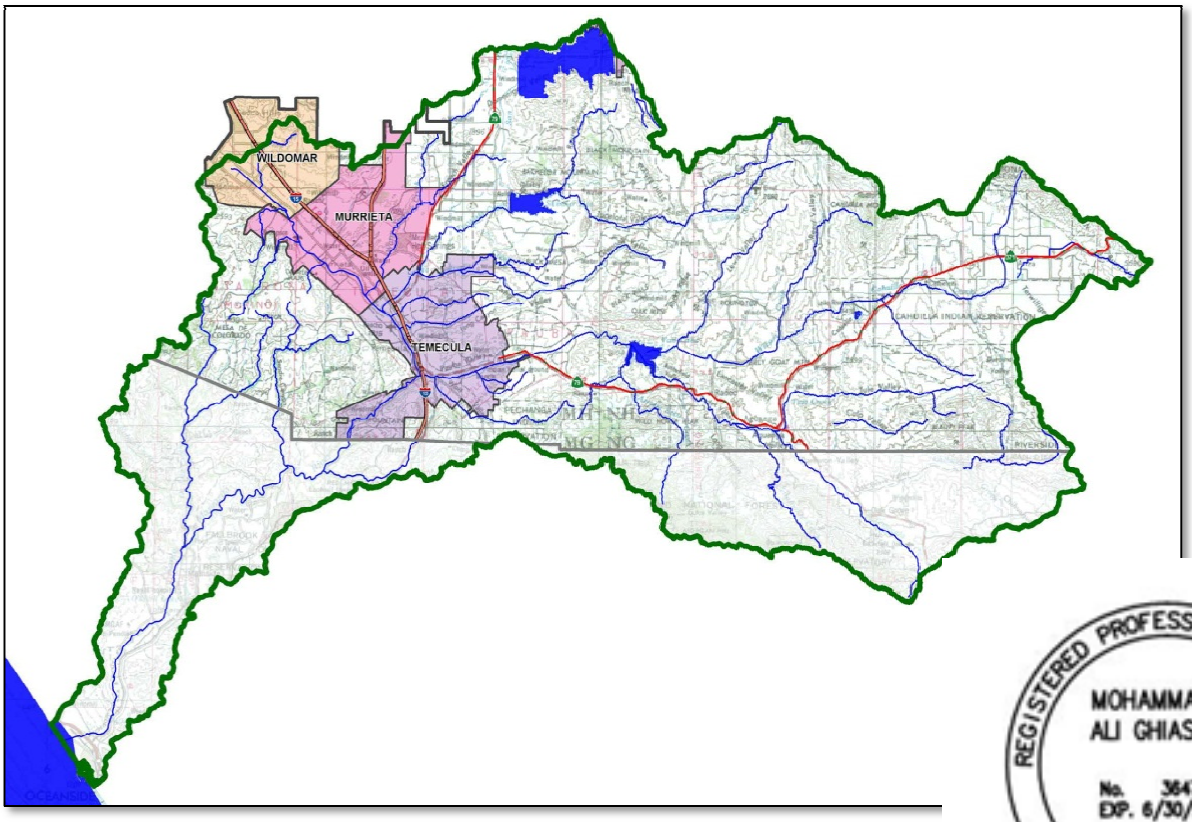
Project Specific Water Quality Management Plan

*A Template for preparing Project Specific WQMPs for Priority Development Projects located within the **Santa Margarita Region** of Riverside County*

Project Title: Wildomar

Development No: Tract 36952

Design Review/Case No:TBD



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☒**Preliminary**
☐**Final**

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Prepared for Compliance with
*Regional Board Order No.***R9-2010-0016**

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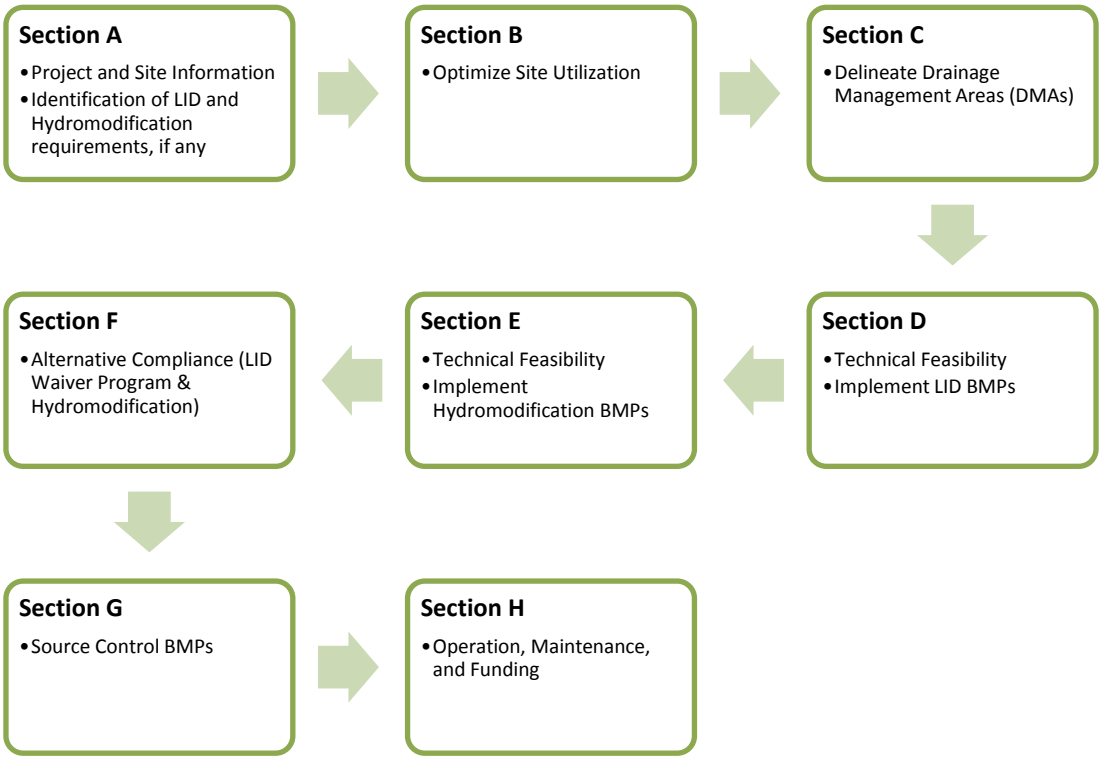
A Brief Introduction

The Municipal Separate Stormwater Sewer System (MS4) Permit[1]for the **Santa Margarita Region** (SMR) requires preparation of a Project-Specific Water Quality Management Plan (WQMP) for all Development Projects as defined in section F.1.d.(1) of the Permit. ThisProject-Specific WQMPTemplate for Development Projects in the **Santa Margarita Region** has been prepared to help document compliance and prepare a WQMP submittal. Below is a flowchart for the layout of this Template that will provide the steps required to document compliance.



[1]Order No. R9-2010-0016, NPDES No. CAS0108766, Waste Discharge Requirements for Discharges from the MS4 Draining the County of Riverside, the Incorporated Cities of Riverside County, and the Riverside County Flood Control and Water Conservation District within the San Diego Region, California Regional Water Quality Control Board, November 10, 2010.

OWNER'S CERTIFICATION

This Project-Specific WQMP has been prepared for Mari Mina LLC. by TL Group Corp. for the TTM No. 36952 project.

This WQMP is intended to comply with the requirements of City of Wildomar for <Insert Ordinance No.>which includes the requirement for the preparation and implementation of a Project-Specific WQMP.

The undersigned, while owning the property/project described in the preceding paragraph, shall be responsible for the implementation and funding of this WQMP and will ensure that this WQMP is amended as appropriate to reflect up-to-date conditions on the site. In addition, the property owner accepts responsibility for interim operation and maintenance of StormwaterBest Management Practices until such time as this responsibility is formally transferred to a subsequent owner. This WQMP will be reviewed with the facility operator, facility supervisors, employees, tenants, maintenance and service contractors, or any other party (or parties) having responsibility for implementing portions of this WQMP. At least one copy of this WQMP will be maintained at the project site or project office in perpetuity.The undersigned is authorized to certify and to approve implementation of this WQMP. The undersigned is aware that implementation of this WQMP is enforceable under City of WildomarWater Quality Ordinance (Municipal Code Section).

"I, the undersigned, certify under penalty of law that the provisions of this WQMP have been reviewed and accepted and that the WQMP will be transferred to future successors in interest."

Owner's Signature	Date
Owner's Printed Name	Owner's Title/Position

PREPARER'S CERTIFICATION

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control Best Management Practices in this plan meet the requirements of Regional Water Quality Control Board Order No.**R9-2010-0016** and any subsequent amendments thereto."

Preparer's Signature	Date
Preparer's Printed Name	Preparer's Title/Position

Preparer's Licensure: 36479

Table of Contents

Section A: Project and Site Information 6
A.1 Maps and Site Plans 6
A.2 Identify Receiving Waters 7
A.3 Drainage System Susceptibility to Hydromodification 7
A.4 Additional Permits/Approvals required for the Project: 8
Section B: Optimize Site Utilization (LID Principles) 9
Section C: Delineate Drainage Management Areas (DMAs) 10
Section D: Implement LID BMPs 12
D.1 Infiltration Applicability 12
D.2 Harvest and Use Assessment 14
D.3 Bioretention and Biotreatment Assessment 16
D.4 Other Limiting Geotechnical Conditions 17
D.5 Feasibility Assessment Summaries 17
D.6 LID BMP Sizing 18
Section E: Implement Hydrologic Control BMPs and Sediment Supply BMPs 19
E.1 Onsite Feasibility of Hydrologic Control BMPs 19
E.2 Meeting the HMP Performance Standard for Small Project Sites 19
E.3 Hydrologic Control BMP Selection 20
E.4 Hydrologic Control BMP Sizing 21
E.5 Implement Sediment Supply BMPs 21
Section F: Alternative Compliance 25
F.1 Identify Pollutants of Concern 27
F.2 Stormwater Credits 28
F.3 Sizing Criteria 28
F.4 Treatment Control BMP Selection 29
F.5 Hydrologic Performance Standard – Alternative Compliance Approach 29
F.6 Sediment Supply Performance Standard - Alternative Compliance 30
Section G: Source Control BMPs 32
Section H: Construction Plan Checklist 33
Section I: Operation, Maintenance and Funding 34
Acronyms, Abbreviations and Definitions 35

List of Tables

Table A.1 Identification of Receiving Waters 7
Table A.2 Identification of Susceptibility to Hydromodification 7
Table A.3 Other Applicable Permits 8
Table C.1 DMA Classifications 10
Table C.2 Type 'A', Self-Treating Areas 10
Table C.3 Type 'B', Self-Retaining Areas 10
Table C.4 Type 'C', Areas that Drain to Self-Retaining Areas 11
Table C.5 Type 'D', Areas Draining to BMPs 11
Table D.1 Infiltration Feasibility 12
Table D.2 Geotechnical Concerns for Onsite Retention Table 17
Table D.3 LID Prioritization Summary Matrix 17
Table D.4 DCV Calculations for LID BMPs 18
Table D.5 LID BMP Sizing 19
Table E.1 LID &Hydromodification BMP Location 20
Table E.2 Hydrologic Control BMP Sizing 21
Table F.1 Potential Pollutants by Land Use Type 27
Table F.2 Stormwater Credits 28
Table F.3 Treatment Control BMP Sizing 28
Table F.4 Treatment Control BMP Selection 29
Table F.5 Offsite Hydrologic Control BMP Sizing 30
Table G.1 Structural and Operational Source Control BMP 32
Table H.1 Construction Plan Cross-reference 33

List of Appendices

Appendix 1: Maps and Site Plans 42
Appendix 2: Construction Plans 44
Appendix 3: Soils Information 45
Appendix 4: Historical Site Conditions 46
Appendix 5: LID Infeasibility 47
Appendix 6: BMP Design Details 48
Appendix 7: Hydromodification 51
Appendix 8: Source Control 84
Appendix 9: O&M 85
Appendix 10: Educational Materials 43

Section A: Project and Site Information

PROJECT INFORMATION	
Type of Project:	Residential
Planning Area:	Insert text here describing how each included Site Design BMP will be implemented.
Community Name:	Insert text here describing how each included Site Design BMP will be implemented.
Development Name:	Insert Planning Area / Community Name/ Development Name, if known
PROJECT LOCATION	
Latitude & Longitude (DMS): N 33d 36' 0.57", W 117d 14' 24.9"	
Project Watershed and Sub-Watershed:Cole Canyon - Murrieta Creek, Santa Margarita	
APN(s): 362-250-001-9 & 362-250-026-2	
Map Book and Page No.:	
PROJECT CHARACTERISTICS	
Proposed or potential land use(s)	Residential
Proposed or Potential SIC Code(s)	1521
Area of Impervious Project Footprint (SF)	253,615
Total area of proposed Impervious Surfaces within the Project Limits (SF)/or Replacement	253,615
Total Project Area (ac)	10.90
Does the project consist of offsite road improvements?	☒ Y ☐ N
Does the project propose to construct unpaved roads?	☐ Y ☒ N
Is the project part of a larger common plan of development (phased project)?	☐ Y ☒ N
Is the project exempt from HMP Performance Standards?	☐ Y ☒ N
EXISTING SITE CHARACTERISTICS	
Total area of existing Impervious Surfaces within the project limits(SF)	0
Is the project located within any Multi-Species Habitat Conservation Plan (MSHCP Criteria Cell?	☐ Y ☒ N
If so, identify the Cell number:	
Are there any natural hydrologic features on the project site?	☐ Y ☒ N
Is a Geotechnical Report attached?	☒ Y ☐ N
If no Geotech. Report, list the Natural Resources Conservation Service (NRCS) soils type(s) present on the site (A, B, Cand/or D)	Insert text here describing how each included Site Design BMP will be implemented.
What is the Water Quality Design Storm Depth for the project?	0.685

A.1 Maps and Site Plans

When completing yourProject-Specific WQMP, include a map of the Project vicinity and existing site. In addition, include all grading, drainage, landscape/plant palette and other pertinent construction plans inAppendix 2.At a **minimum**, your WQMP Site Plan should include the following:

- Drainage Management Areas (DMAs)
- Source Control BMPs

- Drainage infrastructure, inlets, overflows

Use your discretion on whether or not you may need to create multiple sheets or can appropriately accommodate these features on one or two sheets. Keep in mind that theCopermitteeplan reviewer must be able to easily analyze your Project utilizing this template and its associated site plans and maps.

A.2 Identify Receiving Waters

Using Table A.1 below, list in order of upstream to downstream, the Receiving Waters that the Project site is tributary to. Continue to fill each row with the Receiving Water's 303(d) listed impairments (if any), designated Beneficial Uses, and proximity, if any, to a RARE Beneficial Use. Include a map of the Receiving Waters in Appendix1. *(http://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/)*

Table A.1 Identification of Receiving Waters

Receiving Waters	USEPA Approved 303(d) List Impairments	Designated Beneficial Uses	Proximity to RARE Beneficial Use
Cole Canyon	N/A	MUN, AGR, IND, PROC, REC1, REC2, BIOL, WARM, WILD	N/A
Murrieta Creek	Copper, Chlorpyrifos, Toxicity	MUN, AGR, IND, PROC, GWR, REC1, REC2,WARM, WILD	N/A
Santa Margarita River	Enterococcus, Fecal Coliform, Phosphorus, Total Nitrogen as N, Toxicity	MUN, AGR, IND, REC1, REC2, WARM, COLD, WILD, RARE	N/A

A.3 Drainage System Susceptibility to Hydromodification

Using Table A.2 below, list in order of the point of discharge at the project site down to the Santa Margarita River, each drainage system or receiving water that the project site is tributary to. Continue to fill each row with the material of the drainage system, the storm drain susceptibility using the SWCT2 (Stormwater& Water Conservation Tracking Tool - http://rivco.permitrack.com/) or Map 2 of the Hydromodification Susceptibility Documentation Report and Mapping: Santa Margarita Region (Appendix D of the SMR HMP), and the condition for exempting the drainage system, if applicable. If the exemption includes receiving waters that were not evaluated in Appendix D, provide supporting documentation in Appendix 7 to demonstrate that they classify as Engineered, Fully Hardened and Maintained (EFHM) channels, consistent with the definition provided in Appendix D. Include a map exhibiting eachdrainage system and the associated susceptibility in Appendix 1.

Table A.2 Identification of Susceptibility to Hydromodification

Drainage System	Drainage System Material	Susceptibility of Drainage System	Hydromodification Exemption
Cole Canyon	Reinforce Concrete pipe		NONE.
Murrieta Creek	Reinforced Concrete Pipe		NONE.
			Insert exemptions the 3rd receiving water may qualify for. If none, insert NONE.

A.4 Additional Permits/Approvals required for the Project:

Table A.3 Other Applicable Permits

Agency	Permit Required	
State Department of Fish and Game, 1602 Streambed Alteration Agreement	☐ Y	☒ N
State Water Resources Control Board, Clean Water Act Section 401 Water Quality Certification	☐ Y	☒ N
US Army Corps of Engineers, Clean Water Act Section 404 Permit	☐ Y	☒ N
US Fish and Wildlife, Endangered Species Act Section 7 Biological Opinion	☐ Y	☒ N
Statewide Construction General Permit Coverage	☐ Y	☒ N
Statewide Industrial General Permit Coverage	☐ Y	☒ N
Western Riverside MSHCP Consistency Approval (e.g., JPR, DBESP)	☐ Y	☒ N
Other *(please list in the space below as required)*	☐ Y	☒ N

If yes is answered to any of the questions above, the Copermittee may require proof of approval/coverage from those agencies as applicable including documentation of any associated requirements that may affect this Project-Specific WQMP.

Section B: Optimize Site Utilization (LID Principles)

Review of the information collected in Section 'A' will aid inidentifying the principal constraints on site design and selection of LID BMPs as well as opportunities to reduce imperviousness and incorporate LID Principles into the site and landscape design. For example, **constraints** might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, utility locations or safety concerns. **Opportunities** might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for LID Bioretention BMPs), and differences in elevation (which can provide hydraulic head). Prepare a brief narrativefor each of the site optimization strategies describedbelow.This narrative will help you as you proceed with yourLow Impact Development (LID) design and explain your design decisions to others.

