
MS4 Storm Water Permit

- Regulates the discharge of storm water discharged from the municipal separate storm sewer system (MS4) to receiving water
- Requires Permittees to reduce pollution in storm water runoff to the maximum extent practicable
- BMP based permit requiring control measures related to public education and outreach, illicit discharge detection and elimination, municipal operations, construction sites, industrial and commercial facilities, monitoring and post-construction development
Municipal MS4 Storm Water Permit

- Order No. R1-2015-0030, Phase I Permit
- Areas subject to requirements include:
  - Cloverdale
  - Cotati
  - Healdsburg
  - Rohnert Park
  - Santa Rosa
  - Sebastopol
  - Ukiah
  - Windsor
  - Portions of Unincorporated Sonoma County
- Adopted by the North Coast Regional Water Quality Control Board Jan 6, 2016
- Expires January 5, 2021
Planning and Land Development

- Permit Requirements:
  - Project triggers that require LID
  - Exemptions
  - Treat all pollutants of concern including: dissolved and particulate metals, pathogens, nutrients, sediment, hydrocarbons, and trash and find sediment sized at 100 microns or larger
  - Sizing criteria
  - BMP selection
  - LID Manual
  - Approval Process
  - Hydromodification
  - Maintenance Declaration
  - Tracking and Inspections
Projects that trigger LID:

- All new development and redevelopment projects creating or replacing 10,000 square feet or more of impervious surface
- Streets, roads, highways, and freeway construction or reconstruction projects creating or replacing a combined total of 10,000 square feet or more of impervious surface
• Projects that are exempt from LID:
  • Routine Maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, and original purpose of the facility, including pothole repairs and square cut patching
  • Emergency activities required to protect public health and safety
  • Projects undertaken solely to install or reinstall public utilities and do not include any additional street or road development or redevelopment activities beyond paving
  • Stand-alone pedestrian pathways, trails, and off-street bicycle lanes
APPLICABILITY

Which version of LID Manual must be used to comply with the LID requirements?
## Which LID Manual To Use?

### What date did the project receive approval?*

<table>
<thead>
<tr>
<th>Manual</th>
<th>Date Range</th>
<th>Manually Approved</th>
<th>Discretionary Approval</th>
</tr>
</thead>
</table>

*Discretionary approval = Date of discretionary permit issuance  
Ministerial approval = Date of ministerial permit issuance  
Public projects w/o discretionary approval = CEQA determination date
Other Triggers- note these can change

401 Permit

CALGreen
- May be required for non-residential building permit
- Building Code change
- Effective January 2011
- Clarification Memo on Santa Rosa’s website

General Construction Permit

Phase II MS4 Permit
LOW IMPACT DEVELOPMENT MANUAL

HEAVEN MOORE
2017 LID Manual

- Narrative
- Determination Worksheet
- Storm Water Calculator
- Submittal Guide
- Plant List
- LID Design Details
- 2017 BMP Selection Table
- 2017 BMP Inspection Checklist
- Maintenance Declaration
- CalGreen Building Code
- BMP Factsheets
Designing a Project

- Sizing Requirements
- BMP Selection
- Storm Water Calculator
SIZING REQUIREMENTS
Sizing Criteria

Volume Capture and Treatment

- Treat all of the runoff generated using the modified Rational Method with an intensity of 0.2 inches per hours
- Capture the increase in volume generated by the site due to the increase in impervious surface for a 1.0” 24 hour rain event using the Curve Number method.

Treatment Only

- If only treatment is required BMPs must be sized and designed to:
  - 1.5 times the design flow rate using the modified Rational Method;
  - Flow rate of runoff produced by 1.0” 24 hour rain event using the Curve Number method.
Hydromodifications

- Project **create or replace a combined total of 1.0 acre or more** of impervious surface

- *Triggers the 100% Volume Capture Hydromodification Control Requirements*
BMP SELECTION
Prioritization of LID BMPs

- Small scale landscaped based infiltration BMPs that treat storm water as close to the source as possible
- BMPs are categorized into seven priorities
Prioritization of LID BMPs

**Universal**
- Generally not dependent on site constraints
- Should be considered for use at all projects

**Examples**
- Rain Water Harvesting
- Green Roofs
- Interceptor Trees
- Buffer Strips
- Flow Through Planters
Rain Barrel Cisterns

The purpose of a rain barrel cistern is to collect water from a roof. The water is released when needed at a later date. A screen keeps impurities out of the water.
Prioritization of LID BMPs

Priority 1

- Small scale
- Vegetated
- Infiltration based
- No perforated pipe
- No impermeable liners
- Provides infiltration into native soils

Examples

- Bioretention
- Constructed wetland
Prioritization of LID BMPs

**Priority 2**
- Small scale
- Vegetated
- Infiltration based
- **Perforated pipe installed high in the treatment area**
- No impermeable liners
- Use of native soils

**Examples**
- Bioretention
- Constructed wetland
Prioritization of LID BMPs

Priority 3

- Treatment only
- Installed with subdrains
- Use of impermeable liner
- “Treatment train” or when only treatment is required

Examples

- Bioretention
- Flow through planters
- Vegetated swale
Prioritization of LID BMPs

Priority 4

• May not have vegetation
• “Treatment train”

Examples

• Tree filter units
• Modular wetlands
• Infiltration trench without vegetation
Prioritization of LID BMPs