The 2010 SMR MS4 Permit further requires that LID Retention BMPs (Infiltration Only or Harvest and Use) be used unless it can be shown that those BMPs are infeasible. Therefore, it is important that your narrative identify and justify if there are any constraints that would prevent the use of those categories of LID BMPs. Similarly, you should also note opportunities that exist which will be utilized during project design. Upon completion of identifying Constraints and Opportunities, include these on your WQMP Site plan inAppendix1.

Site Optimization

The following questions are based upon Section 3.2 of the WQMP Guidance Document. Review of the WQMP Guidance Document will help you determine how best to optimize your site and subsequently identify opportunities and/or constraints, and document compliance.

Did you identify and preserve existing drainage patterns? If so, how? If not, why?

There are no existing draining patterns to be preserved

Did you identify and protect existing vegetation? If so, how? If not, why?

There are no existing vegetation to be preserved. The entire site will be disturbed.

Did you identify and preserve natural infiltration capacity? If so, how? If not, why?

This item does not exist within the project site.

Did you identify and minimize impervious area? If so, how? If not, why?

All proposed impervious areas are designed per the City's minimum requirements.

Did you identify and disperse runoff to adjacent pervious areas? If so, how? If not, why?

No, but the entire runoff from the proposed development will be discharged into a detention basin and a vegetated swale.

Section C: Delineate Drainage Management Areas (DMAs)

Utilizing the procedure in Section 3.3 of the WQMP Guidance Document which discusses the methods of delineating and mapping your project site into individual DMAs, complete Table C.1 below to appropriately categorize the types of classification (e.g., Type A, Type B, etc.) per DMA for your Project site. Upon completion of this table, this information will then be used to populate and tabulate the corresponding tables for their respective DMA classifications.

Table C.1DMA Classifications

DMA Name or Identification	Surface Type(s)[1]	Area(Sq. Ft.)	DMA Type
A	Mix	456,509	Extended Detention Basin
B	Landscaped	18,295	Vegetated Swale

[1]*Reference Table 2-1 in the WQMP Guidance Document to populate this column*

Table C.2 Type 'A', Self-Treating Areas

DMA Name or Identification	Area (Sq. Ft.)	Stabilization Type	Irrigation Type (if any)
A	456,509		

Table C.3 Type 'B', Self-Retaining Areas

Self-Retaining Area				Type 'C' DMAs that are draining to the Self-Retaining Area		
DMA Name/ ID	Post-project surface type	Area (square feet) [A]	Storm Depth (inches) [B]	DMA Name / ID	[C] from Table C.4 = [C]	Required Retention Depth (inches) [D]
A	Mix	456,509	0.69	A	187,169	0.97

$$[D] = [B] + \frac{[B] \cdot [C]}{[A]}$$

Table C.4 Type 'C', Areas that Drain to Self-Retaining Areas

DMA					Receiving Self-Retaining DMA		
DMA Name/ ID	Area (square feet)	Post-project surface type	Runoff factor	Product	DMA name /ID	Area (square feet)	Ratio
	[A]		[B]	[C] = [A] x [B]		[D]	[C]/[D]
A	456,509	Mix	0.41	187,169			

Note:(See Section 3.3 of WQMP Guidance Document) Ensure that partially pervious areas draining to a Self-Retaining area do not exceed the following ratio:

$$\left(\frac{\mathbf{2}}{\boldsymbol{Impervious\ Fraction}}\right) : \mathbf{1}$$

(Tributary Area**:** Self-Retaining Area)

Table C.5 Type 'D', Areas Draining to BMPs

DMA Name or ID	BMP Name or ID
B	Vegetated Swale

Note:More than one DMAmay drain to a single LID BMP; however, one DMA may not drain to more than one BMP.

Section D: Implement LID BMPs

D.1 Infiltration Applicability

An assessment of the feasibility of utilizing Infiltration BMPs is required for all projects, *except in the following case:*

- ☐ Harvest and Use BMPs will be implemented to address the Design Capture Volume (see the Harvest and Use Assessment below) for all Drainage Management Areas AND the project is exempt from HMP Performance Standards (*Proceed to Section D.2 and Section E*).

If the above box remains unchecked, perform a site-specific evaluation of the feasibility of Infiltration BMPs using each of the applicable criteria identified in Chapter 3.4.1 of the WQMP Guidance Document and complete the remainder of Section D.1.

Is there an infiltration concern (see discussion in Chapter 2.3.4 of the WQMP Guidance Document for further details)? ☒ Y ☐ N

If yes has been checked, both Infiltration BMPs and Hydrologic Control BMPs that include an infiltration functionalities may not be feasible for the site. It is recommended that you contact your Co permittee to verify whether or not infiltration within the Project is infeasible.

Geotechnical Report

A Geotechnical Report or Phase I Environmental Site Assessment may be required by the Copermittee to confirm present and past site characteristics that may affect the use of Infiltration BMPs.In addition, the Copermittee, at their discretion,may not require a geotechnical report for small projects as described in Chapter 2 of the WQMP Guidance Document. If a geotechnical report has been prepared, include it in Appendix 3. In addition, if a Phase I Environmental Site Assessment has been prepared, include it in Appendix 4.

Is this project classified as a small project consistent with the requirements of Chapter 2 of the WQMP Guidance Document? ☐ Y ☒ N

Infiltration Feasibility

Table D.1 below is meant to provide a simple means of assessing which DMAs on your site support Infiltration BMPs and is discussed in the WQMP Guidance Document in Chapter 2.3.4. Check the appropriate box for each question and then list affected DMAs as applicable. If additional space is needed, add a row below the corresponding answer.

Table D.1 Infiltration Feasibility

Does the project site…	YES	NO
…have any DMAs with a seasonal high groundwater mark shallower than 10 feet?	X	
If Yes, list affected DMAs: A, B		
…have any DMAs located within 100 feet of a water supply well?		X
If Yes, list affected DMAs:		
…have any areas identified by the geotechnical report as posing a public safety risk where infiltration of stormwater could have a negative impact?		X
If Yes, list affected DMAs:		
…have measured in-situ infiltration rates of less than 1.6 inches / hour?	X	
If Yes, list affected DMAs: A, B		

…have significant cut and/or fill conditions that would preclude in-situ testing of infiltration rates at the final infiltration surface?		X
If Yes, list affected DMAs:		
…have any contaminated groundwater plume in the vicinity of the site?		X
If Yes, list affected DMAs:		
…geotechnical report identifies other site-specific factors that would preclude effective and safe infiltration?		X
Describe here:		

- ☐ If you answered "Yes" to any of the questions above for any DMA, Infiltration BMPs should not be used for those DMAs and you should proceed to the assessment for Harvest and Use below.

D.2 Harvest and Use Assessment

Please check what applies*:*

Reclaimed water will be used for the non-potable water demands for the Project.

☐Downstream water rights may be impacted by Harvest and Use as approved by the Regional Board (verify with the Copermittee).

☐The Design Capture Volume (DCV) will be addressed using Infiltration Only BMPs. In such a case, Harvest and Use BMPs are still encouraged, but it would not be required if the DCV will be infiltrated or evapotranspired.

If any of the above boxes have been checked, Harvest and Use BMPs need not be assessed for the site. If neither of the above criteria applies, follow the steps below to assess the feasibility of irrigation use, toilet useand other non-potable uses (e.g., industrial use).

Irrigation Use Feasibility

Complete the following steps to determine the feasibility of harvesting stormwater runoff for Irrigation UseBMPs on your site:

Step 1: Identify the total area of irrigated landscape on the site, and the type of landscaping used.

Total Area of Irrigated Landscape: 5.14 acres

Type of Landscaping (Conservation Design or Active Turf): Conservation Design

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for irrigation use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: 5.76 acres

Step 3: Cross reference the Design Storm depth for the project site (see Exhibit A of the WQMP Guidance Document) with the left column of Table2-4 in Chapter 2 to determine the minimum area of Effective Irrigated Area per Tributary Impervious Area (EIATIA).

Enter your EIATIA factor: 1.32

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum irrigated area that would be required.

Minimum required irrigated area: 7.6 acres

Step 5: Determine if harvestingstormwater runoff for irrigation use is feasible for the project by comparing the total area of irrigated landscape (Step 1) to the minimum required irrigated area (Step 4).

Minimum required irrigated area (Step 4)	Available Irrigated Landscape (Step 1)
7.6 acres	5.14 acres

Toilet Use Feasibility

Complete the following steps to determine the feasibility of harvesting stormwater runoff for toilet flushing uses on your site:

Step 1: Identify the projected total number of daily toilet users during the wet season, and account for any periodic shut downs or other lapses in occupancy:

Projected Number of Daily Toilet Users: 308

Project Type: Residential

Step 2: Identify the planned total of all impervious areas on the proposed Project from which runoff might be feasibly captured and stored for toilet use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the Project site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: 5.76 acres

Step 3: Enter the Design Storm depth for the project site (see Exhibit A) into the left column of Table2-3 in Chapter 2 to determine the minimum number or toilet users per tributary impervious acre (TUTIA).

Enter your TUTIA factor: 116

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum number of toilet users that would be required.

Minimum number of toilet users: 668 acres

Step 5: Determine if harvestingstormwater runoff for toilet flushing use is feasible for the Project by comparing the Number of Daily Toilet Users (Step 1) to the minimum required number of toilet users (Step 4).

Minimum required Toilet Users (Step 4)	Projected number of toilet users (Step 1)
668	308

Other Non-Potable Use Feasibility

Are there other non-potable uses for stormwater runoff on the site(e.g. industrial use)? See Chapter 2 of the Guidance for further information. If yes, describe below. If no, write N/A.

N/A

Step 1: Identify the projected average daily non-potable demand, in gallons per day, during the Wet Season and accounting for any periodic shut downs or other lapses in occupancy or operation.

Average Daily Demand: Projected Average Daily Use (gpd)

Step 2: Identify the planned total of all impervious areas on the proposed Project from which runoff might be feasibly captured and stored for the identified non-potable use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the

Project site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: Insert Area (Acres)

Step 3: Enter the Design Storm Depth for the Project site (see Exhibit A) into the left column of Table2-5 in Chapter 2 to determine the minimum demand for non-potable uses of stormwater runoff per tributary impervious acre.

Enter the factor from Table 2-3: Enter Value

Step 4: Multiply the unit value obtained from Step 4 by the total of impervious areas from Step 3 to develop the minimum gpd of non-potable use that would be required.

Minimum required use: Minimum use required (gpd)

Step 5: Determine if harvestingstormwater runoff for other non-potable use is feasible for the Project by comparing the Number of Daily Toilet Users (Step 1) to the minimum required number of toilet users (Step 4).

Minimum required non-potable use (Step 4)	**Projected average daily use (Step 1)**
Minimum use required (gpd)	Projected Average Daily Use (gpd)

If Irrigation, Toilet and Other Use feasibility anticipated demands are less than the applicable minimum values, Harvest and Use BMPs are not required and you should proceed to utilize LID Bioretention and Biotreatment BMPs, unless a site-specific analysis has been completed that demonstrates technical infeasibility as noted in D.3 below.

D.3 Bioretention and Biotreatment Assessment

Other LID Bioretention and BiotreatmentBMPs as described in Chapter 2.3 of the WQMP Guidance Document are feasible on nearly all development sites with sufficient advance planning.

Select one of the following:

☐LID Bioretention/Biotreatment BMPs will be used for some or all DMAs of the Project as noted below in Section D.4

☐A site-specific analysis demonstrating the technical infeasibility of all LID BMPs has been performed and is included in Appendix 5. If you plan to submit an analysis demonstrating the technical infeasibility of LID BMPs, request a pre-submittal meeting with the Copermittee with jurisdiction over the Project site to discuss this option. Proceed to Section E to document your alternative compliance measures.

D.4 Other Limiting Geotechnical Conditions

Onsite retention may not be feasible due to specific geotechnical concerns identified in the Geotechnical Report. If any, describe below. If no, write N/A:

N/A

Table D.2 Geotechnical Concerns for Onsite Retention Table

Type of Geotechnical Concern	DMAs Feasible (By Name or ID)	DMAs Infeasible (By Name or ID)
Collapsible Soil		
Expansive Soil		
Slopes		
Liquefaction		
Other		

D.5 Feasibility Assessment Summaries

- ☐ From the Infiltration, Harvest and Use, Bioretention and Biotreatment Sections above, complete Table D.3 below to summarize which LID BMPs are technically feasible, and which are not, based upon the established hierarchy.
- ☐

Table D.3LID Prioritization Summary Matrix

DMA Name/ID	LID BMP Hierarchy				No LID (Alternative Compliance)
	1. Infiltration	2. Harvest and use	3. Bioretention	4. Biotreatment	
A	☐	☐	☐	☐	☒
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

For those DMAs where LID BMPs are not feasible, provide a brief narrative below summarizing why they are not feasible, include your technical infeasibility criteria in Appendix 5, and proceed to Section E below to document Alternative Compliance measures for those DMAs. Recall that each proposed DMA must pass through the LID BMP hierarchy before alternative compliance measures may be considered.

The project site is identified with a soil in Group D. This soil group is considered impermeable. In addition per the attached soils report, infiltration rate (0.295 in/hr) in the project site resulted below the minimum value. The proposed development utilizes an extended basin and a vegetated swale for the required DCV.

D.6 LID BMP Sizing

Each LID BMP must be designed to ensure that the DCV will be addressed by the selected BMPs. First**,** calculate the DCV for each LID BMP using the V_{BMP} worksheet in Appendix F of the LID BMP Design Handbook. Second**,** design the LID BMP to meet the required V_{BMP} using a method approved by the Copermittee with jurisdiction over the Project site. Utilize the worksheets found in the LID BMP Design Handbook or consult with the Copermittee to assist you in correctly sizing your LID BMPs. Complete Table D.4 below to document the DCV and the Proposed Volume for each LID BMP. Provide the completed design procedure sheets for each LID BMP in Appendix 6. You may add additional rows to the table below as needed.

Table D.4DCV Calculations for LID BMPs

DMA Type/ID	DMA (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Enter BMP Name / Identifier Here* *BMP A*		
	[A]		[B]	[C]	[A] x [C]			
A	*456,509*	*Mixed*	*0.60*	*0.41*	*187,169*	*Design Storm Depth (in)*	*DCV,* $\mathbf{V_{BMP}}$ *(cubic feet)*	*Proposed Volume on Plans (cubic feet)*
	A_T= Σ[A] 456,509				Σ= [D] 187,169	[E] 0.69	$[F] = \frac{[D]x[E]}{12}$ 10,762	[G] 18,484

[B], [C] is obtained as described in Section 2.5 of the WQMP Guidance Document
[E] is obtained from Exhibit A in the WQMP Guidance Document
[G] is obtained from a design procedure sheet, such as in LID BMP Design Handbook and placed in Appendix 6

Each LID BMP must be designed to ensure that the Design Capture Volume (DCV) will be addressed by the selected BMPs. First**,** calculate the Design Capture Volume for each LID BMP using the 'V_{BMP}' worksheet in Appendix F of the LID BMP Design Handbook. Second**,** design the LID BMP to meet the required V_{BMP} using a method approved by the Copermittee. Utilize the worksheets found in the LID BMP Design Handbook or consult with your Copermittee. Complete Table D.5 below to document the Design Capture Volume and the Proposed Volume for each LID BMP. You can add rows to the table as needed. Alternatively, the Santa Margarita Hydrology Model (SMRHM) can be used to size LID BMPs to address the DCV and, if applicable, to size Hydrologic Control BMPs to meet the Hydrologic Performance Standard of the SMR HMP, as identified in Section E.

Table D.5LID BMP Sizing

BMP Name / ID	DMA No.	BMP Type / Description	Design Capture Volume (ft^3)	Proposed Volume (ft^3)
Extended Basin	A	Extended Basin	10,652	18,484

Section E: Implement Hydrologic Control BMPs and Sediment Supply BMPs

If a completed Table A.2 demonstrates that the project is exempt from HMP Performance Standards, specify N/A of proceed to Section F, if applicable, and Section G.

E.1 Onsite Feasibility of Hydrologic Control BMPs

An assessment of the feasibility of implementing onsite Hydrologic Control BMPs is required for all projects.

Select one of the following:

☐ Yes – The implementation of Hydrologic Control BMPs is feasible onsite. *(Proceed to Step E.3 and Step E.4)*

- *Or* -

X No – The project site is larger than one acre and the implementation of Hydrologic Control BMPs is not feasible onsite. *(Proceed to Step E.5 and Step F for Alternative Compliance upon approval of the Technical Feasibility Assessment by the Copermittee)*

☐ No – The project site is smaller than one acre and the implementation of Hydrologic Control BMPs is not feasible onsite. *(Proceed to Step E.2)*

If the reasons for infeasibility are different from those listed in Section D.1, describe the technical or spatial reasons that preclude the implementation of onsite Hydrologic Control BMPs. If none, write N/A:

N/A

Approval of the condition for infeasibility, if any, is required by the Copermittee. Has the condition for infeasibility been approved by the Copermittee?

☐ Y ☐ N ☒ N/A

E.2 Meeting the HMP Performance Standard for Small Project Sites

Select one of the following:

X Yes – The project site is equal to or larger than one acre. *(Proceed to Step E.3, Step E.4, and Step E.5)*

- *Or* -

☐ No – The project site is less than one acre. *(Follow the remainder of Step E.2)*

Only a Simplified Technical Feasibility Study is required from the applicant. Complete the Simplified Technical Feasibility Study in Appendix 7, which must include, at a minimum, the soil conditions at the PDP, a demonstration of the lack of available space for onsite Hydrologic Control BMPs, an explanation of prohibitive costs to implement Hydrologic Control BMPs, and a written opinion from a Registered Geotechnical Engineer identifying the infeasibility due to geotechnical concerns.