Priority 5
- Physical structured units
- Treatment only
- No vegetation
- “Treatment train”

Examples
- Chambered separator units
- Centrifugal separator units
- Filter inserts
Prioritization of LID BMPs

Priority 6

- Offset
- Requires Regional Water Approval
Prioritization of LID BMPs

Detention

• May be used if the design meets the design criteria specified for LID
BMP selection

- The proposed design must meet the technical requirements
- The selected BMPs must be LID type BMPs (Universal, Priority level 1 or 2), unless:
  - The project is only required to do treatment or
  - The BMP is use as apart of a “treatment train”

*LID features are small scale, infiltration based, landscape features that aim to mimic the undeveloped site.*
The selected BMPs must be LID type BMPs (Universal, Priority level 1 or 2), unless:

- It is infeasible to infiltrate for one of the following reasons only:
  - High groundwater or deadpan
  - Soil contamination (must be evaluated and confirmed by the Regional Board)
  - Geotechnical hazard
- Priority level 3, 4, or 5 may be used in these cases- along with offset.
Approval Authority

If these conditions aren’t met the municipality doesn’t have the authority to approve the project and it must be referred to the Regional Board for review and approval.

A joint meeting will be convened between the applicant, Regional Water Board, and the municipality.
Trash Capture

- Trash capture must be provided for all tributary areas, or in the downstream system, unless it is provided in the BMP by virtue of its design.

  - Trash is defined as material over 100 microns in diameter.
  - Can be part of a treatment train.
Other notes and things to remember...

- BMS must have all three elements (small scale, infiltration based, vegetated) to qualify as LID and be approvable by the municipality.
- Retention systems such as oversized pipes and chambers are not LID by themselves and must be part of a treatment train.
- LID features must be 51% vegetated.
- Permeable pavement is not a BMP, but rather a conveyance method and an impermeable area reduction tool.
Other notes and things to remember...

- All tributary areas must receive treatment and trash capture, however volume capture may be done on a site basis.
  - If one area of the site is not suited for infiltration, that calculated volume may be provided for in a different BMP. The physical water does not need to reach that BMP. This has been referred to as “on-site offset.”

- Offsite improvements need to be considered in the calculations. If it isn’t feasible to physically capture the runoff from these improvements, “on-site offset” may be utilized.
Other notes and things to remember...

• Don’t forget you high flow bypass! Flood flows still need to be routed to the Storm Drain System.

• Make sure that the BMPs are located so that they can and will be inspected and maintained. BMPs that take up most of a small backyard are very likely to be removed by a homeowner.

• Think about construction sequencing. LID BMPs are designed to handle the level of load coming from the finished project. Construction runoff can foul them requiring them to be replaced before the site is accepted!
STORM WATER CALCULATOR
Calculator available at www.srcity.org/stormwaterLID
# BMP Input Worksheet

## Enter BMP ID and BMP's Information:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP ID (MUST BE unique)</td>
<td></td>
</tr>
<tr>
<td>BMP’s Physical Tributary Area</td>
<td>0 ft&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>BMP Design Criteria</td>
<td>Treatment Only</td>
</tr>
</tbody>
</table>

## Instructions:

- Enter individual BMP’s tributary parameters in the yellow cells. To view the calculation worksheet, click on the Display button for that section. All calculations are performed in the individual worksheets. To update the results on this worksheet, use the “Calculate Results” or “Calculate All” buttons. CAUTION - MUST USE the Calculate button(s) to update results!

## Action Buttons:

<table>
<thead>
<tr>
<th>Action Buttons</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear/Reset All Inputs</td>
<td>Clear or load default values into cells of individual section or entire page.</td>
</tr>
<tr>
<td>Calculate</td>
<td>Will load values into worksheet, calculate and display results.</td>
</tr>
<tr>
<td>Display Calculation Worksheet</td>
<td>Will load the values, calculate and display the corresponding worksheet with results.</td>
</tr>
<tr>
<td>Save BMP Data and Results</td>
<td>Calculates all sections before saving the BMP’s design data, and then copies the results to the Summary worksheet by BMP ID. Will not save BMP if error(s) are present in the Runoff Reduction Measures or selected treatment method.</td>
</tr>
</tbody>
</table>
**Runoff Reduction Measures**

<table>
<thead>
<tr>
<th>Intercepter Trees</th>
<th>Note: The maximum Runoff Reduction Measures allowed is 50% of the physical area.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new <em>Evergreen Trees</em> that qualify as interceptor trees:</td>
<td></td>
</tr>
<tr>
<td>Number of new <em>Deciduous Trees</em> that qualify as interceptor trees:</td>
<td></td>
</tr>
<tr>
<td>Enter square footage of qualifying existing tree canopy:</td>
<td>0 ft²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disconnected Roof Drains</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Method 1</td>
<td>Select disconnection condition:</td>
</tr>
<tr>
<td>Amount of rooftop area that drain to disconnected downsputs:</td>
<td>0 ft²</td>
</tr>
<tr>
<td>OR Method 2</td>
<td></td>
</tr>
<tr>
<td>Percent of rooftop area to be disconnected from downsputs:</td>
<td>0 %</td>
</tr>
<tr>
<td>Select Density:</td>
<td>1 Units per Acre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paved Area Disconnection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved Area Type (select from drop down list):</td>
<td>Select paved area type</td>
</tr>
<tr>
<td>Enter area of alternatively designed paved area:</td>
<td>0.0 ft²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Buffer Strips &amp; Bovine Terraces</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area draining to a Buffer Strip or Bovine Terrace:</td>
<td>0.0 ft²</td>
</tr>
</tbody>
</table>