Select one of the following:

X Yes – Onsite Hydrologic Control BMPs are feasible. *(Proceed to Step E., Step E.4, and Step E.5)*

- *Or* -

☐ No – Onsite Hydrologic Control BMPs are not feasible per the Simplified Technical Feasibility Study. *(Proceed to Section E.5 for Sediment Supply Performance Standard and Section F for Alternative Compliance)*

E.3 Hydrologic Control BMP Selection

Capture of the DCV and achievement of the Hydrologic Performance Standard may be met by combined and/or separate structural BMPs. Similarly, compliance with the two identified requirements may be fully or partially achieved onsite.

For each DMA, identify in Table E.1 if the DCV is fully or partially captured onsite, if the Hydrologic Performance Standard is fully or partially met onsite (by using the SMRHM identified in Step E.4), and if structural BMPs for compliance with the LID requirement and the Hydrologic Performance Standard are combined.

Table E.1 LID &Hydromodification BMP Location

DMA	LID BMP	Hydrologic Control BMP	Combined BMP	BMP type and ID
A	☒ Onsite ☐ Partially Onsite ☐ Offsite ☐ None Required	☒ Onsite ☐ Partially Onsite ☐ Offsite ☐ None Required	☒ Yes ☐ No	Extended Basin
B	☒ Onsite ☐ Partially Onsite ☐ Offsite ☐ None Required	☒ Onsite ☐ Partially Onsite ☐ Offsite ☐ None Required	☒ Yes ☐ No	Vegetated Swale

	☐ Onsite ☐ Partially Onsite ☐ Offsite ☐ None Required	☐ Onsite ☐ Partially Onsite ☐ Offsite ☐ None Required	☐ Yes ☐ No	Identify the ID and type of Hydrologic Control BMP to mitigate 3rd DMA

For each DMA provide a narrative describing if the DCV and the Hydrologic Performance Standard are to be fully managed onsite. If not, the narrative should detail how and where offsite structural BMPs will achieve management of the DCV and the Hydrologic Performance Standard.

DMA #1 - DCV and Hydrologic Performance standard are managed through a proposed Extended Basin. The basin is design to detain the required DCV.

DMA #2 - The entire tributary area is all grass. Any runoff will be collected through a vegetated swale onsite.

DMA #3 - N/A

E.4 Hydrologic Control BMP Sizing

Each Hydrologic Control BMP must be designed to ensure that the flow duration curve of the post-development DMA will not exceed that of the pre-existing, naturally occurring, DMA by more than ten percent over a one-year period. Using SMRHM, the applicant shall demonstrate that the performance of each designed Hydrologic Control BMP complies with the Hydrologic Performance Standard. Complete Table E.2 below and identify, for each DMA, the type of Hydrologic Control BMP, if the SMRHM model confirmed the management (Identified as "passed" in SMRHM), the total volume capacity of the Hydrologic Control BMP, the Hydrologic Control BMP footprint at top floor elevation, and the drawdown time of the Hydrologic Control BMP. SMRHM summary reports should be documented in Appendix 7. Refer to the SMRHM Guidance Document for additional information on SMRHM. You can add rows to the table as needed.

Table E.2 Hydrologic Control BMP Sizing

BMP Name / ID	DMA No.	BMP Type / Description	SMRHM Passed	BMP Volume (ac-ft)	BMP Footprint (ac)	Drawdown time (hr)
Detention Basin	A	Detention Basin	☒	0.5362	0.1047	71.44
			☐			
			☐			
			☐			

E.5 Implement Sediment Supply BMPs

The applicant may refer to Section 2.3 of the SMR HMP for a comprehensive description of the methodology to meet the Sediment Supply Performance Standard. Complete the following steps to determine compliance with the Sediment Supply Performance Standard:

Step 1: Identify if the site is a Significant Source of Bed Sediment Supply to the receiving channel

☐ Step 1.A – Is the Bed Sediment of onsite streams similar to that of receiving streams?

Rate the similarity: ☐ High
☐ Medium
☐ Low

Results from the geotechnical and sieve analysis to be performed both onsite and in the receiving channel should be documented in Appendix 7. Of particular interest, the results of the sieve analysis, the soil erodibility factor, a description of the topographic relief of the project area, and the lithology of onsite soils should be reported in Appendix 7.

☐ Step 1.B – Are onsite streams capable of delivering Bed Sediment Supply from the site, if any, to the receiving channel?

Rate the potential: ☐ High
☐ Medium
☐ Low

Results from the analyses of the sediment delivery potential to the receiving channel should be documented in Appendix 7 and identify, at a minimum, the Sediment Source, the distance to the receiving channel, the onsite channel density, the project watershed area, the slope, length, land use, and rainfall intensity.

☐ Step 1.C – Will the receiving channel adversely respond to a change in Bed Sediment Load?

Rate the need for bed sediment supply:
☐ High
☐ Medium
☐ Low

Results from the in-stream analysis to be performed both onsite should be documented in Appendix 7. The analysis should, at a minimum, quantify the bank stability and the degree of incision, provide a gradation of the Bed Sediment within the receiving channel, and identify if the channel is sediment supply-limited.

☐ Step 1.D – Summary of Step 1

Summarize in Table E.3 the findings of Step 1 and associate a score (in parenthesis) to each step. The sum of the three individual scores determines if a stream is a significant contributor to the receiving stream.

- Sum is equal to or greater than eight - Site is a significant source of sediment bed material – all on-site streams must be preserved or by-passed within the site plan. The applicant shall proceed to Step 2 for all onsite streams.

- Sum is greater than five but lower than eight. Site is a source of sediment bed material – some of the on-site streams must be preserved (with identified streams noted). The applicant shall proceed to Step 2 for the identified streams only.
- Sum is equal to or lower than five. Site is not a significant source of sediment bed material. The applicant may advance to Section F.

Table E.3 Triad Assessment Summary

Step	**Rating**			**Total Score**
1.A	☐ High (3)	☐Medium (2)	☐Low (1)	
1.B	☐ High (3)	☐Medium (2)	☐Low (1)	
1.C	☐ High (3)	☐Medium (2)	☐Low (1)	
Significant Source Rating of Bed Sediment to the receiving channel(s)				

Step 2: Preservation of Identified Onsite Channels

Onsite streams identified as a Significant Source of Bed Sediment should be avoided in the site design.

Check one of the following:

☐The site design does avoid all onsite channels identified as a Significant Source of Bed Sediment *(The applicant may disregard subsequent steps of Section E.5 and directly advance directly to Section F.*)

- *Or* -

☐The site design **does NOT avoid** all onsite channels identified as a Significant Source of Bed Sediment*(The applicant may proceed with the subsequent steps of Section E.5).*

Provide in Appendix 7 a site map that identifies all onsite channels and highlights those onsite channels that were identified as a Significant Source of Bed Sediment. The site map shall demonstrate, if feasible, that the site design avoids those onsite channelsidentified as a Significant Source of Bed Sediment. In addition, the applicant shall describe the characteristics of each onsite channel identified as a Significant Source of Bed Sediment. If the design plan cannot avoid the onsite channels, please provide a rationale for each channel individually.

Identified Channel #1 - Insert narrative description here

Identified Channel #2 - Insert narrative description here

Identified Channel #3 - Insert narrative description here

Step 3: By-Pass of Upstream Drainage(s) to Preservethe discharge of Bed Sediment Supply to the receiving channel(s)

Onsite channels identified as a Significant Source of Bed Sediment Supply should be by-passed the discharge of Bed Sediment Supply to the receiving channel(s).

Check one of the following:

☐The site design does avoid and/or bypass all onsite channels identified as a source of Bed Sediment Supply*(The applicant may directly advance to Section F.*)

- *Or* -

☐The site design **does NOT avoid or by-pass** all onsite channels identified as a source of Bed Sediment Supply*(The applicant may proceed to an Alternative Approach, as defined in Section F).*

Provide in Appendix 7 a site map that identifies all onsite channels and highlights those onsite channels that were identified as a Significant Source of Bed Sediment Supply. The site map shall demonstrate, if feasible, that the site design avoids or by-passes those onsite channels of significant Bed Sediment Supply to the receiving channel(s). In addition, the applicant shall describe the characteristics of each onsite channel identified as a Significant Source of Bed Sediment Supply. If the design plan cannot avoid or by-pass the onsite channels, please provide a rationale for each channel individually.

Identified Channel #1 - Insert narrative description here

Identified Channel #2 - Insert narrative description here

Identified Channel #3 - Insert narrative description here

Section F: Alternative Compliance

LID BMPs and Hydrologic Control BMPs are expected to be feasible on virtually all projects. Where LID BMPs and/or Hydrologic Control BMPs have been demonstrated to be infeasible as documented in Section D and/or Section E, respectively, other Treatment Control BMPs or alternative compliance approaches must be used (subject LID waiver and/or HMP alternative compliance approval by the Copermittee).

In addition, if supporting documentation demonstrates the infeasibility to implement Sediment Supply BMPs onsite (See Section E.5), the applicant may refer to Section F.5.

Check one of the following boxes:

X LID Principles, LID BMPs, Hydrologic Control BMPs, and Sediment Supply BMPs have been incorporated into the site design to fully address all Drainage Management Areas. No alternative compliance measures are required for this project and thus this Section is not required to be completed.

Or -

☐ LID Principles and LID BMPs have NOT been incorporated into the site design to fully address the LID requirements for all Drainage Management Areas AND HMP Performance Standards are not fully addressed in the following Drainage Management Areas.

☐ The following Drainage Management Areas are unable to be addressed using LID BMPs. A site specific analysis demonstrating technical infeasibility of LID BMPs has been approved by the Copermittee and included in Appendix 5. The following alternative compliance measures on the following pages are being implemented to ensure that any pollutant loads expected to be discharged by not incorporating LID BMPs, are fully mitigated.The applicant should complete Section F.1, Section F.2, and Section F.3, as applicable.

☐ A site specific analysis demonstrating technical infeasibility of Hydrologic Control BMPs and Sediment Supply BMPs has been approved by the Copermittee and included in Appendix 7. Projects less than one acre have completed the Simplified Technical Feasibility Study. The applicant should complete Section F.5 and/or Section F.6, as applicable.

☐

☐ List DMAs Here.

☐

☐ Or -

☐

☐ LID Principles and LID BMPshave been incorporated into the site design to fully address the DCV for all Drainage Management Areas. However, HMP Performance Standards are not fully addressed in the following Drainage Management Areas. A site specific analysis demonstrating technical infeasibility of Hydrologic Control BMPs and Sediment Supply BMPs has been approved by the Copermittee and included in Appendix 7. Projects less than one acre have completed the Simplified Technical Feasibility. The applicant should complete Section F.5 and/or Section F.6, as applicable.

List DMAs Here.

F.1 Identify Pollutants of Concern

Utilizing Table A.1 from Section A above which noted your project's Receiving Waters and their associatedUSEPAapproved 303(d) listed impairments, cross reference this information with that of your selected Priority Development Project Category in Table F.1 below. If the identified General Pollutant Categories are the same as those listed for your Receiving Waters, then these will be your Pollutants of Concern and the appropriate box or boxes will be checked on the last row. The purpose of this is to document compliance and to help you appropriately plan for mitigating your Pollutants of Concern in lieu of implementing LID BMPs.

Table F.1 Potential Pollutants by Land Use Type

Priority Development Project Categories and/or Project Features (check those that apply)	General Pollutant Categories							
	Bacterial Indicators	Metals	Nutrients	Pesticides	Toxic Organic Compounds	Sediments	Trash & Debris	Oil & Grease
☒ Detached Residential Development	P	N	P	P	N	P	P	P
☐ Attached Residential Development	P	N	P	P	N	P	P	P(2)
☐ Commercial/Industrial Development	P(3)	P	P(1)	P(1)	P(5)	P(1)	P	P
☐ Automotive Repair Shops	N	P	N	N	P(4, 5)	N	P	P
☐ Restaurants (>5,000 ft^2)	P	N	N	N	N	N	P	P
☐ Hillside Development (>5,000 ft^2)	P	N	P	P	N	P	P	P
☐ Parking Lots (>5,000 ft^2)	P(6)	P	P(1)	P(1)	P(4)	P(1)	P	P
☐ Retail Gasoline Outlets	N	P	N	N	P	N	P	P
Project Priority Pollutant(s) of Concern	☒	☐	☒	☒	☐	☒	☒	☒

P = Potential
N = Not Potential
(1) A potential Pollutant if non-native landscaping exists or is proposed onsite; otherwise not expected
(2) A potential Pollutant if the project includes uncovered parking areas; otherwise not expected
(3) A potential Pollutant is land use involving animal waste
(4) Specifically petroleum hydrocarbons
(5) Specifically solvents
(6) Bacterial indicators are routinely detected in pavement runoff

F.2 Stormwater Credits

Projects that cannot implement LID BMPs but nevertheless implement Smart Growth Principles are potentially eligible forStormwater Credits. Utilize Table 3-7 within the WQMP Guidance Document to identify your Project Category and its associated Water Quality Credit. If not applicable, write N/A.

Table F.2Stormwater Credits

Qualifying Project Categories	Credit Percentage[2]
N/A	
Total Credit Percentage[1]	

[1]*Cannot Exceed 50%*
[2]*Obtain corresponding data from Table 3-7 in the WQMP Guidance Document*

F.3 Sizing Criteria

After you appropriately considered Stormwater Credits for your Project, utilize Table F.3 below to appropriately size them to the DCV, or Design Flow Rate, as applicable. Please reference Chapter 3.5.5 of the WQMP Guidance Document for further information.

Table F.3 Treatment Control BMP Sizing

DMA Type/ID	**DMA (square feet)**	**Post-Project Surface Type**	**Effective Impervious Fraction, I_f**	**DMA Runoff Factor**	**DMA x Runoff Factor**		***Enter BMP Name / Identifier Here***		
	[A]		[B]	[C]	[A] x [C]				
A	456,508	Mixed	0.60	0.41	187,169	*Design Storm Depth (in)*	*Minimum DCV or Design Flow Rate (cubic feet or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T= Σ[A] 456,508				Σ= [D] 187,169	[E] 0.69	$[F] = \frac{[D]x[E]}{[G]}$ 10,762	[F] X(1-[H]) 10,762	[I] 21,361

[B], [C] is obtained as described in Section 2.5 from the WQMP Guidance Document
[E] is obtained from Exhibit A in the WQMP Guidance Document
[G] isfor Flow-Based Treatment Control BMPs [G] = 43,560, for Volume-Based Control Treatment BMPs, [G] = 12
[H] is from the Total StormwaterCredit Percentage as Calculated from Table E.2 above
[I] as obtained from a design procedure sheet from the BMP manufacturer and should be included in Appendix 6

F.4 Treatment Control BMP Selection

Treatment Control BMPs typically provide proprietary treatment mechanisms to treat potential Pollutants in runoff, but do not sustain significant biological processes. Treatment Control BMPs must have a removal efficiency of a medium or high effectiveness as quantified below:

- **High**: equal to or greater than 80% removal efficiency
- **Medium**: between 40% and 80% removal efficiency

Such removal efficiency documentation (e.g., studies, reports, etc.) as further discussed in Chapter 3.5.2 of the WQMP Guidance Document, must be included in Appendix 6. In addition, ensure that proposed Treatment Control BMPs are properly identified on the WQMP Site Plan in Appendix 1.

Table F.4 Treatment Control BMP Selection

Selected Treatment Control BMP Name or ID[1]	Priority Pollutant(s) of Concern to Mitigate[2]	Removal Efficiency Percentage[3]
Extended Detention Basin	Sediment Nutrients Trash Bacteria Oil and Grease	Medium Low High Medium Medium
Vegetated Swale	Sediment Nutrients Trash Bacteria Oil and Grease	Medium Low Low Low Medium

[1] *Treatment Control BMPs must not be constructed within Receiving Waters. In addition, a proposed Treatment Control BMP may be listed more than once if they possess more than one qualifying pollutant removal efficiency.*
[2] *Cross Reference Table E.1 above to populate this column.*
[3] *As documented in a Copermittee Approved Study and provided in Appendix 6.*

F.5 Hydrologic Performance Standard – Alternative Compliance Approach

Alternative compliance options are only available if the governing Copermittee has acknowledged the infeasibility of onsite Hydrologic Control BMPs and approved an alternative compliance approach. Attach to Appendix 7 the Technical Feasibility Study(Projects equal or greater than one acre) or Simplified Technical Feasibility Study (Projects less than one acre) along with a written approval from the Copermittee. The applicant may refer to Section 2.2.iv of the SMR HMP for extensive guidelines on the alternative compliance approach.

Select the pursued alternative and describe the specifics of the alternative:

- ☐ Offsite Hydrologic Control Management within the same channel system
- ☐ N/A
- ☐

- ☐ In-Stream Restoration Project
- ☐ N/A

For Offsite Hydrologic Control BMP Option

Each Hydrologic Control BMP must be designed to ensure that the flow duration curve of the post-development DMA will not exceed that of the pre-existing, naturally occurring, DMA by more than ten percent over a one-year period. Using SMRHM, the applicant shall demonstrate that the performance of each designed Hydrologic Control BMP is equivalent with the Hydrologic Performance Standard for onsite conditions. Complete Table F.4 below and identify, for each Hydrologic Control BMP, the equivalent DMA the Hydrologic Control BMP mitigates, that the SMRHM model passed, the total volume capacity of the BMP, the BMP footprint at top floor elevation, and the drawdown time of the BMP. SMRHM summary reports for the alternative approach should be documented in Appendix 7. Refer to the SMRHM Guidance Document for additional information on SMRHM. You can add rows to the table as needed.

Table F.5 Offsite Hydrologic Control BMP Sizing

BMP Name / Type	Equivalent DMA (ac)	SMRHM Passed	BMP Volume (ac-ft)	BMP Footprint (ac)	Drawdown time (hr)
N/A		☐			
		☐			
		☐			
		☐			

For Instream Restoration Option

Attach to Appendix 7 the technical report detailing the condition of the receiving channelsubject to the proposed hydrologic and sediment regimes. Provide the full design plans for the in-stream restoration project that have been approved by the Copermittee.

F.6 Sediment Supply Performance Standard - Alternative Compliance

The alternative compliance option to the Sediment Supply Performance Standard is only available if the governing Copermittee has approved the investigation of alternative Bed Sediment Supply options. Attach to Appendix 7 the Technical Feasibility Study, along with the modeling analysis, the long-term monitoring program, and the potential corrective actions, that demonstrate the performance of the overall alternative compliance program. The applicant may refer to Section 2.3.ii of the SMR HMP for extensive guidelines on the alternative compliance approach.

Provide a narrative describing the alternative Bed Sediment Supply approach, including the long-term monitoring program and the findings of the numerical modeling.

N/A

Section G: Source Control BMPs

Source Control BMPs include permanent, structural features that may be required in your Project plans—such as roofs over and berms around trash and recycling areas—and Operational BMPs, such as regular sweeping and "housekeeping", that must be implemented by the site's occupant or user. The Maximum Extent Practicable (MEP) standard typically requires both types of BMPs. In general, Operational BMPs cannot be substituted for a feasible and effective structural BMP. Using the Pollutant Sources/Source Control Checklist in Appendix 8, review the following procedure to specify Source Control BMPs for your site:

1. ***Identify Pollutant Sources***: Review Column 1 in the Pollutant Sources/Source Control Checklist. Check off the potential sources of Pollutants that apply to your site.

2. ***Note Locations on Project-Specific WQMP Exhibit***: Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist. Show the location of each Pollutant source and each permanent Source Control BMP in your Project-Specific WQMP Exhibit located in Appendix 1.

3. ***Prepare a Table and Narrative***: Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist. In the left column of Table G.1 below, list each potential source of Pollutants on your site (from those that you checked in the Pollutant Sources/Source Control Checklist). In the middle column, list the corresponding permanent, Structural Source Control BMPs (from Columns 2 and 3 of the Pollutant Sources/Source Control Checklist) used to prevent Pollutants from entering runoff. **Add additional narrative** in this column that explains any special features, materials or methods of construction that will be used to implement these permanent, Structural Source Control BMPs.

4. ***Identify Operational Source Control BMPs:*** To complete your table, refer once again to the Pollutant Sources/Source Control Checklist. List in the right column of your table the Operational BMPs that should be implemented as long as the anticipated activities continue at the site. Copermittee storm water ordinances require that applicable Source Control BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable Discretionary Approval for use of the site.

Table G.1 Structuraland Operational Source Control BMP

Potential Sources of Runoff Pollutants	Structural Source Control BMPs	Operational Source Control BMPs
Storm Drain Inlets	Filter Insert	
Trash Storage Areas		

Section H: Construction Plan Checklist

Populate Table H.1 below to assist the plan checker in an expeditious review of your project. The first two columns will contain information that was prepared in previous steps, while the last column will be populated with the corresponding plan sheets. This table is to be completed with the submittal of your final Project-Specific WQMP.

Table H.1 Construction Plan Cross-reference

BMP No. or ID	BMP Identifier and Description	Corresponding Plan Sheet(s)
DMA A	Extended Detention Basin	WQMP Site Plan
DMA B	Vegetated Swale	WQMP Site Plan

Note that the updated table—or Construction Plan WQMP Checklist—is **only a reference tool** to facilitatean easy comparison of the construction plans to your Project-Specific WQMP. The Copermitteewith jurisdiction over the Project site can advise you regarding the process required to propose changes to the approved Project-Specific WQMP.

Section I: Operation, Maintenance and Funding

The Copermittee with jurisdiction over the Project site will periodically verify that BMPs on your Project are maintained and continue to operate as designed. To make this possible, the Copermittee will require that you include in Appendix 9 of this Project-Specific WQMP:

1. A means to finance and implement maintenance of BMPs in perpetuity, including replacement cost.
2. Acceptance of responsibility for maintenance from the time the BMPs are constructed until responsibility for operation and maintenance is legally transferred. A warranty covering a period following construction may also be required.
3. An outline of general maintenance requirements for the Stormwater BMPs you have selected.
4. Figures delineating and designating pervious and impervious areas, location, and type of Stormwater BMP, and tables of pervious and impervious areas served by each facility. Geo-locating the BMPs using a coordinate system of latitude and longitude is recommended to help facilitate a future statewide database system.
5. A separate list and location of self-retaining areas or areas addressed by LID Principles that do not require specialized Operations and Maintenance or inspections but will require typical landscape maintenance as noted in Chapter 5, in the WQMP Guidance. Include a brief description of typical landscape maintenance for these areas.

The Copermitteewith jurisdiction over the Project site will also require that you prepare and submit a detailed BMP Operation and Maintenance Plan that sets forth a maintenance schedule for each of the BMPs built on your site. An agreement assigning responsibility for maintenance and providing for inspections and certification may also be required.

Details of these requirements and instructions for preparing a BMP Operation and Maintenance Plan are in Chapter 5 of the WQMP Guidance Document.

Maintenance Mechanism: Insert text here.

Will the proposed BMPs be maintained by a Homeowners' Association (HOA) or Property Owners Association (POA)?

☒ Y ☐ N

Include your Operation and Maintenance Plan and Maintenance Mechanism in Appendix 9. Additionally, include all pertinent forms of educational materials for those personnel that will be maintaining the proposed BMPs within this Project-Specific WQMP in Appendix 10.

Acronyms, Abbreviations and Definitions

2010 SMR MS4 Permit	Order No. R9-2010-0016, an NPDES Permit issued by the San Diego Regional Water Quality Control Board.
Applicant	Public or private entity seeking the discretionary approval of new or replaced improvements from the Copermittee with jurisdiction over the project site. The Applicant has overall responsibility for the implementation and the approval of a Priority Development Project. The WQMP uses consistently the term "user" to refer to the applicant such as developer or project proponent. The WQMP employs also the designation "user" to identify the Registered Professional Civil Engineer responsible for submitting the Project-Specific WQMP, and designing the required BMPs.
Best Management Practice (BMP)	Defined in 40 CFR 122.2 as schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. In the case of municipal storm water permits, BMPs are typically used in place of numeric effluent limits.
BMP Fact Sheets	BMP Fact Sheets are available in the LID BMP Design Handbook. Individual BMP Fact Sheets include sitting considerations, and design and sizing guidelines for seven types of structural BMPs (infiltration basin, infiltration trench, permeable pavement, harvest-and-use, bioretention, extended detention basin, and sand filter).
California Stormwater Quality Association (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks, available at www.cabmphandbooks.com.
Conventional Treatment Control BMP	A type of BMP that provides treatment of stormwater runoff. Conventional treatment control BMPs, while designed to treat particular Pollutants, typically do not provide the same level of volume reduction as LID BMPs, and commonly require more specialized maintenance than LID BMPs. As such, the 2010 SMR MS4 Permit and this WQMP require the use of LID BMPs wherever feasible, before Conventional Treatment BMPs can be considered or implemented.
Copermittees	The 2010 SMR MS4 Permit identifies the Cities of Murrieta, Temecula, and Wildomar, the County, and the District, as Copermittees for the SMR.
County	The abbreviation refers to the County of Riverside in this document.
CEQA	California Environmental Quality Act - a statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.

CIMIS	California Irrigation Management Information System - an integrated network of 118 automated active weather stations all over California managed by the California Department of Water Resources.
CWA	Clean Water Act - is the primary federal law governing water pollution. Passed in 1972, the CWA established the goals of eliminating releases of high amounts of toxic substances into water, eliminating additional water pollution by 1985, and ensuring that surface waters would meet standards necessary for human sports and recreation by 1983. CWA Section 402(p) is the federal statute requiring NPDES permits for discharges from MS4s.
CWA Section 303(d) Waterbody	Impaired water in which water quality does not meet applicable water quality standards and/or is not expected to meet water quality standards, even after the application of technology based pollution controls required by the CWA. The discharge of urban runoff to these water bodies by the Copermittees is significant because these discharges can cause or contribute to violations of applicable water quality standards.
Design Storm	The 2010 SMR MS4 Permit has established the 85th percentile, 24-hour storm event as the "Design Storm". The applicant may refer to Exhibit A to identify the applicable Design Storm Depth (D85) to the project.
DCV	Design Capture Volume (DCV) is the volume of runoff produced from the Design Storm to be mitigated through LID Retention BMPs, Other LID BMPs and Volume Based Conventional Treatment BMPs, as appropriate.
Design Flow Rate	The design flow rate represents the minimum flow rate capacity that flow-based conventional treatment control BMPs should treat to the MEP, when considered.
DCIA	Directly Connected Impervious Areas - those impervious areas that are hydraulically connected to the MS4 (i.e. street curbs, catch basins, storm drains, etc.) and thence to the structural BMP without flowing over pervious areas.
Discretionary Approval	A decision in which a Copermittee uses its judgment in deciding whether and how to carry out or approve a project.
District	Riverside County Flood Control and Water Conservation District.
DMA	A Drainage Management Area - a delineated portion of a project site that is hydraulically connected to a common structural BMP or conveyance point. The Applicant may refer to Section 3.3 for further guidelines on how to delineate DMAs.

Drawdown Time	Refers to the amount of time the design volume takes to pass through the BMP. The specified or incorporated drawdown times are to ensure that adequate contact or detention time has occurred for treatment, while not creating vector or other nuisance issues. It is important to abide by the drawdown time requirements stated in the fact sheet for each specific BMP.
Effective Area	Area which 1) is suitable for a BMP (for example, if infiltration is potentially feasible for the site based on infeasibility criteria, infiltration must be allowed over this area) and 2) receives runoff from impervious areas.
ESA	An Environmental Sensitive Area (ESA) designates an area "in which plants or animals life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments". (Reference: California Public Resources Code § 30107.5).
ET	Evapotranspiration (ET) is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). It is also an indicator of how much water crops, lawn, garden, and trees need for healthy growth and productivity
FAR	The Floor Area Ratio (FAR) is the total square feet of a building divided by the total square feet of the lot the building is located on.
Flow-Based BMP	Flow-based BMPs are conventional treatment control BMPs that are sized to treat the design flow rate.
FPPP	Facility Pollution Prevention Plan
HCOC	Hydrologic Condition of Concern - Exists when the alteration of a site's hydrologic regime caused by development would cause significant impacts on downstream channels and aquatic habitats, alone or in conjunction with impacts of other projects.
HMP	Hydromodification Management Plan – Plan defining Performance Standards for PDPs to manage increases in runoff discharge rates and durations.
Hydrologic Control BMP	BMP to mitigate the increases in runoff discharge rates and durations and meet the Performance Standards set forth in the HMP.
HSG	Hydrologic Soil Groups – soil classification to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSGs are A (very low runoff potential/high infiltration rate), B, C, and D (high runoff potential/very low infiltration rate)
Hydromodification	The 2010 SMR MS4 Permit identifies that increased volume, velocity, frequency and discharge duration of storm water runoff from developed areas has the potential to greatly accelerate downstream erosion, impair stream habitat in natural drainages, and negatively impact beneficial uses.

JRMP	A separate Jurisdictional Runoff Management Plan (JRMP) has been developed by each Copermittee and identifies the local programs and activities that the Copermittee is implementing to meet the 2010 SMR MS4 Permit requirements.
LID	Low Impact Development (LID) is a site design strategy with a goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques. LID site design BMPs help preserve and restore the natural hydrologic cycle of the site, allowing for filtration and infiltration which can greatly reduce the volume, peak flow rate, velocity, and pollutant loads of storm water runoff.
LID BMP	A type of stormwater BMP that is based upon Low Impact Development concepts. LID BMPs not only provide highly effective treatment of stormwater runoff, but also yield potentially significant reductions in runoff volume – helping to mimic the pre-project hydrologic regime, and also require less ongoing maintenance than Treatment Control BMPs. The applicant may refer to Chapter 2.
LID BMP Design Handbook	The LID BMP Design Handbook was developed by the Copermittees to provide guidance for the planning, design and maintenance of LID BMPs which may be used to mitigate the water quality impacts of PDPs within the County.
LID Bioretention BMP	LID Bioretention BMPs are bioretention areas are vegetated (i.e., landscaped) shallow depressions that provide storage, infiltration, and evapotranspiration, and provide for pollutant removal (e.g., filtration, adsorption, nutrient uptake) by filtering stormwater through the vegetation and soils. In bioretention areas, pore spaces and organic material in the soils help to retain water in the form of soil moisture and to promote the adsorption of pollutants (e.g., dissolved metals and petroleum hydrocarbons) into the soil matrix. Plants use soil moisture and promote the drying of the soil through transpiration. The 2010 SMR MS4 Permit defines "retain" as to keep or hold in a particular place, condition, or position without discharge to surface waters.
LID Biotreatment BMP	BMPs that reduce stormwater pollutant discharges by intercepting rainfall on vegetative canopy, and through incidental infiltration and/or evapotranspiration, and filtration, and other biological and chemical processes. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded, and sequestered by the soil and plants, and collected through an underdrain.
LID Harvest and Reuse BMP	BMPs used to facilitate capturing Stormwater Runoff for later use without negatively impacting downstream water rights or other Beneficial Uses.

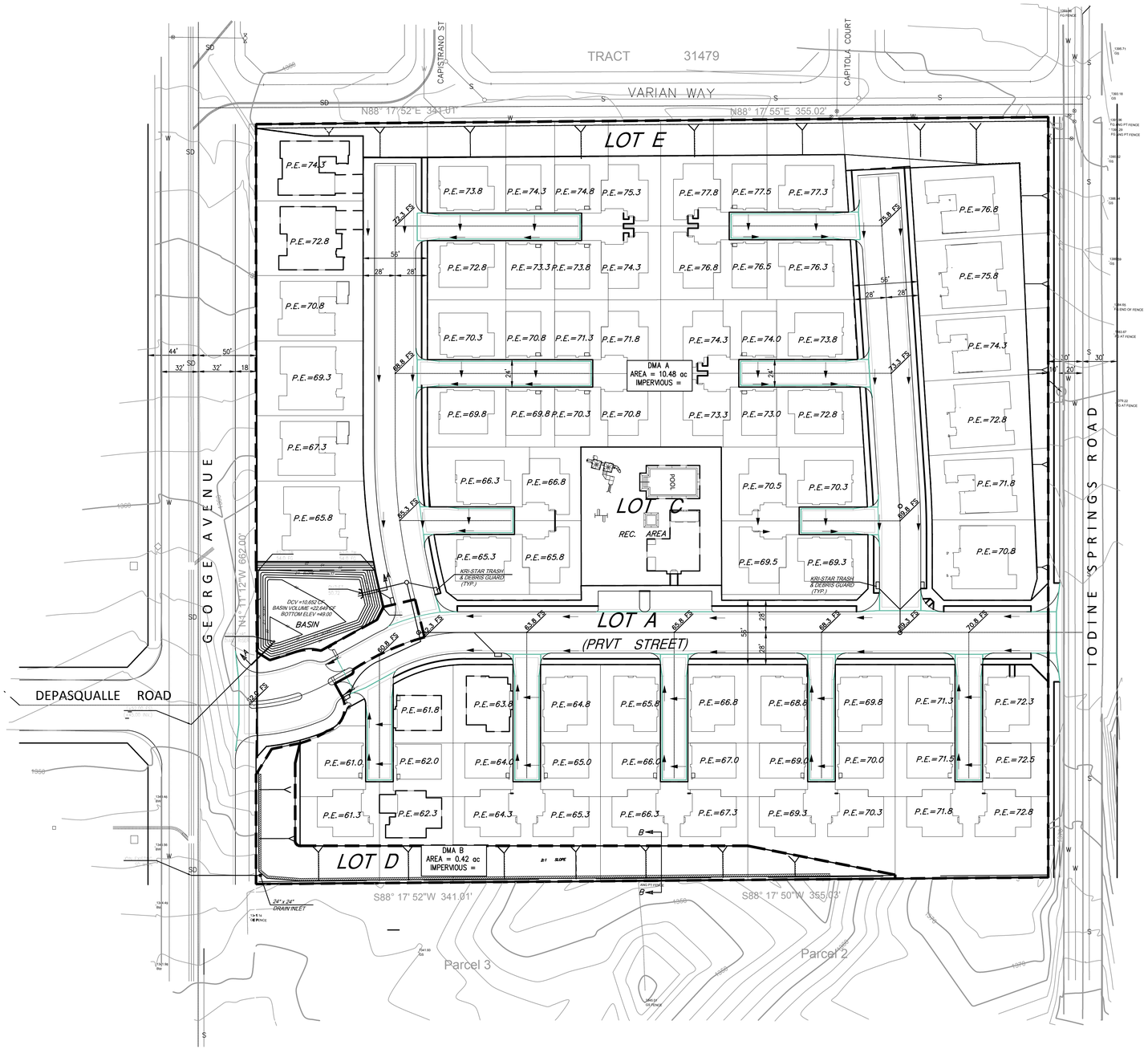
LID Infiltration BMP	BMPs to reduce stormwater runoff by capturing and infiltrating the runoff into in-situ soils or amended onsite soils. Typical LID Infiltration BMPs include infiltration basins, infiltration trenches and pervious pavements.
LID Retention BMP	BMPs to ensure full onsite retention without runoff of the DCV such as infiltration basins, bioretention, chambers, trenches, permeable pavement and pavers, harvest and reuse.
LID Principles	Site design concepts that prevent or minimize the causes (or drivers) of post-construction impacts, and help mimic the pre-development hydrologic regime.
MEP	Maximum Extent Practicable - standard established by the 1987 amendments to the CWA for the reduction of Pollutant discharges from MS4s. Refer to Attachment C of the 2010 SMR MS4 Permit for a complete definition of MEP.
MF	Multi-family – zoning classification for parcels having 2 or more living residential units.
MS4	Municipal Separate Storm Sewer System (MS4) is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or designated and approved management agency under section 208 of the CWA that discharges to waters of the United States; (ii) Designated or used for collecting or conveying storm water; (iii) Which is not a combined sewer; (iv) Which is not part of the Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.26.
New Development Project	Defined by the 2010 MS4 permit as 'Priority Development Projects' if the project, or a component of the project meets the categories and thresholds described in Section 1.1.1.
NPDES	National Pollution Discharge Elimination System - Federal program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 318, 402, and 405 of the CWA.
NRCS	Natural Resources Conservation Service
PDP	Priority Development Project - IncludesNew Development and Redevelopment project categories listed in Section F.1.d(2) of Order No. R9-2009-0002.