**Total Runoff Reduction Measures:** 0 ft²

**Resulting reduced Tributary Area used for BMP sizing:** 0 ft²
HYDROMODIFICATION
CONTROL
# 100% Treatment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_{post}</td>
<td>0.0</td>
<td>Post development surface</td>
</tr>
<tr>
<td>Post development surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{post}</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>User Composite post development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{comp}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Factor (TF)</td>
<td>1.0</td>
<td>Calculated</td>
</tr>
<tr>
<td>Design Storm</td>
<td>0.20</td>
<td>Default Value</td>
</tr>
<tr>
<td>Q_{TREATMENT}</td>
<td>0.0000</td>
<td></td>
</tr>
</tbody>
</table>

If User Composite C_{POST} and or I_{historical} are used, supporting calculations are required to be submitted.

---

**Reset Treatment Inputs**

**Display "100% Treatment" calculation worksheet**

**Calculate Results**
HORIZONTAL FLOWS - SWALES
VERTICAL FLOW – PLANTER BOXES
**Delta Volume Capture; \( V_{\text{delta}} \)**

If User Composite CN is used, supporting calculations are required to be submitted.

<table>
<thead>
<tr>
<th>Soil Type within Tributary Area</th>
<th>A: greater than 0.30 in/hr Infiltration (transmission) ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predo development ground cover description</td>
<td>Brush: weed-grass mixture with brush major element - Poor (&lt;50% ground cover)</td>
</tr>
<tr>
<td>Post development ground cover description</td>
<td>Brush: weed-grass mixture with brush major element - Poor (&lt;50% ground cover)</td>
</tr>
</tbody>
</table>

\[ \text{CN}_{\text{PRE}} = 48 \]

\[ \text{CN}_{\text{POST}} = 48 \]

User Cells must be blank to use \( \text{CN}_{\text{PRE}} \) OR \( \text{CN}_{\text{POST}} \) from drop down lists.

\[ V_{\text{DELTA}} = 0.000 \text{ ft}^3 \]

---

**BMP Sizing Tool: Delta Volume Capture Requirements**

<table>
<thead>
<tr>
<th>BMP Depth:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured from ground surface WITHOUT perforated pipe.</td>
</tr>
<tr>
<td>Measured from bottom of perforated pipe if installed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Imported BMP Soil Porosity</th>
<th>BMP Volume Below Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth: 0.10 ft</td>
<td>Depth: 0.00 ft</td>
</tr>
<tr>
<td>Width: 0.00 ft</td>
<td>Width: 0.00 ft</td>
</tr>
<tr>
<td>Length: 0.00 ft</td>
<td>Length: 0.00 ft</td>
</tr>
</tbody>
</table>

Enter Area number will override Width & Length information!

<table>
<thead>
<tr>
<th>Area BMP: 0 \text{ ft}^2</th>
<th>Area: 0 \text{ ft}^2</th>
</tr>
</thead>
</table>

Total Volume for calculation: 0.00 \text{ ft}^3

---

Select Delta Volume Capture BMP Design Requirements when Saving? Yes

---

DELTA VOLUME CAPTURE
CN Composite Work Sheet

<table>
<thead>
<tr>
<th>Soil Type (Infiltration Rate)</th>
<th>Cover Description</th>
<th>CN</th>
<th>Area ft²</th>
<th>Product of CN x Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Entry</td>
<td>No Entry</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No Entry</td>
<td>No Entry</td>
<td>6</td>
<td>0</td>
<td>0</td>
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<td>No Entry</td>
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<td>No Entry</td>
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<td>6</td>
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</tr>
<tr>
<td>No Entry</td>
<td>No Entry</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ CN_{COMPOSITE} = (CN \times Area) + (CN \times Area) + (CN \times Area) \]

\[ = \text{Use this CN}_{COMPOSITE} = \text{NA} \]

CN COMPOSITE WORK SHEET
C FACTOR COMPOSITE WORK SHEET
SUBMITTING A PROJECT

What needs to be in a SW LID Submittal
What needs to be in the submittal?

- Completed Submittal Guide (Initial or Final)
- Copy of the completed Determination Worksheet
- Narrative Description
- Exhibits
- Calculation
- BMP details

Each SUSMP Report needs to be complete.

The version don’t need to match each other, but they do need to match the plan set they accompany!
## APPENDIX D
### Preliminary SUSMP Submittal Guide

### Project Information:

<table>
<thead>
<tr>
<th>Applicant Name</th>
<th>(Owner or Developer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mailing Address</td>
<td></td>
</tr>
<tr>
<td>City/State/Zip</td>
<td></td>
</tr>
<tr>
<td>Phone/Email/Fax</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Address</td>
<td></td>
</tr>
<tr>
<td>City/State/Zip</td>
<td></td>
</tr>
<tr>
<td>Permit # (s)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineer Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mailing Address</td>
<td></td>
</tr>
<tr>
<td>City/State/Zip</td>
<td></td>
</tr>
<tr>
<td>Phone/Email/Fax</td>
<td></td>
</tr>
</tbody>
</table>

### Type of Application/Project:

- [ ] Subdivision
- [ ] Grading Permit
- [ ] Building Permit
- [ ] Design Review
- [ ] Use Permit

### What your Preliminary Plan must include:

**Narrative:**

- Description of proposed project type, location, and any specific uses or features.
- Description of any sensitive features (creeks, wetlands, trees, etc.) and whether these features will be removed or altered.
- Description of the existing site.
- Description of how this project triggers these requirements (Impervious area, CALG...)