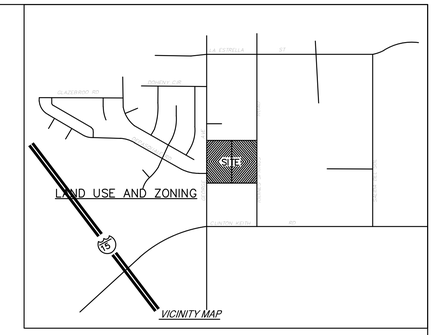
Priority Pollutants of Concern	Pollutants expected to be present on the project site and for which a downstream water body is also listed as Impaired under the CWA Section 303(d) list or by a TMDL.
Project-Specific WQMP	A plan specifying and documenting permanent LID Principles and Stormwater BMPs to control post-construction Pollutants and stormwater runoff for the life of the PDP, and the plans for operation and maintenance of those BMPs for the life of the project.
Receiving Waters	Waters of the United States.
Redevelopment Project	The creation, addition, and or replacement of impervious surface on an already developed site. Examples include the expansion of a building footprint, road widening, the addition to or replacement of a structure, and creation or addition of impervious surfaces. Replacement of impervious surfaces includes any activity that is not part of a routine maintenance activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include trenching and resurfacing associated with utility work; resurfacing existing roadways; new sidewalk construction, pedestrian ramps, or bike lane on existing roads; and routine replacement of damaged pavement, such as pothole repair. Project that meets the criteria described in Section 1.
Runoff Fund	Runoff Funds have not been established by the Copermittees and are not available to the Applicant. If established, a Runoff Fund will develop regional mitigation projects where PDPs will be able to buy mitigation credits if it is determined that implementing onsite controls is infeasible.
San Diego Regional Board	San Diego Regional Water Quality Control Board - The term "Regional Board", as defined in Water Code section 13050(b), is intended to refer to the California Regional Water Quality Control Board for the San Diego Region as specified in Water Code Section 13200.State agency responsible for managing and regulating water quality in the SMR.
SCCWRP	Southern California Coastal Water Research Project
Site Design BMP	Site design BMPs prevent or minimize the causes (or drivers) of post-construction impacts, and help mimic the pre-development hydrologic regime.
SF	Parcels with a zoning classification for a single residential unit.
SMC	Southern California Stormwater Monitoring Coalition
SMR	The Santa Margarita Region (SMR) represents the portion of the Santa Margarita Watershed that is included within the County of Riverside.

Source Control BMP	Source Control BMPs land use or site planning practices, or structural or nonstructural measures that aim to prevent runoff pollution by reducing the potential for contamination at the source of pollution. Source control BMPs minimize the contact between Pollutants and runoff.
Stormwater Credit	Stormwater Credit can be claimed by an Applicant if certain development practices that provide broad-scale environmental benefits to communities are incorporated into the project design. Refer to Section 3.5.4 for additional information on Stormwater Credits.
Structural BMP	Structures designed to remove pollutants from stormwater runoff and mitigate hydromodification impacts.
SWPPP	Storm Water Pollution Prevention Plan
Tentative Tract Map	Tentative Tract Maps are required for all subdivision creating five (5) or more parcels, five (5) or more condominiums as defined in Section 783 of the California Civil Code, a community apartment project containing five (5) or more parcels, or for the conversion of a dwelling to a stock cooperative containing five (5) or more dwelling units.
TMDL	Total Maximum Daily Load - the maximum amount of a Pollutant that can be discharged into a waterbody from all sources (point and non-point) and still maintain Water Quality Standards. Under CWA Section 303(d), TMDLs must be developed for all waterbodies that do not meet Water Quality Standards after application of technology-based controls.
USEPA	United States Environmental Protection Agency
Volume-Based BMP	Volume-Based BMPs applies to BMPs where the primary mode of pollutant removal depends upon the volumetric capacity such as detention, retention, and infiltration systems.
WQMP	Water Quality Management Plan
Wet Season	The 2010 SMR MS4 Permit defines the wet season from October 1 through April 30.

Appendix 1:Maps and Site Plans

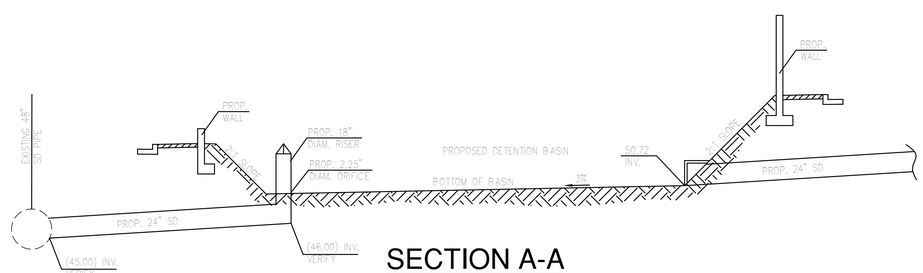
Location Map, WQMP Site Plan and Receiving Waters Map





LOCATION	AREA SF	AREA AC	IMPERVIOUS	PERVIOUS	Q_{TM} cfs	DCV (cf) Required	DCV (cf) Design
DMA A	456,509	10.48	55	45	5.02	10,652	22,649 cf Detention Basin
DMA B	18,295	0.42	0	100	0.005	122	2'W x 581'L (Vegetated Swale)
TOTAL	474,804	10.90	--	--	5.02	10,774	

SCALE 1"=50'



SECTION A-A

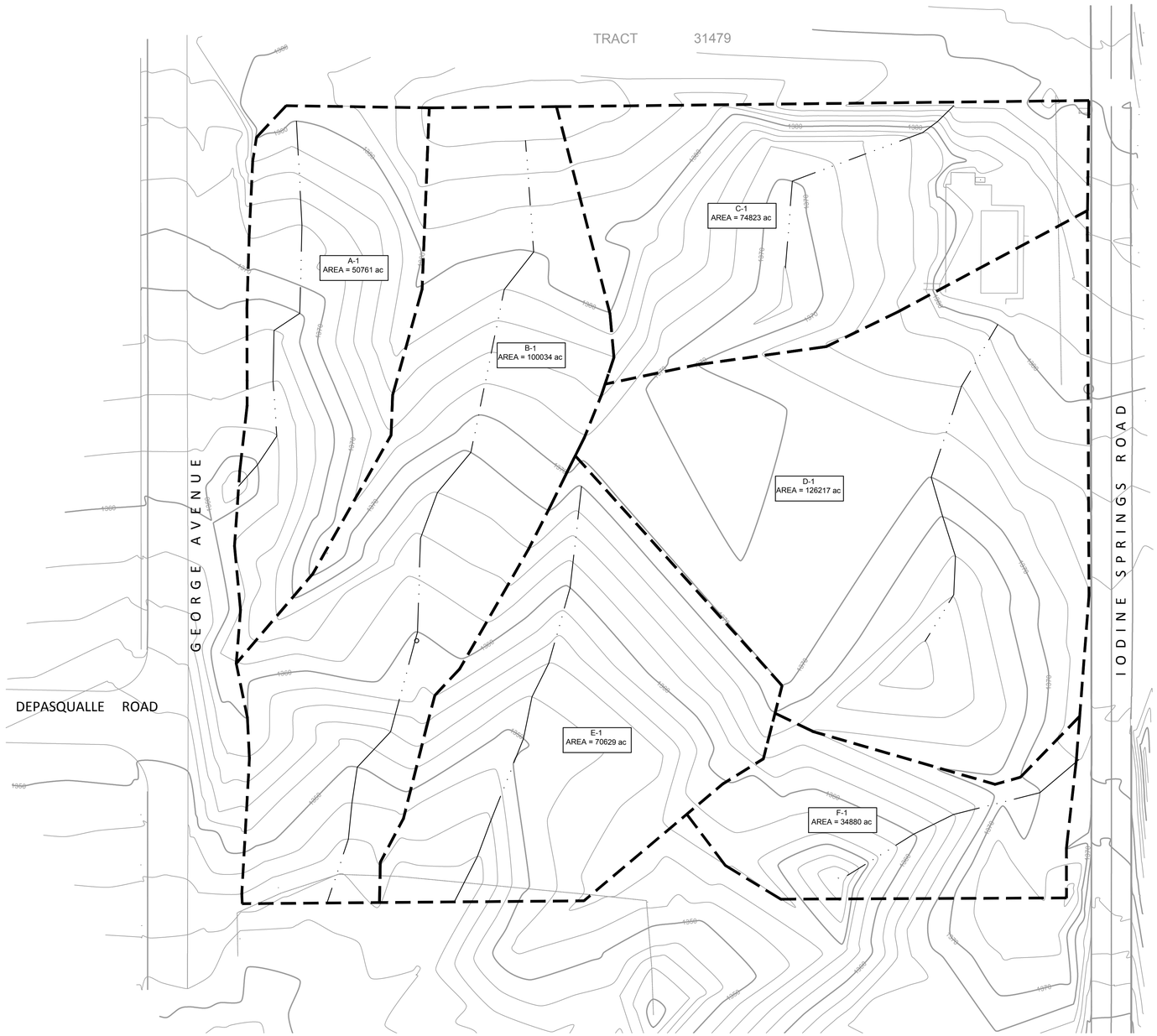
N.T.S.

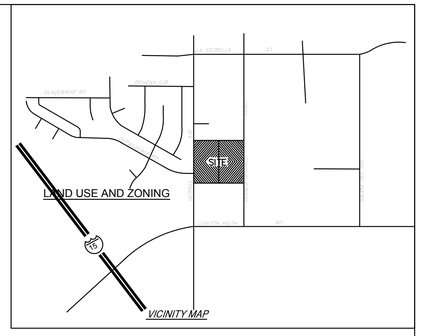
OWNER/SUBDIVIDER:
MARI MINA, LLC
4030 BIRCH STREET
SUITE 100
NEWPORT BEACH, CA 92660
TELEPHONE: (909) 262-1558
Attn: Emad Bolous

PREPARED BY:
TL Group Corp.
CIVIL ENGINEERING, SURVEYING, & LAND PLANNING
4883 La Palma, Suite 501-A
Anaheim, CA 92807 TEL.(714)982-4057

WQMP SITE PLAN
TENTATIVE TRACT MAP No. 36952
LOCATED IN THE CITY OF WILDOMAR
COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

SCALE: 1"=50'
J.N. 15-101
DATE: 08-28-2015
SHT. 1 OF 1





LOCATION	AREA SF	AREA AC	IMPERVIOUS	PERVIOUS	2-YR STORM Q_{10} (cfs)	2-YR STORM V_{10} (cf)	10-YR STORM Q_{100} (cfs)	10-YR STORM
A-1	50,761	1.16	0	100	1.18	3,155	2.07	7,869
B-1	100,034	2.30	0	100	1.97	6,229	3.45	15,535
C-1	74,823	1.72	10	90	2.17	5,444	3.73	12,622
D-1	126,217	2.90	0	100	2.94	7,863	5.16	19,609
E-1	70,629	1.62	0	100	1.68	4,398	2.81	10,968
F-1	34,880	0.80	0	100	0.94	2,172	1.62	5,417
TOTAL	457,380	10.50	--	--	10.88	14,061	18.84	72,021

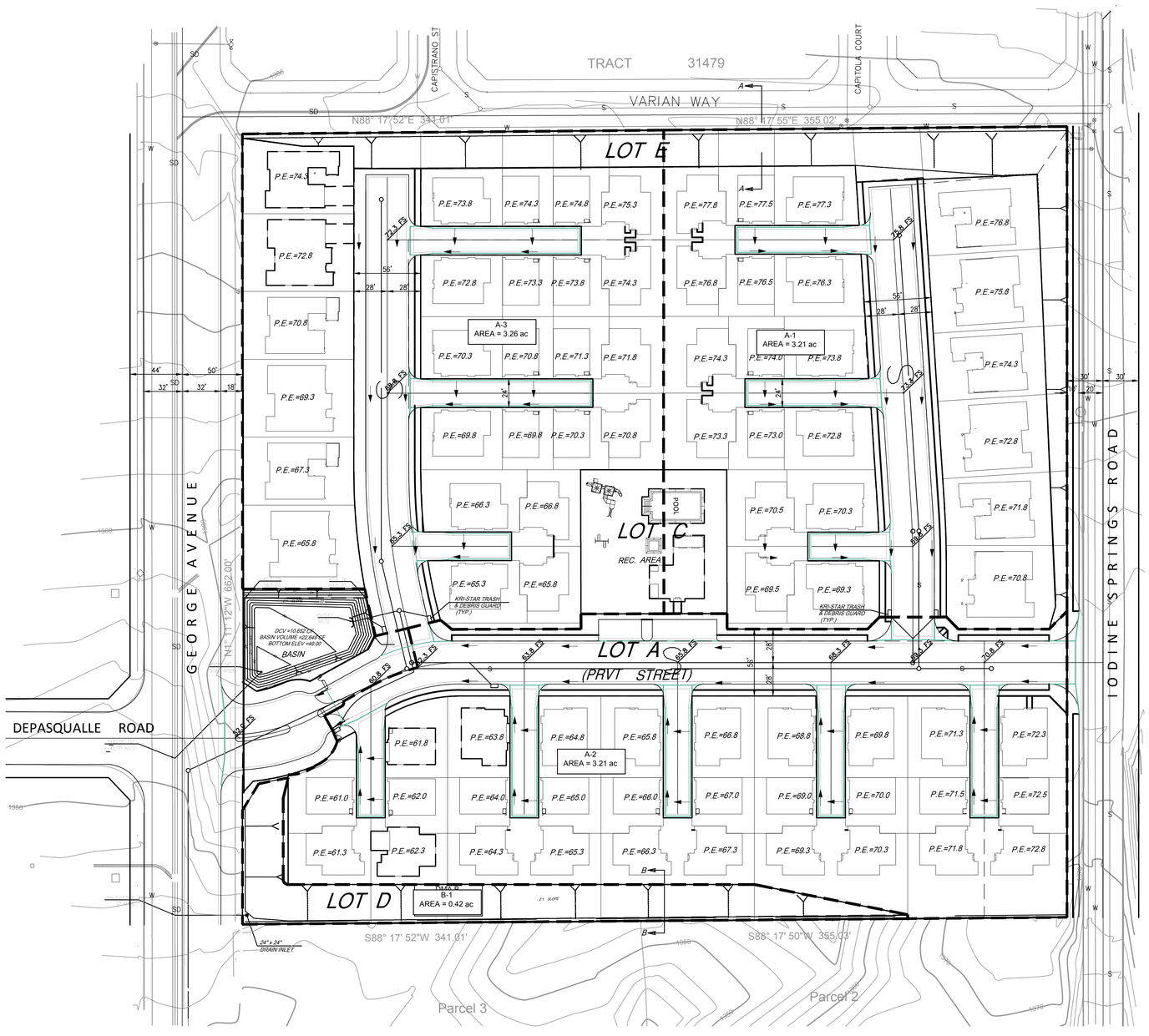
SCALE 1"=50'

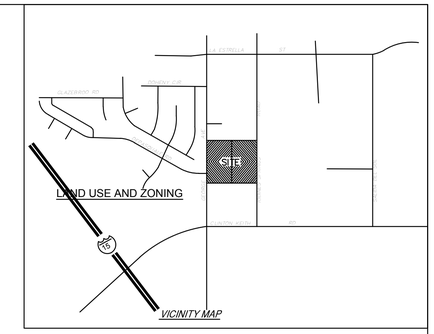
OWNER/SUBDIVIDER:
MARI MINA, LLC
4030 BIRCH STREET
SUITE 100
NEWPORT BEACH, CA 92660
TELEPHONE: (909) 262-1558
Attn: Emad Bolous

PREPARED BY:
TL Group Corp.
CIVIL ENGINEERING, SURVEYING, & LAND PLANNING
4883 La Palma, Suite 501-A
Anaheim, CA 92807 TEL.(714)982-4057

EXISTING HYDROLOGY MAP
TENTATIVE TRACT MAP No. 36952
LOCATED IN THE CITY OF WILDOMAR
COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

SCALE: 1"=50'
J.N. 15-101
DATE: 08-28-2015
SHT. 1 OF 1





LOCATION	AREA SF	AREA AC	IMPERVIOUS	PERVIOUS	2-YR STORM Q_{2} (cfs)	2-YR STORM V_{2} (cf)	10-YR STORM Q_{10} (cfs)	10-YR STORM V_{10} (cf)
A-1	139,827	3.21	65	35	3.59	17,723	6.27	34,579
A-2	139,827	3.21	65	35	3.50	17,762	6.02	34,646
A-3	142,006	3.26	65	35	3.80	18,265	6.55	35,473
B-1	18,295	0.42	0	100	0.23	355	0.48	1,250
TOTAL	142,006	9.68	--	--	*10.88	54,104	*18.89	115,639

*Confluence Analysis

SCALE 1"=50'

OWNER/SUBDIVIDER:
MARI MINA, LLC
4030 BIRCH STREET
SUITE 100
NEWPORT BEACH, CA 92660
TELEPHONE: (909) 262-1558
Attn: Emad Bolous

PREPARED BY:
TL Group Corp.
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4883 La Palma, Suite 501-A
Anaheim, CA 92807 TEL.(714)982-4057

PROP. HYDROLOGY MAP
TENTATIVE TRACT MAP No. 36952
LOCATED IN THE CITY OF WILDOMAR
COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

SCALE: 1"=50'
J.N. 15-101
DATE: 08-28-2015
SHT. 1 OF 1

Riverside County SWCT²
Stormwater & Water Conservation Tracking Tool

WQMP Project Report

County of Riverside Stormwater Program

Santa Ana River Watershed Geodatabase

Monday, June 15, 2015

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

Project Site Parcel Number(s):	362250027, 362250003, 362250026, 362250001
Latitude/Longitude:	33.6002, -117.2395
Thomas Brothers Page:	897
Project Site Acreage:	8.63
Watershed(s):	SANTA MARGARITA
This Project Site Resides in the following Hydrologic Unit (s) (HUC):	**HUC Name** - HUC Number **Cole Canyon-Murrieta Creek** - 180703020402
The HUCs Contribute stormwater to the following 303d listed water bodies and TMDLs which may include drainage from your proposed Project Site:	**WBID Name** - WBID Number **Santa Margarita River (Lower)** - CAR9021100019980911161346 **Santa Margarita River (Upper)** - CAR9022200020011001141050 **Murrieta Creek** - CAR9023200020010924152136
These 303d listed Water bodies and TMDLs have the following Pollutants of Concern (POC):	**Bacterial Indicators** - Enterococcus, Fecal Coliform **Metals/Metalloids** - Copper, Iron, Manganese **Nutrients** - Nitrogen, Phosphorus, Total Nitrogen as N **Pesticides** - Chlorpyrifos **Toxicity** - Toxicity
Is the Site subject to Hydromodification:	Yes
Limitations on Infiltration:	**Project Site Onsite Soils Group(s)** - A, D **Known Groundwater Contamination Plumes within 1000'** - No **Adjacent Water Supply Wells(s)** - No information available please contact your local water agency for more information. Your local contact agency is ELSINORE VALLEY M.W.D.. Your local wholesaler contact agency is METROPOLITAN WATER DISTRICT.
Environmentally Sensitive Areas within 200'(Fish and Wildlife Habitat/Species):	None
Environmentally Sensitive Areas within 200'(CVMSHCP):	None
Environmentally Sensitive Areas within 200'(WRMSHCP):	Burrowing Owl Survey Required Area
Groundwater elevation from Mean Sea Level:	No Data
85th Percentile Design Storm Depth (in):	0.685
Groundwater Basin:	TEMECULA VALLEY
MSHCP/CVMSHCP Criteria Cell(s):	No Data
Retention Ordinance Information:	No Data
Studies and Reports Related to Project Site:	IBI Scores - Southern Cal bulletin118_4-sc water_fact_3_7.11 Complete Final GWMP_Mar 2005 Urban Water Management Plan Murrieta Creek Santa Margarita River Watershed Annual Watermaster Murrieta Creek/Murrieta Valley ADP Map 1 Murrieta Creek/Murrieta Valley ADP Map 2 Murrieta Creek/Murrieta Valley ADP Report SMR Annual Report 2009-10

Appendix 2: Construction Plans

Grading and Drainage Plans

Appendix 3:Soils Information

Geotechnical Study and Other Infiltration Testing Data

SOILS SOUTHWEST, INC.