### BNP Details:

- [ ] Preliminary detail for each type of BMP selected: provide a preliminary 8.5"x11" detail for each BMP type or include on submitted drawings. These can be taken straight from the Fact Sheets if no significant changes are required.

### On Plans:

- [ ] Show all applicable elements of the selected BMPs on the appropriate sheets.

### Calculations:

- [ ] Preliminary calculations; both volume and treatment, using the "storm water calculator" for each inlet.

### Proposed SUSMP Exhibit:

- [ ] Exhibit should include: street names, property lines, and north arrow.
- [ ] Tributary areas shown for all inlets (including storm sewers).
- [ ] C-value for each tributary area.
- [ ] Soil Type of existing site.
- [ ] New or replaced impervious area.
- [ ] All inlets shown (including identifier).
- [ ] All interceptors shown.
- [ ] All proposed BMPs shown.

### Existing Condition Exhibit:

- [ ] Exhibit should include: street names, property lines, scale, and north arrow.
- [ ] Soil Type of existing site.
- [ ] Proposed tributary areas shown for all proposed projects.
- [ ] Existing impervious areas.

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City of Santa Rosa and County of Sonoma

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Low Impact Development Technical Design...
Narrative:

*Project Description*

- Description of proposed project type, location, and any specific uses or features.
- Description of any sensitive features (creeks, wetlands, trees, etc) and whether they are going to be preserved, removed or altered.
- Description of the existing site.
- Description of how this project triggers these requirements (impervious area, CALGreen, 401 Permit, etc).
Pollution Prevention and Runoff Reduction Measures

- Description of all proposed pollution prevention measures (street sweeping, covered trash enclosures, indoor uses, etc).
- Description of all Runoff Reduction Measures (Interceptor Trees, Impervious Area Disconnection, and/or Alternative Driveway Design).
Type of BMPs proposed

• Description of the types of BMPs selected including priority group that each is in.
• Description of level of treatment and volume capture achieved.
Maintenance

- Description of maintenance for each type of BMP.
- Description of funding mechanism.
- Designation of Responsible Party.
ALL OF THIS CAN BE DONE IN JUST A PAGE OR TWO!
EXHIBITS AND ATTACHMENTS
**COMPLETED BMP SELECTION TABLE FOR EACH TRIBUTARY AREA INCLUDING EXPLANATION FOR EACH PRIORITY NOT USED.**
PRELIMINARY DETAIL FOR EACH TYPE OF BMP SELECTED
SHOW ALL APPLICABLE ELEMENTS OF THE SELECTED BMPS ON THE APPROPRIATE PLAN SHEETS

CALCULATIONS USING THE “STORM WATER CALCULATOR” FOR EACH INLET.
FACT SHEET- LIVING ROOF

Universal BMP

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the Final SWLID Submittal. The maintenance plan shall include; recommended maintenance practices, identify the parties responsible for maintenance and upkeep, specify the funding source for ongoing maintenance with provisions for full replacement when necessary, and provide site specific inspection checklist.

At a minimum inspection and maintenance shall include the following:

- Drainage features should be inspected and cleaned as necessary to remove any obstructions.
- Irrigation should be routinely inspected to ensure plant establishment and survival.
- Plants should be pruned, weeds pulled, and dead plants replaced as needed.
- Eroded areas should be repaired as needed.

MAINTENANCE CHECKLIST FOR EACH BMP
**Existing Condition Exhibit**

- Exhibit should include: street names, property lines, proposed storm drainage system, waterways, title block, scale, and north arrow.
- Soil Type of existing site.
- Proposed tributary areas shown for all proposed inlets (including offsite drainage areas).
- Existing impervious area
• **Proposed Condition Exhibit**
  • Exhibit should include: street names, property lines, storm drainage system, waterways, title block, scale, and north arrow.
  • Tributary areas shown for all inlets (including offsite drainage areas).
  • C value for each tributary area.
  • Soil Type of existing site.
  • New or replaced impervious area.
  • All inlets shown (including identifier).
  • All interceptor trees shown.
  • All proposed BMPs shown.
**Impervious Area Exhibit**

- Exhibit should include: street names, property lines, proposed storm drainage system, waterways, title block, scale, and north arrow.
- Proposed tributary areas shown for all proposed inlets (including offsite drainage areas).
- Proposed impervious area.
- C value used for each area.
MAINTENANCE AND INSPECTIONS
Maintenance Declaration

- Ensure that BMPs remain fully functional and that all areas identified for treatment will discharge to the treatment BMP system
- Verification at a minimum shall include the developer’s recorded maintenance declaration accepting responsibility for maintenance until the responsibility is legally transferred to an entity for permanent responsibility
DESIGN EXAMPLE

Yoash Tilles
Documentation of approved project

**Conditions of Approval**

- **Date:** December 27, 2017
- **Applicant:** Ken Taub
- **Owner:** RMB Real Estate Investments 2, LLC
- **File No.:** ADR17-0117
- **APN:** 058-050-042
- **Address:** 4440 Old Redwood Hwy

**Project Description:** Request for Administrative Design Review on a 96 unit residential housing project to replace 70 units lost in the 2017 Sonoma Complex Fire.

12. A final Storm Water Low Impact Development Submittal (SWLIDS), based upon the approved initial SWLIDS, shall be submitted with the grading and/or building permit application, and be subject to review and approval by the Grading & Storm Water Section of the Permit and Resource Management Department (Permit Sonoma) prior to the issuance of any grading or building permits.
### INITIAL STORM WATER CALCULATION WORKSHEET

#### A1 (Post-Construction)

<table>
<thead>
<tr>
<th>Surface</th>
<th>CN</th>
<th>Area (sq.ft)</th>
<th>CN x A</th>
</tr>
</thead>
<tbody>
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</table>

Weighted CN: 87
### Initial Storm Water Calculation Worksheet

**BMP Input Worksheet**

**Enter BMP ID and BMP’s Information:**

- BMP ID (MUST BE unique):
  - BMP 1
- BMP’s Physical Tributary Area:
  - 235,829 ft²
  - 5.406 Acres

**BMP Design Criteria:**

- 100% Capture & Treatment

**Action Buttons:**

- Clear/Reset All Inputs
- Calculate
- Display Calculation Worksheet
- Save BMP Data and Results

**Type of BMP Design (select from pull down):**

- Priority 1: P1-06 Swale with Bioretention

**BMP Notes:**

**Clear/Reset All Inputs**

**Calculate All Sections**

**Save BMP Data and Results**

### Runoff Reduction Measures

**Interceptor Trees**

- Number of new Evergreen Trees that qualify as interceptor trees: 0
- Number of new Deciduous Trees that qualify as interceptor trees: 0
- Enter square footage of qualifying existing tree canopy: 0 ft²

**Disconnected Roof Drains**

- Interceptor Tree trunk must be no greater than 25 feet from impervious surface.

**Method 1**

- Amount of rooftop area that drain to disconnected downspouts: 0 ft²

**Method 2**

- Percent of rooftop area to be disconnected from downspouts: 0%
- Select Density: 1

**Paved Area Disconnection**

- Paved Area Type (select from drop down list): Not Directly-connected Paved Area
- Enter area of alternatively designed paved area: 43,700.0 ft²

**Buffer Strips & Bovine Terraces**

- Area draining to a Buffer Strip or Bovine Terrace: 0.0 ft²

**Not Directly-connected Paved Area**

- Enter area of alternatively designed paved area: 43,700.0 ft²

**Total Runoff Reduction Measures**

- Total Runoff Reduction Measures: 43,700 ft²

**Resulting reduced Tributary Area used for BMP sizing**

- Total Tributary Area: 191,929 ft²

**Hydromodification Control Requirement: 100% Volume Capture; V<sub>hydromod</sub>**

- If User Composite CN is used, Supporting calculations are required to be submitted
Initial Storm Water Calculation Worksheet

Post development hydrologic soil type within tributary area:
A: greater than 0.30 in/hr infiltration (transmission) rate
Post development ground cover description:
CN_POST =
User Composite post development CN: 96.8

Entering a calculated composite CN will override selections made from the pull down menus above.

BMP Sizing Tool: Hydromodification Control Requirement
Enter BMP Dimensions for below and or ponded water above ground

- OR - Entering an Area information will override Width & Length information!

Percent of Requirement Achieved: 102.15 %
Results must be at least 100%
### Design Elements

#### BMP Selection Table

**Project Name:** 4940 OLD REDWOOD HIGHWAY APARTMENTS

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<th>Detail Title</th>
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**NOT IN CAGE, TO REMAIN CONSERVATIVE**

**South Corner of Property**

**Priority 2 BMPs, soil stabilization unless otherwise indicated**

| Elementation | | | | | | | | | | | | |
| Probable | P2-02 | Probable | x | x | x | x | x | x | x | x | x | x |
| Probable | P2-03 | Probable | x | x | x | x | x | x | x | x | x | x |
| Probable | P2-04 | Probable | x | x | x | x | x | x | x | x | x | x |
| Probable | P2-05 | Probable | x | x | x | x | x | x | x | x | x | x |
| Constructed | N/A | N/A | x | x | x | x | x | x | x | x | x | x |
NOTES:
1. IF SWALE PROVIDES TREATMENT, LENGTH SHALL BE DESIGNED TO PROVIDE 12 MINUTES OF CONTACT TIME IF FLOW ENTERS UNIFORMLY ALONG LENGTH. LENGTH SHALL PROVIDE 5 MINUTES OF CONTACT TIME IF 90% OR MORE OF THE FLOW ENTERS AT THE UPSTREAM END.
2. SOIL TO BE SPECIFIED BY DESIGN ENGINEER TO MEET VOLUME CAPTURE AND GOVERNING AGENCY REQUIREMENTS. IF NON-STRUCTURAL SOIL IS SELECTED A CUTOFF WALL IS REQUIRED IN PLACE OF A MOISTURE BARRIER.
3. SWALE MUST CONVEY HIGH FLOWS PER GOVERNING AGENCY DESIGN STANDARDS.
### Final Storm Water Calculation Worksheet