SOILS, MATERIALS AND ENVIRONMENTAL ENGINEERING CONSULTANTS

897 VIA LATA, SUITE N • COLTON, CA 92324 • (909) 370-0474 • (909) 370-0481 • FAX (909) 370-3156

Report of Preliminary Soils and Foundation Evaluations
Proposed 11+ac. 77-lot Residential Development
35775 Iodine Springs Road
City of Wildomar
Riverside County, California
APN: 362-250-001 & 362-250-026

Project No. 15021-F

July 22, 2015

Prepared for:

Mr. Raffaele Suprano, CFO
% Marimina LLC.
245 Fischer Avenue, Suite A-8A
Costa Mesa, CA 92626

soilssouthwest@gmail.com
Established 1984

SOILS SOUTHWEST, INC.

SOILS, MATERIALS AND ENVIRONMENTAL ENGINEERING CONSULTANTS

897 VIA LATA, SUITE N • COLTON, CA 92324 • (909) 370-0474 • (909) 370-0481 • FAX (909) 370-3156

July 22, 2015

Project No. 15021-F

Nova Homes, Inc.
% Marimina LLC.
245 Fischer Avenue, Suite A-8A
Costa Mesa, CA 92626

Attention: Mr. Mr. Raffaele Suprano, CFO

Subject: Proposed 11+ac. 77-lot Residential Development
35775 Iodine Springs Road
City of Wildomar, Riverside County, California

Reference: Preliminary Conceptual Plan Prepared by Nova Homes, Inc.

Gentlemen:

Presented herewith are the Report of Preliminary Soils and Foundation Evaluations conducted for the site of the proposed 77-lot single family dwellings to be located at 35775 Iodine Springs Road, Wildomar, Riverside County, California. In absence of final grading and development plans, the recommendations supplied should be considered as "preliminary", subject to revisions following topographic, grading and development plan review.

The soils encountered consist, in general of, upper disturbed, dry and compressible, fine to medium coarse silty gravelly sands up to about 4 to 5 feet, overlying deposits dense, well cemented, coarse to very coarse, friable, gravelly sand of decomposed granitic origin. With the presence of minor pin-holes and traces of Caliche, laboratory testing dictates the natural deposits may be potentially susceptible to hydoconsolidation.

Based on review of the available published documents, it is our opinion that the subject site is not situated within an A-P Special Studies Zone, and the site should be considered non-susceptible to seismically induced soil liquefaction.

Based on the geotechnical evolutions completed as described herein, it is our opinion that the site should be considered suitable for the planned development, provided the recommendations presented are incorporated in final design and construction. The findings as described should be available to the project design professionals for their review and use. We offer no other warranty, express or implied.

Respectfully submitted,
Soils Southwest, Inc.

REGISTERED PROFESSIONAL ENGINEER
MOLOY K. GUPTA
NO. 31708 EXP. 12-31-16
CIVIL
STATE OF CALIFORNIA

Moloy Gupta, RCE 31708

John Flippin
Project Coordinator

dist/5-addressee

Introduction

1.1 Purpose and Scope of Work

This report presents the preliminary results of Soils and Foundation Evaluations conducted for the site of the proposed 77-lot residential development to be located on the 11.7-acre parcel situated at 35775 Iodine Springs road, City of Wildomar, Riverside County, California. In absence of topographic, site grading and development plans, the recommendations supplied should be considered as "preliminary", subject to revision prior to actual grading and construction.

The soils/material descriptions included are based on visual observations made during test explorations conducted at this time, supplemented by laboratory testing completed as described.

The recommendations contained reflect our best estimate of the soils conditions encountered during field investigations conducted. It is not to be considered as a warranty of the soils for other areas, or for the depths beyond the explorations completed at this time.

The recommendations supplied should be considered valid and applicable when the following conditions, in minimum, are observed:

i. Pre-grade meeting with contractor, public agency and soils engineer,
ii. Excavated bottom inspections and verifications by soils engineer prior to backfill placement,
iii. Continuous observations and testing during site preparation and structural fill soils placement,
iv. Observation and inspection of footing trenching prior to steel and concrete placement,
v. Plumbing trench backfill placement prior to concrete slab-on-grade placement,
vi. On and off-site utility trench backfill testing and verifications, and
vii. Consultations as required during construction, or upon your request

1.2 Site Description

Primarily vacant and undeveloped, the uneven 11.7 acres site is bounded by a residential development currently underway on the north, by other undeveloped properties on the south, by the paved Iodine Springs Road on the east, and by George Street followed by other residential tract homes on the west. Overall vertical relief is currently unknown, but sheet-flow from incidental rainfall appear to flow towards the south. With the exception of weeds, minor scattered brush and isolated debris, presence of no other significant features pertinent to the planned development are noted.

1.3 Proposed Development and Grading

No grading plan, topographic map or detailed site improvement plans are available for review. However, based on the tentative development information supplied, it is understood that the subject site will be developed to include 77 detached single family dwellings, along with on and off-site street improvements. Use of conventional wood-frame and stucco construction are assumed with 2 kips and 15 klf for isolated pier and conventional wall loadings, respectively. Moderate site preparations and grading should be anticipated with the development currently planned.

1.4 Subsurface Investigation

Subsurface explorations consisted of 4 (four) geotechnical test explorations by using a 24-inch bucket backhoe advanced to a maximum 12 feet below grade. Prior to actual test explorations an underground utility clearance was made by the Underground Service Alert (USA) of Southern California to avoid possible subsurface life-line obstruction. The approximate test locations are shown on the attached Plate 1. Following necessary soil sampling and in-situ testing, the exploratory test trenches were backfilled with local soils using minimum compaction effort. During mass grading operations, areas of such should required additional compaction efforts using appropriate construction equipments.

During test excavations, representative bulk and undisturbed California ring samples were procured. Collected samples were subsequently sent to our laboratory for necessary geotechnical testing. It should be noted that with the presence of the friable, very dense, dry gravelly sandy soils retrievals of some of the undisturbed soils samplings were not complete.

1.5 Laboratory Testing

Representative bulk and undisturbed site soils samples were tested in our laboratory to aid in the soils classification and to evaluate relevant engineering properties pertaining to the project requirements. In general, the laboratory testing included the following:

- In-situ moisture contents and dry density (ASTM Standard D2216)
- Maximum dry density and optimum moisture content (ASTM Standard D1557)
- Direct Shear (ASTM Standard D3080)
- Soil Consolidation (ASTM Standard D2435)
- Soil gradation analysis (ASTM Standard D422)
- Soil Expansion index, EI (ASTM Standard D4829)

Description of the test results and test procedures used are provided in Appendix B.

- o Based on the field investigation and laboratory testing, engineering analyses and evaluations were made on which to base our preliminary recommendations for design of foundations, slab-on-grade, paving and parking, site grading, utility trench backfill, site preparations and grading and monitoring during construction.

- o Preparation of this report for initial use by the project design professionals. The recommendations supplied should be considered as 'tentative' and may require revision and/or upgrading following final development plan review.

2.0 Geotechnical Conditions

2.1 Site Soil Conditions

The soils encountered consist in general of upper disturbed, dry and compressible, fine to medium coarse gravelly sands up to about 4 feet, overlying natural deposits of light brown to brown, dense to very dense, well cemented, coarse to very coarse, friable, gravelly sand of decomposed granitic origin. With the presence of scattered pin-holes and Caliche, laboratory testing dictates the natural deposits may be potentially susceptible to consolidation (hydocollapsible) in contact with free water. Presence of no shallow depth bedrock or groundwater was detected.

The near surface loose and compressible soils existing as described are considered inadequate for directly supporting structural loadings without excessive differential settlements to load bearing footings and concrete slab-on-grade. When, however, graded in form of load bearing structural fill soils placement as recommended herein, the structural pads thus constructed for the dwellings planned should be adequate for load bearing support.

Laboratory shear tests conducted on the upper soils remolded to 90% indicate moderate shear strengths under increased moisture conditions. Results of the laboratory shear tests are provided in Plate B-1 of this report.

Slight soil compressibility is expected on similar remolded samples, thereby anticipating potential for "tolerable" settlements to footings and concrete slab-on-grade. Results of the laboratory determined soils consolidation potential is shown on Plate B-2 in Appendix B.

The near grade silty sandy alluviums exposed are considered "very low" in expansion characteristics requiring no special construction requirements when such are used overlain by concrete conventional slab on grade. Since soil matrix is expected to change following mass grading, it is our opinion that supplemental soil expansion potential verifications should be made to provide supplemental/revised recommendations, if warranted.

2.2 Subsurface Variations

During grading, buried irrigation, debris, organic and others may be encountered. In addition, variations in soil strata, their continuity and orientations may be expected. Due to the nature and depositional characteristics of the natural soils encountered, care should be exercised interpolating or extrapolating the subsurface soils conditions existing in between and beyond the test explorations conducted.

2.3 Excavatability

It is our opinion that the grading required for the project may be accomplished using conventional heavy-duty construction equipment. However, some difficulty may be expected during deep trenching due to soil caving. No blasting or jack-hammering, however, is anticipated.

2.4 Soil Corrosivity Potential

Since change in soil matrix is expected during site preparations and grading, no soil chemical analysis is initiated at this time to determine potentials for soils corrosivity to concrete and steel. Following mass grading completions evaluations on such will be made to determine, in minimum, pH, sulfate, chloride and resistivity. Results of such will be supplied, if and, when requested.

2.5 Groundwater

No shallow depth groundwater was encountered within the current maximum exploratory test depth of about at about 12 feet below existing grade. Based on review of the data available from the Water Library, historical shallowest groundwater level is estimated at about 7 feet below the current grade surface elevation of 1330.41.

While the groundwater described is expected not to affect the current planned development, it is our opinion, however, that provisions should be maintained so as to dispose of surface runoff away from the individual structural pads, once constructed.

Fluctuations in groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, altered natural drainage paths, and other factors not evident at the test explorations were completed. Consequently, the project civil engineer and grading contractor should establish a surface water runoff pattern so as to directed surface runoff away from the structural pads, once constructed.

3.0 Faulting And Seismicity

3.1 Faulting and Seismicity

Based on review of the information as published by the Department of Conservation, State of California, it is understood that the site is *not* situated within an A-P Special Study Zone (*where a fault(s) runs through or adjacent to the development site*
However, considering the Southern California being in a seismically risky area susceptible to strong motion earthquake thereby causing structural damages, it is recommended that implementation of the current CBC seismic design parameters, along with the recommendations as described herein should be considered with the intention to "reduce" potentials for earthquake induced excessive structural distress, if any.

3.2 Direct or Primary Seismic Hazards

Surface ground rupture along with active fault zones and ground shaking represent primary or direct seismic hazards to structures. There are no known active or potentially active faults that pass through or towards the subject site, and the site is not situated within an AP Special Studies Zone. According to the 2013 current CBC, the site is considered within Seismic Zone 4. As a result, it is likely that during the life expectancy of the structure built, moderate to severe ground shaking may have potential for adverse effects on the site.

3.3 Induced or Secondary Seismic Hazards

In addition to ground shaking, effects of seismic activity may include surface rupture, flooding, land-sliding, lateral spreading, settlements and subsidence. Potential effects of such are as described below.

3.4 Liquefaction

Liquefaction is caused by build-up of excess hydrostatic pressures in saturated cohesionless soils due to cyclic stress generated by ground shaking. The significant factors on which liquefaction potential of a soil deposit depends, among others, include soil type, relative soil density, intensity of earthquake, duration of ground shaking, and depth of ground water, among others.

Although no site-specific site soils liquefaction susceptibility potential is currently included, it is our opinion, however, that considering the presence of very dense gravelly sandy soils or granitic bedrock at depth as described in Test Boring Logs, the site soils should be considered non-susceptibility to seismically induced liquefaction. Further evaluations on such may be initiated, if and, on request.

3.5 Shallow Ground Rupture

The site is not situated within an AP Special Studies Zone. Based on review of existing geologic information, no major fault is noted to cross through or extends towards the site. The potential for surface rupture resulting from nearby fault movement is not known for certainty, but is considered "remote" due to the distance of the site with respect to the nearby earthquake fault identified as described.

3.6 Flooding

Flooding hazards include tsunamis (seismic sea waves), Seiches, and failure of manmade reservoirs, tanks and aqueducts. The potential for these hazards is considered "remote" considering the inland site location and absence of any nearby any nearby bodies of water or storage reservoir.

3.7 Landslides

Seismically induced landslides and other slope failures are common occurrences during or soon after an earthquake. Considering that the subject site and its adjacent being relatively flat, it is our opinion that potential for seismically induced landslides should be considered as "remote".

3.8 Lateral Spreading

Seismically induced lateral spreading involves lateral movement of soils due to ground shaking. Lateral spreading is demonstrated by near vertical cracks with predominantly horizontal movement of the soil mass involved. The topography of the site being near level, it is our opinion that the potential for seismically induced lateral spreading should be considered as "remote".

3.9 Seismically Induced Settlement and Subsidence

The site is situated at about 1.56 km from the Elsinore GL+T Fault capable of generating an earthquake magnitude M=7.2 and Peak Ground Acceleration, PGA, of 0.532g. Considering the proximity of the earthquake fault described, it is our opinion that potential for some settlement may be anticipated during life-time use of the structures once built. Although no evaluations are currently made to estimate extents of potential ground settlement, it is our opinion that adverse effects of such on the structures built may be minimized by using appropriate structural deign by using the guidelines presented in the current CBC and that of the requirements of the local public agency as dictates. If and when requested, supplemental settlement analyses may be programmed following additional field explorations and field testing (SPT) using a drillrig.

3.10 Seismic Design Parameters

The design spectrum was developed based on the 2013 CBC. Site Coordinate, of 33.300480°N, -117.238968°W were used to establish the seismic parameters presented below

3.11 Seismic Design Coefficients as per 2013 CBC

The site is situated at about 1.56 km from the Elsinore GL+T Fault. For foundation and structural design, based on the current CBC, the following seismic design parameters are suggested.

Recommended values are based upon USGS Design Maps Summary and Detailed Reports website for Mapped Acceleration Parameters, USGS 2008 National Seismic Hazard Maps-Fault Parameters, and the California Geologic Survey: Probabilistic Seismic Hazards Mapping and supplemental seismic parameters are provided in Appendix C of this report.

The following presents the seismic design parameters as based on available publications as currently published by the California Geological Survey and 2013 CBC

TABLE 3.11A.1 Seismic Design Parameters

CBC Chapter 16 Paragraph/Table	2013 ASCE 7 Standard Seismic Design Parameters	Recommended Values
1613A.5.2	Site Class	C
1613.5.1	The mapped spectral accelerations at short period	S_s
1613.5.1	The mapped spectral accelerations at 1.0-second period	S_1
1613A5.3(1)	Site Class B / Seismic Coefficient, S_s	2.279 g
1613A5.3(2)	Site Class B / Seismic Coefficient, S_1	0.921 g
1613A5.3(1)	Site Class D / Seismic Coefficient, F_a	1.000 g
1613A5.3(2)	Site Class D / Seismic Coefficient, F_v	1.500 g
16A-37 Equation	Spectral Response Accelerations, $S_{Ms} = F_a S_s$	2.279 g
16A-38 Equation	Spectral Response Accelerations, $S_{M1} = F_v S_1$	1.198g
16A-39 Equation	Design Spectral Response Accelerations, $S_{Ds} = 2/3 \times S_{Ms}$	1.519 g
16A-40 Equation	Design Spectral Response Accelerations, $S_{D1} = 2/3 \times S_{Ms}$	0.799 g

TABLE 3.11A.2 Seismic Source Type

Peak Horizontal Ground Acceleration (PHGA) is based on an earthquake having a 10 percent probability of exceedance in a 50 year period.

Seismic Source Type / Appendix C	
Nearest Maximum Fault Magnitude	M>\=7.2
Peak Horizontal Ground Acceleration	0.450g - 0.532g

In design, vertical acceleration may be assumed to about 1/2 of the estimated horizontal ground accelerations described.