#### LID BMP Summary Page & Site Global Values

**Project Information:**
- Project Name: 9000 Ranch Apartments Homes
- Address/Staion: 6440 W 14th Street
- Design: By Ted Melo, PE
- Date: 8/11/11

**Site Information:**
- Mean Storm Precipitation (MSP) of Project Site: 36.00 inches
- Crime: S
- Impervious area - pre development: 580.1940 ft²
- Impervious area - post development: 144.0500 ft²

#### Summary of Saved BMP Results:

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<th>BMP ID</th>
<th>Tributary Area (ft²)</th>
<th>Runoff Reduction Measures (Y/N)</th>
<th>Type of Requirement Met</th>
<th>Type of BMP Design</th>
<th>Percent Achieved</th>
<th>Required V_{required} (ft³)</th>
<th>Achieved V_{achieved} (ft³)</th>
<th>Required Q_{required} (cfs)</th>
<th>Achieved Q_{achieved} (cfs)</th>
<th>Required Delta Volume Capture (ft³)</th>
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</table>
Final Storm Water Calculation Worksheet

STORM WATER CALCULATOR

BMP Tributary Parameters

- BMP ID: A1
- BMP Design Criteria: 100% Capture & Treatment
- Type of BMP Design: Priority 2: P2-02 Roadside Bioretention - Flush Design
- BMP's Physical Tributary Area: 11,833.0 ft²
- Description/Notes: Roadside infiltration planter BMP

Runoff Reduction Measures

- Resulting reduced Tributary Area used for BMP sizing = 11,533.0 ft²
- Total Runoff Reduction Measures = 300.0 ft²

Interceptor Trees

- Number of new Evergreen Trees: 0
- Number of new Deciduous Trees: 3
- Square footage of qualifying existing tree canopy: 0.0 ft²

Disconnected Roof Drains

- Select disconnection condition: Select disconnection condition

Disconnected Roof Drains Method 1

- Roof area of disconnected downspouts: 0 ft²

Disconnected Roof Drains Method 2

- Percent of rooftop area: 0%
- Select Density: 1 Units per Acre

Paved Area Disconnection

- Paved Area Type: Select paved area type
- Alternatively designed paved area: 0.0 ft²

Buffer Strips & Bovine Terraces

- Area draining to a Buffer Strip or Bovine Terrace: 0.0 ft²

Hydromodification Requirement: 100% Volume Capture; V_{HYDROMOD}

- V_{HYDROMOD} = 604.44 ft³

Post development hydrologic soil type within tributary area

- Brush: 0.15 - 0.30 in/hr infiltration (transmission) rate
- User Composite post development CN: 93.0

BMP Sizing Tool: Hydromodification Requirement

- BMP Volume Below Ground: Depth: 0.30 ft
- Depth below perforated pipe if present: 2.50 ft
- Width: 5.00 ft
- Length: 170.00 ft
- Area: 0.00 ft²

- Ponded Water Above Ground: Depth: 0.00 ft

Percent of Goal Achieved = 105.47 %
Final Storm Water Calculation Worksheet

STORM WATER CALCULATOR

CN Composite Work Sheet

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<th>Project:</th>
<th>4440 Old Redwood Highway</th>
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<tbody>
<tr>
<td>Address/Location:</td>
<td>4440 Old Redwood Highway</td>
</tr>
<tr>
<td>Designer:</td>
<td>Chad Moll, PE</td>
</tr>
<tr>
<td>Date:</td>
<td>August 13, 2018</td>
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<td>Inlet Number/Tributary Area/BMP:</td>
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INSTRUCTIONS: Please refer to the "Urban Hydrology for Small Watersheds" (TR-55 manual).

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<th>Soil Type (Infiltration Rate)</th>
<th>Cover Description</th>
<th>CN</th>
<th>Area ft²</th>
<th>Product of CN x Area</th>
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<td>9928</td>
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</table>

**Total CN** = (CN x Area) + (CN x Area) + (CN x Area) ... / Total Tributary Area = 93.3

Use this CN\textsubscript{COMPOSIT} = 93.3
### Final Storm Water Calculation Worksheet

#### STORM WATER CALCULATOR

**BMP Tributary Parameters**

- **Project Name**: 4440 Old Redwood Highway
- **BMP ID**: A8
- **BMP Design Criteria**: 100% Capture & Treatment
- **Type of BMP Design**: Priority 1: P1-07 Infiltration Trench
- **BMP's Physical Tributary Area**: 2,314.0 ft²
- **Description/Notes**: Rain Garden Bioretention

### Runoff Reduction Measures

**Resulting reduced Tributary Area used for BMP sizing =** 2,906.0 ft²
**Total Runoff Reduction Measures =** 308.0 ft²

#### Interceptor Trees

- **Number of new interceptor Evergreen Trees**: 0
- **Number of new interceptor Deciduous Trees**: 1
- **Square footage of qualifying existing tree canopy**: 0.0 ft²

**Total Number of New trees in BMP Tributary Area**: 1

#### Disconnected Roof Drains

- **Select disconnection condition**: Select disconnection condition

#### Disconnected Roof Drains Method 1

- **Roof area of disconnected downspouts**: 0 ft²
- **Percent of rooftop area**: 0%

#### Disconnected Roof Drains Method 2

- **Select Density**: 1 Units per Acre

#### Paved Area Disconnection

- **Paved Area Type**: Not Directly-connected Paved Area
- **Alternatively designed paved area**: 208.0 ft²