It should be noted that lateral force requirement in design by structural engineer should be intended to resist total structural collapse due to the described PHGA or greater. However, during life time use of the structure built, it is our opinion that some structural damage may be anticipated thereby requiring some structural repairs. Adequate structural design and implementation of the current CBC design requirements should be strictly observed. To minimize potentials for rupture during an earthquake, use of flexible lifelines for gas, water, electricity and others, are strongly suggested.

4.0 Recommendations

4.1 General Evaluations

Based on field explorations, laboratory testing and subsequent engineering analysis, the following conclusions and recommendations are presented for the site under study:

(I) From geotechnical viewpoint, the site is considered grossly stable for the proposed development, provided the recommendations supplied herein are incorporated in design and construction. Foundation design should reflect considerations of the seismically induced PHGA as described.

(II) Because of the dry, disturbed, and compressible nature of the upper soils as encountered, it is our opinion that for structural support, the near surface soils should be reworked in form of subexcavations, followed by scarification, moisturization and replacement of the excavated soils to planned grades compacted to minimum 90%. In event new fill soils are required over the current grade surface such should be placed on the prepared subgrades as described.

(III) The subexcavation depth described in the following section should be considered as "minimum". During grading, localized deeper subexcavations may be required within areas underlain by buried debris, utilities and others. It will be the responsibility of the grading contractor to inform the project soils engineer of the presence of such debris or utilities such as septic tank etc.

(IV) In order to minimize potential differential settlements, it is recommended that structural footings should be established exclusively into engineered fills of local soils compacted to the minimum requirements as described in this repor. Construction of footings and slabs straddling over cut/fill transition, shall be avoided.

(V) Structural design consideration should include probability for moderate to high peak ground acceleration from relatively active nearby earthquake faults. Implementing, however, it is our opinion that the adverse effects of ground shaking may be minimized using the design guidelines as described in the current CBC.

(VI) Although no groundwater was encountered within the depths explored, provisions should be maintained during construction to divert incidental rainfall away from the structural pads constructed.

(VII) It is our opinion that, if site preparations and grading are performed as recommended and as per the generally accepted construction practices and current CBC, the proposed development will not adversely affect the stability of the site, or it's adjacent.

4.1.1 Site Preparations (general)

The site preparations within the planned structural pads and beyond should include complete removals of the surficial weed, and scattered debris, followed by subexcavations to the approximate depths as described in his report. Site preparations should also include stock-piling of the subexcavated soils and moisturization of the surface exposed to about 3% to 5% over optimum moisture content, followed by its recompaction prior to the approved stockpile soil replacement as engineered fills compacted to desired pad grades. During grading, the local excavated soils stockpiled should be spread in 6 to 8-inch thick compacted lifts to pad finish grades compacted to minimum 90%.

4.1.2 Preparations for Structural Pads (Specific)

In absence of site-specific grading, topographic or development plan the following general recommendations are provided for "estimation" purposes, subject to revision prior to actual grading and construction.

Considering the upper existing disturbed or loose dry, low density and compressible soils encountered as described, it is recommended that no structural footings and/or paving shall be constructed bearing directly on the near surface soils currently existing. Additionally, "transition" conditions should be allowed underneath footings and slabs straddling over cut and fill subgrades and no rocks larger that 6-inch are diameter should be allowed directly underneath load bearing foundations. Overnight 'flooding' prior to actual site preparations and grading, may be considered..

In absence of precise grading/development plan, it is assumed that the subject development will be located either on (A) near existing grade, or (B) on pads constructed by minor fill soils placement over the current grade surface, or (C) by minor cuts to the grades currently existing.

For the development planned, it is assumed that wood frame and stucco construction will be used using conventional spread footings measuring approximately 12"x12" and 15"x18' for 1-story and 2-story structures, respectively. Actual foundation dimensions should be supplied by the project structural engineer based on static vertical loading and soil bearing capacity, along with the requirements of the current CBC and the seismically induced ground accelerations as described earlier.

The planned site preparations and grading required for structural pads proposed should include (i) subexcavations of the existing soils, (ii) followed by replacement of the same in thin lifts compacted to minimum 90%, or better. For the pads planned at near or on the existing grade surface, site preparations should include subexcavations measuring vertically either to:

A> For the planned pads requiring new structural fill soils placement on existing grades, site preparations prior to new soils placement should include subexcavations of the upper dry and loose soils to (I) *a minimum 5 feet* below the present grade surface, or (II) to the depth of the underlying moist and dense gravelly sandy natural soils, (iii) or to the depth as required to maintain a *24-inch thick compacted fill mat blanket below the planned footing bottoms,* whichever is greater.

B> For the pads requiring "cuts" to the present grades, the site preparations, following such planned cuts, should include further subexcavations of the excavated bottoms to the sufficient depth so as to maintain a minimum 18-inch thick compacted fill mat blanket below the planned footing bottoms, or to the depth as recommended by soils engineer during grading.

C> For cut/fill transition areas, it is recommended that following cuts to planned grade, the cut portions of the pads should be further subexcavated to sufficient depth so as to maintain an overall minimum compacted fill mat blanket as described below:

4.1.3 Cut/Fill Transition Pad Preparations (General)

Cut/fill transitions within structural pads should be avoided to minimize potentials for differential settlements to footings and concrete slab-on-grade where required fill depth exceeds planned footing depth. Within areas of cut-fill transition, it is suggested that following necessary subexavations within cut areas, the entire structural pad should be established on uniform bearing compacted fills with the grading guidelines as described below.

Pad Preparation Guideline for Cut/Fill Transition Areas

Fill Depth Required for Finish Grade (within low-lying areas)	Overexcavation Depth below Finish Grade (within cut areas)
Up to 5 feet	Equal Depth
5 to 10 feet	5 feet
Greater than 10 feet	One-half the maximum thickness of fill placed on the "fill" portion (20 feet maximum)

Cut portions should be over-excavated beyond the structural perimeter lines a horizontal distance equal to the depth of over excavation or to a minimum distance of 5 feet, whichever is greater. Actual subexcavation depths, however, should be determined by soils engineer during grading.

The subexcavation depths described should be considered "approximate". Actual subexcavation depths should be determined in field by the project soils engineer during grading. The site grading procedures described should, in minimum, encompass the planned building footprint areas and five (5) feet beyond. Imported fill soils, if required, should be approved by soils engineer prior to their use.

Supplemental general grading recommendations are provided in Section 5 of this report.

4.1.4 Structural Fill Soils Requirements

(i) Non-expansive in nature, the on-site soils free of organic, debris and rocks larger than 6-inch in diameter, should be considered suitable for re-use as structural backfills.

(ii) Following mass-grading completion, representative site soils sampled from graded fills expected in contact with footings and utilities should be laboratory tested to verify presence of Sulfate, pH, chloride and Resistivity. Based on the chemical test results, supplemental design recommendations will be supplied prior to concrete pour. Such chemical testing will be programmed, if and when requested by the addressee.

4.2 Recommendations for Load Bearing Spread Foundation Design

For the development proposed, use of light-loaded conventional wood frame construction with concrete slab-on-grade and load bearing spread foundations, are anticipated. Structural loadings are assumed within not to exceed 2 klf and 30 kips for continuous wall and isolated pier foundations, respectfully. The one to two-story structures are expected to be supported by continuous wall and/or isolated spread footings founded exclusively into engineered fills of local gravelly sandy soils or its equivalent compacted to minimum 90%.

For design, an allowable soil vertical bearing capacity of 1800 psf may be considered. If normal code requirements are applied, the above capacities may further be increased by an additional 1/3 for short duration of loading which includes the effect of wind and seismic forces.

To minimize potential differential settlements, use of footings straddling over cut/fill transition, shall be avoided. Considering dry gravelly nature, it is recommended that the excavated footing trenches should be sufficiently "moistened" immediately prior to concrete placement.

Considering the presence of the nearby earthquake faults as described earlier, it is recommended that, unless specified otherwise by the project structural engineer, from geotechnical view point, conventional footings may be sized to a minimum 12"x12" and 15"x18" for one and two-story construction, respectively. The footing depths described should be measured vertically from the *lowest adjacent outside grade, and NOT from the finished pad grade or finished floor surface.* Footing depths and dimensions shall be verified by soils engineer prior to footing-forming, rebar and concrete placement.

It will be the contractor's responsibly to arrange footing verification by soils engineer.

Structural design should conform to the current CBC Seismic Design, including the PHGA requirements as described earlier in Section 3.6 of this report.

From Static Loading conditions, footing reinforcements consisting of 2-#4 rebar placed near the top and 2-#4 rebar near bottom of continuous footings, are recommended. Additional reinforcements, as specified by project structural engineer, should be incorporated during construction.

The settlements of properly designed and constructed foundations supported on engineered fill, comprising of site soils or its equivalent or better, and carrying maximum anticipated vertical loadings, are expected to be within tolerable limits. Estimated total and differential settlements are about 1 and 3/4-inch, respectively. Considering the sandy nature of the soils as encountered, it is our opinion that most of the elastic deformations should be expected immediately during construction.

4.3 Concrete Slab-on-Grade

No concrete slabs, sidewalks and flatworks should be placed bearing directly on the surface soils existing. The prepared subgrades to receive footings should be adequate for concrete slab-on-grade placement. Considering the close proximity of earthquake faults, 4-inch thick concrete slabs reinforced with #3 rebar at 18-inch o/c is recommended or as designed by the structural engineer based upon structural loading requirements for the seismic design parameters and for the horizontal peak ground acceleration (PGA) as described in this report. Additionally, concrete slabs must maintain positive contact with footings by use of dowels, or similar means as designed by the project structural engineer.

For driveways, it is our opinion that concrete slabs should be 5-inch thick, placed over local gravelly sandy soils compacted to at least 95%. Driveway slab reinforcing and construction and expansion joints etc. should be incorporated if required by the project structural engineer.

Within moisture sensitive areas, concrete slabs should be underlain by 2-inch of compacted

clean sand, followed by 6-mil thick vapor barrier such as commercially available StegoWrap,

Visqueen or other approved coverings, underlain by an additional 2-inch of approved sand covering. The gravelly sands used underneath concrete slabs should have a Sand Equivalent, SE, of 30 or greater.

Subgrades to receive concrete should be "'dampened" as would be expected in any such concrete placement. Use of low-slump concrete is recommended. In addition, it is recommended that utility trenches underlying concrete slabs and driveways should be thoroughly backfilled with gravelly sandy soils mechanically compacted to minimum 90%. Slab subgrade verification by soils engineer is required prior to vapor barrier placement. No water jetting should be allowed in an effort to compact utility trench backfills.

4.3.1 Concrete Curing

In order to minimize potential for excessive concrete shrinkage or cracking, concrete slabs shall be 'cured' by using water for at least 7 days or as determined by the structural engineer prior to structural load placement.

4.4 Resistance to Lateral Loads

Resistance to lateral loads can be restrained by friction acting at the base of foundation and by passive earth pressure. A coefficient of friction of 0.3 may be assumed with normal dead load forces for footing established on compacted fill.

An allowable passive lateral earth resistance of 250 pounds per square foot per foot of depth may be assumed for the sides of foundations poured against compacted fill. The maximum lateral passive earth pressure is recommended not to exceed 2500 pounds per square foot.

For design, lateral pressures from local soils when used as level backfill may be estimated from the following equivalent fluid density:

Lateral Earth Pressures

CONDITIONS	EQUIVALENT FLUID WEIGHT(pcf)	
	Level Backfill	2:1 Backfill Sloping Upwards
Active	35	55
At Rest	60	73
Passive	250	-

4.5 Swimming Pool (If planned)

For adequate support, it is recommended that the swimming pool shell should be founded exclusively on underlying competent natural subgrade. For design, the following criteria may be considered:

1. Swimming pool full, with no passive resistance;
2. Swimming pool empty, with lateral active pressures from surrounding soils;
3. Swimming pool full, with supported soil surrounding.

With soil vertical bearing capacity of 1800 psf, for design, lateral active pressures and passive resistance in form of "equivalent fluid density" from horizontal backfill, may be considered from the Table 2.0 described.

4.6 Shrinkage and Subsidence

It is our opinion that during grading the upper soils may be subjected to a volume change. Assuming a 90% relative compaction for structural fills and assuming an overexcavation and re-compaction depth as described, such volume change due to shrinkage may be on the order of 10 to 15 percent. Further volume change may be expected due to supplemental shrinkage during preparation of subgrade soils. For estimation purpose, such may be approximated to about 2-inch when conventional construction equipments are used.

4.7 Construction Consideration

4.7.1 Unsupported Excavation

Gravelly sandy site soils encountered are considered highly susceptible to caving. Temporary excavations up to 5 feet may be made without rigorous lateral supports. Excavated surface should be "'wetted" during construction in order to minimize potential surface soil raveling. No surcharge loading should be allowed within an imaginary 1:1 line drawn upward from toe of temporary excavations.

4.7.2 Supported Excavations

If vertical excavations exceeding 5 feet in depths become warranted, such should be achieved using shoring to support sidewalls.

4.8 Soil Caving

Considering dry gravelly in nature, the site soils are considered "highly" susceptible to caving. Temporary excavations in excess of 5 feet should at a slope 2 to 1 (h:v), or flatter, and as per the construction guidelines provided by the Cal-Osha.

4.9 Structural Pavement Thickness (Tentative)

Flexible Asphalt Paving

Anticipating change in soil-matrix following mass grading operation, no actual soil R-value determination is made at this time. Based on estimated Traffic Index (TI) and on assumed soil R-value of 65, the following paving sections are supplied for estimation purposes. Prior to actual paving soil R-value should be determined on samples procured from the planned street grade based on which actual paving sections should be determined to be used. For estimation purposes, the following tentative paving sections may be considered.

Table 3.0 - Preliminary Pavement Design

Preliminary Asphalt Concrete (AC) Pavement Design (Off-Site)	
Assumed Traffic Index	7.0
R-value (assumed)	65
AC Thickness (inches)	4.0*
AB Thickness (inches)	6.5*

Notes: AC - Asphaltic Concrete
AB - Aggregate CLASS II "clean" Base
** Should meet or exceed City of Rancho Cucamonga Minimum Thickness Requirements*

For a.c over base a minimum upper 12-inch of the subgrade soils should be compacted to 90%.

Base material used should conform to Caltrans Class II specification compacted to minimum 95%. Paving sections supplied; should be verified by the City for their minimum pavement thickness requirements.

4.10 Private Concrete Flatwork/Driveways

Concrete flatworks (such as walkways and driveways) have potential for cracking due to fluctuations in soil volume in relationship to moisture content changes. In order to prevent excessive cracking or lifting, concrete paving should meet the minimum guidelines as shown in the table below. It is our opinion that when designed and adequately constructed, the following guidelines will help "reduce" potential for irregular cracking or lifting, but will not eliminate all concrete distress.

	Private Sidewalks	***Private Drives***	***Patios/Entryways***	***City Sidewalk/Curb and Gutters***
Minimum Thickness (in.)	4 (nominal)	4 (full)	4 (full)	City/Agency Standard
Pressoaking (+/-2% Optimum)	12 inches	12 inches	12 inches	City/Agency Standard
Reinforcement	—	No. 3 at 24 inches on centers	No. 3 at 24 inches on centers	City/Agency Standard
Thickness Edge	—	8" x 8"	8" x 8 "	City/Agency Standard
Crack Control	Saw cut or deep open tool joint to a minimum of 1/3 of concrete thickness	Saw cut or deep open tool joint to a minimum of 1/3 of concrete thickness	Saw cut or deep open tool joint to a minimum of 1/3 of concrete thickness	City/Agency Standard
Maximum Joint Spacing	5 feet	10 feet or quarter cut whichever is closer	6 feet	City/Agency Standard

No concrete slabs, sidewalks and flatworks should be placed bearing directly on the surface soils currently existing. The prepared subgrades to receive footings should be adequate for concrete slab-on-grade placement. The maximum density of the base material should be more than its supporting subgrade material.

Unless otherwise specified in this report or by the local public agency, the following guidelines may be considered in subgrade preparations for the paving described:

Type of Compaction	Minimum Required Compaction (%)
Sidewalks,Patios, Paths,Breezeways	90
Concrete Slab	90
Driveways, Parking, Ramps	95
Street/Driveway Subgrade ***with*** base	90
Street/Drive Subgrade ***without*** base	95
Curb and Gutter/V-Gutter ***with*** base	90
Curb and Gutter/V-Gutter ***Without*** base	95
Base and Asphalt	95

Driveway slab reinforcing and construction and expansion joints etc. should be incorporated if required by the project structural engineer.

Within moisture sensitive areas, concrete slabs should be underlain by 2-inch of compacted clean sand, followed by 6-mil thick Visqueen. The gravelly sands used should have a Sand Equivalent, SE, of 30 or greater.

Subgrades to receive concrete should be "pre-moistened" as would be expected in any such concrete placement. Use of low-slump concrete is recommended. In addition, it is recommended that utility trenches underlying concrete slabs and driveways should be thoroughly backfilled with gravelly sandy soils mechanically compacted to minimum 90% (+2 feet below final grade) and 95% (0-2 feet below final grade) immediately prior to concrete pour.

4.11 Boundary Wall/Retaining Wall

It is our opinion that retaining structure, if planned, should be designed based on following parameters:

Slope of Retained Material (H:V)	Equivalent Fluid Density, pcf	
	Clean Sand	Local Soil
level	30	35
2:1	42	55

Walls adjacent to traffic areas should be designed to resist a uniform lateral pressure of 100 pounds per square foot, which is a result of an assumed 300 pounds per square foot surcharge behind the walls due to normal traffic. If the traffic is kept back ten feet from the wall, the traffic surcharge may be neglected. The design parameters do not include any hydrostatic pressure build-up. Consequently, installation of "'french-drain" behind retaining walls is recommended to minimize water pressure build-up behind retaining walls. Use of impervious material is preferred within upper 18 inches of the backfill placed.

Backfill behind retaining wall should be compacted to a minimum 90 percent relative laboratory Maximum Dry Density as determined by the ASTM D15571 test method. Flooding and/or jetting behind wall should not be permitted. Local sandy soils may be used as backfill. Supplemental geotechnical specifications on such will be supplied following construction details review.