#### Buffer Strips & Bovine Terraces

- **Area draining to a Buffer Strip or Bovine Terrace**: 0.0 ft²

### Hydromodification Requirement: 100% Volume Capture; \( V_{HYDROMOD} \)

- **Post development hydrologic soil type within tributary area**: B: 0.15 - 0.30 in/hr infiltration (transmission) rate
- **Post development ground cover description**: Brush: weed-grass mixture with brush major element - Poor (<50% ground cover)
- **User Composite post development CN**: 88.0

**\( V_{HYDROMOD} = \)** 62.09 ft³

### BMP Sizing Tool: Hydromodification Requirement

#### BMP Volume Below Ground

- **Porosity**: 0.66
- **Depth below perforated pipe if present**: 3.50 ft
- **Width**: 0.00 ft
- **Length**: 0.00 ft
- **Area**: 27.00 ft²

#### Ponded Water Above Ground

- **Depth**: 0.30 ft
- **Width**: 0.00 ft
- **Length**: 0.00 ft
- **Area**: 20.00 ft²

**Percent of Goal Achieved =** 100.99 %
Final Storm Water Calculation Worksheet

**STORM WATER CALCULATOR**

**CN Composite Work Sheet**

**Project:** 4440 Old Redwood Highway

**Address/Location:** 4440 Old Redwood Highway

**Designer:** Chad Moll, PE

**Date:** August 13, 2018

**Inlet Number/Tributary Area/BMP:** AB

**INSTRUCTIONS:** Please refer to the "Urban Hydrology for Small Watersheds" (TR-55 manual).

<table>
<thead>
<tr>
<th>Soil Type (Infiltration Rate)</th>
<th>Cover Description</th>
<th>CN</th>
<th>Area ft²</th>
<th>Product of CN x Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>B: 0.15 - 0.30 in/hr infiltration (transmission) rate</td>
<td>Impervious - Paved Parking, Rooftop, Driveways</td>
<td>98</td>
<td>1506</td>
<td>147,588.0</td>
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<tr>
<td>B: 0.15 - 0.30 in/hr infiltration (transmission) rate</td>
<td>Open Space (lawns, parks, golf courses, cemeteries, etc.) - Fair (50% to 75% grass cover)</td>
<td>69</td>
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</table>

**CN**

\[
\text{CN}_{\text{COMPOST}} = \frac{(\text{CN x Area}) + (\text{CN x Area}) + (\text{CN x Area})}{\text{Total Tributary Area}}
\]

**Use this CN_{\text{COMPOST}} = 87.9**

**Totals**

\[
\text{Totals} = 2314 \times 203,340.0
\]
Final Design Elements
Final Design Elements

RAIN GARDEN BIORETIENION DETAIL
<table>
<thead>
<tr>
<th>BMP</th>
<th>TYPE</th>
<th>WIDTH (FT)</th>
<th>LENGTH (FT)</th>
<th>AREA (FT²)</th>
<th>DEPTH (FT)</th>
<th>VOLUME (CY)</th>
<th>MATERIAL</th>
<th>REQUIRED VOLUME CAPTURE (CF)</th>
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<tbody>
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PANEL DISCUSSION
SPECIAL CASES
## 1. Clarifications Provided - Under 1 AC

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<th>Description of Tributary Area</th>
<th>Design Requirements</th>
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<tbody>
<tr>
<td>• Tributary area consists of <strong>both existing</strong> <strong>and</strong> new and/or replaced impervious area.</td>
<td>• Existing impervious area: Treatment required.</td>
</tr>
<tr>
<td></td>
<td>• New and/or replaced impervious area: 100% Volume Capture or both Delta Volume Capture and Treatment required.</td>
</tr>
<tr>
<td></td>
<td>• Trash capture must be met in all tributary areas.</td>
</tr>
</tbody>
</table>
1. TRIBUTARY AREA - BOTH EXISTING AND NEW OR REPLACED IMPERVIOUS AREA.

- EXISTING PARKING LOT - TREATMENT ONLY
- NEW PARKING - TREATMENT & Δ VOLUME
- NEW BUILDING - TREATMENT & Δ VOLUME

BMP

CAN ALSO BE MET BY PROVIDING 100% VOLUME CAPTURE

SITE LESS THAN 1.0 ACRE
## 2. Clarifications Provided - Under 1 AC

<table>
<thead>
<tr>
<th>Description of Tributary Area</th>
<th>Design Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tributary area consists of <strong>new and/or replaced</strong> impervious area <strong>only.</strong></td>
<td>• 100% Volume Capture or both Delta Volume Capture and Treatment required.</td>
</tr>
<tr>
<td></td>
<td>• Trash capture must be met in all tributary areas.</td>
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</tbody>
</table>
2. TRIBUTARY AREA - NEW OR REPLACED IMPERVIOUS AREA ONLY.

EXISTING PARKING LOT

NEW PARKING
- TREATMENT & VOLUME

NEW BUILDING
- TREATMENT & VOLUME

SITE LESS THAN 1.0 ACRE

- IF SITE IS 1.0 ACRE OR GREATER, 100% VOLUME CAPTURE/HYDROMODIFICATION CONTROL IS REQUIRED.

* CAN ALSO BE MET BY PROVIDING 100% VOLUME CAPTURE
## 3. Clarifications Provided - Under 1 AC

<table>
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<th>Design Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tributary area consists of existing impervious area only.</td>
<td>• No requirements apply.</td>
</tr>
</tbody>
</table>
3. **TRIBUTARY AREA** - **EXISTING IMPERVIOUS AREA ONLY.**

- **EXISTING PARKING LOT**
  - **NO REQUIREMENTS APPLY**

- **NEW PARKING**
- **NEW BUILDING**
## 4. Clarifications Provided- Under 1 AC

<table>
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<th>Description of Tributary Area</th>
<th>Design Requirements</th>
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</thead>
<tbody>
<tr>
<td>• Tributary area consists of off-site improvements or public improvements only.</td>
<td>• New and/or replaced impervious area only: 100% Volume Capture or both Delta Volume Capture and Treatment required.</td>
</tr>
</tbody>
</table>

A BMP does not need to be constructed to intercept the physical runoff at this location if not readily feasible. The BMP may be constructed onsite as a “onsite off-set” or the runoff accounted for by oversizing another BMP within the same project, but in another tributary area.
4. Tributary Area - Off-Site or Public Improvements.

NOTE:

The BMP does not need to intercept the physical runoff. If not readily feasible, may be constructed as an "onsite offset."

CAN BE MET BY PROVIDING 100% VOLUME CAPTURE.
5. Clarifications Provided - Under 1 AC

<table>
<thead>
<tr>
<th>Description of Tributary Area</th>
<th>Design Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Run-on from outside the project site.</td>
<td>• No requirements apply if run-on is bypassed.</td>
</tr>
</tbody>
</table>

If the run-on reaches a BMP it must be either included in the sizing or designed to bypass.
5. TRIBUTARY AREA - RUN-ON FROM OUTSIDE THE PROJECT AREA.
## Clarifications Provided - Over 1 AC

<table>
<thead>
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<th>Description of Tributary Area</th>
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<tbody>
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<td>• 100% Volume Capture/Hydromodification Control required.</td>
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<tr>
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## Clarifications Provided - Over 1 AC

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</thead>
<tbody>
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<td>• Tributary area consists of <strong>new and/or replaced</strong> impervious area <strong>only</strong>.</td>
<td>• <strong>100% Volume Capture/Hydromodification Control</strong> required.</td>
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<td></td>
<td>• Trash capture must be met in all tributary areas.</td>
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## Clarifications Provided - Over 1 AC

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<td>• Tributary area consists of existing impervious area only.</td>
<td>• No requirements apply.</td>
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## Clarifications Provided - Over 1 AC

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<tr>
<td>• Tributary area consists of off-site improvements or public improvements only.</td>
<td>• New and/or replaced impervious area only: 100% Volume Capture/ Hydromodification Control or both Delta Volume Capture and Treatment required.</td>
</tr>
</tbody>
</table>

A BMP does not need to be constructed to intercept the physical runoff at this location if not readily feasible. The BMP may be constructed onsite as a “onsite off-set” or the runoff accounted for by oversizing another BMP within the same project, but in another tributary area.
## Clarifications Provided- Over 1 AC

<table>
<thead>
<tr>
<th>Description of Tributary Area</th>
<th>Design Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run-on from outside the project site.</td>
<td>No requirements apply if run-on is bypassed.</td>
</tr>
</tbody>
</table>

If the run-on reaches a BMP it must be either included in the sizing or designed to bypass.
But we have clay soil!

Clay soil expands when water is introduced. Infiltration is limited.

Infiltration is very slow in our native clay soil.

In fact our native soil can be used for pond liners and pottery!
Solution

- A storage volume is provided in the BMP. Therefore, native soil type does not prevent infiltration type BMPS from being used.

Same idea as a french drain, except storage volume is provide below the pipe.
Design Challenges

• But we will have curb overturn, conflicts with utilities and trees, and sidewalk undercutting!

Planting type soil compacts easily.

Utilities and trees were in conflict with space needed for BMPs.
Solution

• Solution: Structural Soil.

Developed in the 1990s for urban tree planting.

Angular rock, organics, and a tackafier.

Is compacted to 95% so that it provides structural support.

Provides 26% porosity when compacted.

Trees love it!
Solution

- Solution: Structural Soil.

Trees in structural soil grow bigger and faster.

Structural soil can also used for other load baring needs, such as fire access.

Provides a solution to root bound urban trees too.
Design Challenge

• We can’t have depressions in the planter strip!

Curb openings to allow storm water from the street.

Grades in planter strips are limited by the sidewalk and street grades.

In some cases, the surface swale in the planter strip can cause a physical barrier to pedestrians and street parking.
Solution

- Solution: Permeable gutter.
Solution

• Solution: Permeable gutter.

- Allows for storm water to come in subsurface.

- Needs to be placed by a certified contractor.
- Doesn’t remove larger pollutants like trash.
Design Challenge

• But we can’t maintain them!

- Fewer swirl chambers and chamber separators.
- Too many plants can block flow.

Plants love bioretention!

These BMPs need to be weeded, and sediment and trash need to be removed regularly.

Maintenance needs to be considered and a Maintenance Declaration needs to be signed by the Developer and recorded.
Updated - All triggers reflected on the Determination Worksheet

- Required to be submitted with all discretionary and ministerial applications.

- If the result of the Determination Worksheet is that LID is required, a Initial SWLID Submittal must be submitted as part of the completed application package.