4.12 Utility Trench Backfill

Utility trench backfill within the structural pad and beyond should be placed in accordance with the following recommendations:

- Trench backfill should be placed in 6 to 8-inch thin lifts mechanically compacted to 90 percent or better of the laboratory maximum dry density for the soils used. Jetting is not recommended within utility trench backfill. Within streets, upper 2 feet of the trench backfill should be compacted to 95% or better.

- Exterior trenches along a foundation or a toe of a slope and extending below a 1:1 imaginary line projected from the outside bottom edge of the footing or toe of the slope should be compacted to 90 percent of the Maximum Dry Density for the soils used during backfill. Excavations should conform to the requirements of Cal-Osha

4.13 Pre-Construction Meeting

It is recommended that no clearing of the site or any grading operation be performed without the presence of a representative of this office. An on-site pre-grading meeting should be arranged between the soils engineer and the grading contractor prior to any construction.

4.14 Seasonal Limitations

No fill shall be placed, spread or rolled during unfavorable weather conditions. Where the work is interrupted by heavy rains, fill operations shall not be resumed until moisture conditions are considered favorable by the soils engineer.

4.15 Planters

In order to minimize potential differential settlement to foundations, use of planters requiring heavy irrigation *should be restricted from using adjacent to structural footings.* In event such becomes unavoidable, planter boxes with sealed bottoms, should be considered.

4.16 Landscape Maintenance

Only the amount of irrigation necessary to sustain plant life should be provided. Pad drainage should be directed towards streets and to other approved areas away from foundations. Slope areas should be planted with draught resistant vegetation. Over watering landscape areas could adversely affect the proposed site development during its life-time use.

4.17 Observations and Testing During Construction

Recommendations provided are based on the assumption that structural footings and slab-on-grade be established exclusively into compacted fills. Excavated footings should be inspected, verified and certified by soils engineer prior to steel and concrete placement to ensure their sufficient embedment and proper bearing as recommended. Structural backfills discussed should be placed under direct observations and testing by this facility. Excess soils generated from footing excavations should be removed from pad areas and such should not be allowed on subgrades underlying concrete slab.

4.18 Plan Review

No precise grading or development plans are prepared and none such is available for review. Prior to actual mass grading, grading and foundation plans should be available for review to ensure applicability of the assumptions made in preparing this report. If during construction, conditions are observed different from those as presented, revised and/or supplemental recommendations will be required.

5.0 Earth Work Guidelines

The project area is currently underlain with dry loose silty sandy alluviums with minor rocks. Prior to grading commencement, it is suggested that any and all debris and loose stockpiles etc., should be cleared and disposed off of-site to the satisfaction of soils engineer. In general, site preparations and grading for the project should include, in minimum the following:

Structural Backfill:

Local soils free of organic, debris and rocks larger than 6-inch in overall diameter should be considered suitable for reuse as structural backfill. Loose soils, formwork and debris should be removed prior to backfilling retaining walls. Local soils backfill should be placed and compacted in accordance with the recommended specifications provided below. Where space limitations do not allow conventional backfilling operations, special backfill materials and procedures may be required. Pea gravel or other select backfill can be used within limited space areas. Additional recommendations on such will be provided during construction.

Site Drainage:

Adequate positive drainage should be provided maintained away from structural pad in order to prevent water from ponding and to reduce potential percolation into backfill. A desirable slope for surface drainage is 2 percent in landscape areas and 1 percent in paved areas. Planters and landscaped areas adjacent to building perimeter should be adequately designed to minimize water filtration into subsoils. Considerations should be given to the use of closed planter bottoms, concrete slabs and perimeter subdrains where applicable.

Utility Trenches:

Buried utility conduits should be bedded and backfilled around the conduit in accordance with the project specifications. Where conduit underlies concrete slab-on-grade and pavement, the remaining trench backfill above the pipe should be placed and compacted to at least 90%.

General Grading Recommendations:

Recommended general specifications for surface preparation to receive fill and compaction for structural and utility trench backfill and others are presented below.

1. Areas to be graded, backfilled or paved, shall be grubbed, stripped and cleaned of all buried and undetected debris, structures, concrete, vegetation and other deleterious materials prior to grading.

2. Where compacted fill is to provide vertical support for foundations, all loose, soft and other incompetent soils should be removed to full depth as approved by soils engineer, or at least up to the depth as previously described in this report. The areas of such removal should extend at least 5 feet beyond the perimeter of exterior foundation limit or to the extent as approved by soils engineer during grading.

3. The recommended compaction for fill to support foundations and slab-on-grade is 90% of soil's Maximum Dry Density at or near Optimum Moisture Content. To minimize potential differential settlements to foundations and slabs straddling over cut and fill transition, cut portions following cut, should be further over-excavated and such be replaced as engineered fill compacted to at least 90% of the soil's Maximum Dry Density as described in this report.

Utility trenches planned within building pad areas and beyond should be backfilled with granular material and such should be mechanically compacted to at least 90% of the maximum density for the material used. No water jetting shall be allowed for compaction in lieu of mechanical compaction.

4. Compaction for structural fills shall be determined relative to the maximum dry density as determined by ASTM D1557 compaction methods. All in-situ field density of compacted fill shall be determined by the ASTM D1556 standard methods or by other approved procedures.

5. All new imported soils, if required, shall be clean, granular, non-expansive material requiring prior approval by soils engineer.

6. During grading, fill soils shall be placed as thin layers, thickness of which following compaction shall not exceed six inches.

7. In accordance with the CBC; rock sizes greater than 12 inches (305 mm) and up to 24 inches (610 mm) in maximum dimension shall be three feet (914 mm) or more below grade, measured vertically. Rock sizes greater than 24 inches (610 mm) in maximum dimension shall be 10 feet (3048 mm) or more below grade, measured vertically.

8. No jetting and/or water tampering be considered for backfill compaction for utility trenches without prior approval of the soils engineer. For such backfill, hand tampering with fill layers of 8 to 12 inches in thickness or as approved by the soils engineer is recommended.

9. Any and all utility trenches at depth as well as cesspool and abandoned septic tank within building pad area and beyond, should either be completely excavated and removed from the site, or should be backfilled with gravel, slurry or by other material, as approved by soils engineer.

10. Any and all import soils if required during grading should be equivalent to the site soils or better. The soils engineer prior to their use should approve such.

11. Any and all grading required for pavement, side-walk or other facilities to be used by general public, should be constructed under direct observation of soils engineer or as required by the local public agencies.

12. A site meeting should be held between grading contractor and soils engineer prior to actual construction. Two days of prior notice will be required for such meeting.

6.0 Closure

The conclusions and recommendations presented are based on the findings and observations made at the time of subsurface test explorations. However, the recommendations supplied should be considered "preliminary" since they are based upon soil samples only. Supplemental investigations and additional recommendations may be warranted in event the site soils exposed during construction appear different from those as described earlier in this report.

Recommendations provided are based on assumptions that structural footings will be established exclusively into compacted engineered fills. No footings and/or slabs are allowed straddling over cut/fill transition interface.

FOOTING TRENCH EXCAVATIONS AND SLAB SUBGRADES SHALL BE VERIFIED IMMEDIATELY PRIOR TO VAPORT BARRIER COVERING AND CONCRETE POUR. SOILS SOUTHWEST WILL ASSUME NO RESPONSIBILITY OF ANY FUTURE STRUCTURAL DISTRESS IN EVENT THE ABOVE CONDITIONS ARE NOT MET.

This office should review final grading and foundation plans when they become available. Footing excavations should be inspected prior to steel and concrete placement to ensure that foundations are founded into satisfactory soils and excavations are free of loose and disturbed materials. Similar subgrade verifications are recommended prior to concrete slab-on-grade placement.

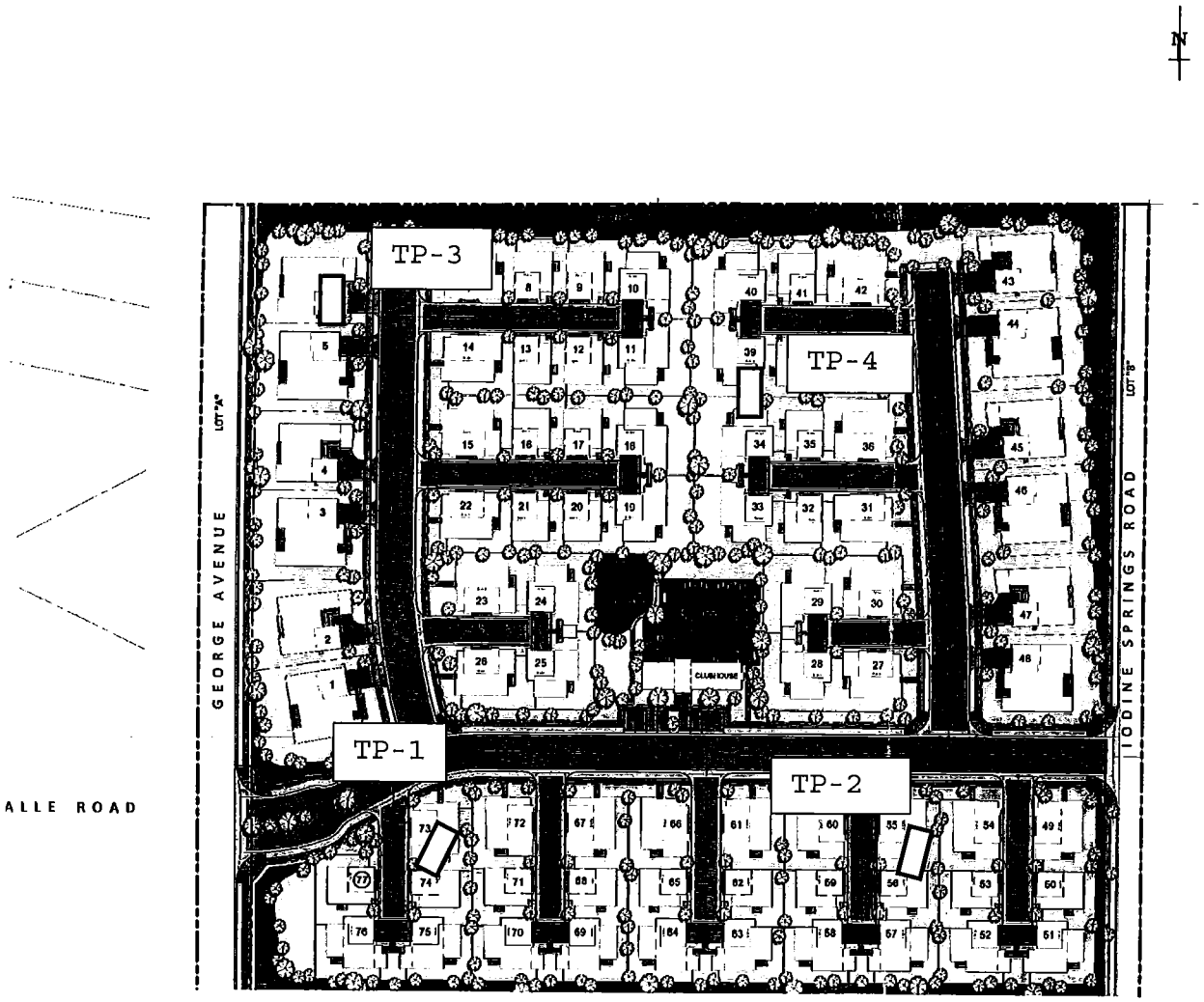
A pregrading meeting between grading contractor and soils engineer is recommended prior to construction preferably at the site, to discuss the grading procedures to be implemented and other requirements described in this report to be fulfilled.

This report has been prepared exclusively for the use of the addressee for the project referenced in the context. It shall not be transferred or be used by other parties without a written consent by Soils Southwest, Inc. We cannot be responsible for use of this report by others without the necessary inspection and testing by our personnel.

Should the project be delayed beyond one year after the date of this report; the recommendations presented shall be reviewed to consider any possible change in site conditions.

The recommendations presented are based on the assumption that a representative of this office will perform the necessary geotechnical observations and testing during construction. The field observations are considered a continuation of the geotechnical investigation performed. If another firm is retained for geotechnical observations and testing, our professional liability and responsibility shall be limited to the extent that Soils Southwest, Inc. would not be the geotechnical engineer of record and a letter of Transfer of Responsibility should be provided accordingly.

PLOT PLAN AND TEST LOCATIONS
(Schematic, Not To Scale)



Legend ▭ TP-1 Approximate Test Trench Explorations Plate 1

7.0 APPENDIX A

Field Explorations

Field evaluations included site reconnaissance and four (4) test trenches using a backhoe. During site reconnaissance, the surface conditions were noted and test exploration locations were determined.

Soils encountered during explorations were logged and such were classified by visual observations in accordance with the generally accepted classification system. The field descriptions were modified, where appropriate, to reflect laboratory test results. Approximate test locations are shown on Plate 1.

Relatively undisturbed soils were sampled using a drive sampler lined with soil sampling rings. The split barrel steel sampler was driven into the bottom of test excavations at various depths. Soil samples were retained in brass rings of 2.5 inches in diameter and 1.00 inch in height. The central portion of each sample was enclosed in a close-fitting waterproof container for shipment to our laboratory. In addition to undisturbed sample, bulk soil samples were procured as described in the logs.

Logs of test explorations are presented in the following summary sheets that include the description of the soils and/or fill materials encountered.

LOG OF TEST EXPLORATIONS

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF TEST PIT TP-1

Project: Marimina, LLC / Nova Homes, Inc.		**Job No.:** 15021-F/BMP
Logged By: John F.	**Boring Diam.:** 18" Bucket	**Date:** June 30, 2015

Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
				SP-SM			SOUTHWEST weeds SAND - dense gray brown to dark gray, semi-cemented fine to medium with silts, pebble,loose, damp
■	6.0	113	86	SP			- Well cemented gravely gray-brown fine to coarse with small piholes, pebbles scattered rock fragments, damp
						5	- No sample recovery - color change to pale yellow gray brown, very dense well cemented slightly silty, traces of caliche fine, damp, small pinholes
						10	- very dense, dg, fine to coarse with silts, rippible soft granite, damp
				SM			SILTY SAND - fine, moist
						15	- End of test trench @ 12.0 ft. - no bedrock - no groundwater
						20	
						25	
						30	

Groundwater: n/a **Approx. Depth of Bedrock:** n/a **Datum:** n/a **Elevation:** n/a	**Site Location** 35775 Iodine Springs Road n/o Clinton Keith Rd. Wildomar, California	**Plate #**

■ California sampler ◥ Bulk/Grab sample

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF TEST PIT TP-2

Project: Marimina, LLC / Nova Homes, Inc.		**Job No.:**	15021-F/BMP
Logged By: John F.	**Boring Diam.:** 18" Bucket	**Date:**	June 30, 2015

Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
				SP-SM			SOUTHEAST weeds
							SAND - gray brown to dark gray, slightly silty, semi-cemented, fine to medium, pebbles, loose, damp
	7.5	114	87	SP		5	- color change to pale yellow brown, cemented, dense, fine to medium coarse, pebbles - color change to pale yellow gray-brown to white, well-cemented, traces of caliche, silts, fine to medium coarse, very dense, dry. slighty porous (small pinholes).
						10	- fine to coarse gravely with rock fragments, very dense, damp - color change to light brown, traces of silt, gravely, coarse to very coarse, moist
						15	- * NR - End of test boring @ 8.0 ft. - no bedrock - no groundwater * NR = No Recovery
						20	
						25	
						30	

Groundwater: n/a **Approx. Depth of Bedrock:** n/a **Datum:** n/a **Elevation:** n/a	**Site Location** 35775 Iodine Springs Road n/o Clinton Keith Rd. Wildomar, California	**Plate #**

California sampler Bulk/Grab sample

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF TEST PIT TP-3

Project: Marimina, LLC / Nova Homes, Inc.		**Job No.:** 15021-F/BMP
Logged By: John F.	**Boring Diam.:** 18" Bucket	**Date:** June 30, 2015

Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
				SP-SM			NORTHWEST weeds, rock, cobbles, scattered boulders
				GP-SP			SAND - brown, slightly silty, fine to medium coarse, pebble, rock fragments
■	10	119	91				- color change to light gray, gravely, medium to coarse, dg, rippible granite, dry
						5	- color change to yellowish light brown very dense, decomposed granite, rippible granite, dry to damp
						10	- Abandoned test trench @ 3.5 ft. due to resistance (very dense granitic material) - bedrock @ +/- 3.0 ft. - no groundwater
						15	
						20	
						25	
						30	

Groundwater: n/a **Approx. Depth of Bedrock:** n/a **Datum:** n/a **Elevation:** n/a	**Site Location** 35775 Iodine Springs Road n/o Clinton Keith Rd. Wildomar, California	**Plate #**

■ California sampler ◥ Bulk/Grab sample

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF TEST PIT TP-4

Project: Marimina, LLC / Nova Homes, Inc.		**Job No.:**	15021-F/BMP
Logged By: John F.	**Boring Diam.:** 18" Bucket	**Date:**	June 30, 2015

Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
				SP-SM			NORTH CENTER weeds
							SAND - light gray brown, gravely, slightly silty, fine to medium coarse, rock fragments, dry
						5	- color change to dark gray to black, slightly silty, traces of clay, fine moist
				SP			- color change to light brown, slightly silty, fine to medium coarse pebbles
							- (Max Density =131 pcf @ 8.5%)
				GP-SP			
						10	- color change to gray, traces of silt, fine to medium coarse, decomposed granite, rippible granite, dry
							- * NR
							- color change to gray-brown with traces of clay, fine to medium, pebbles
						15	
							- gravely medium coarse, decomposed granite, rippible granite
							- End of test trench @ 8.5 ft.
							- bedrock @ +/- 8.0 ft.
						20	- no groundwater
							* NR = No recovery
						25	
						30	

Groundwater: n/a **Approx. Depth of Bedrock:** n/a **Datum:** n/a **Elevation:** n/a	**Site Location** 35775 Iodine Springs Road n/o Clinton Keith Rd. Wildomar, California	**Plate #**

California sampler Bulk/Grab sample

8.0 APPENDIX B

Laboratory Test Programs

Laboratory tests were conducted on representative soils for the purpose of classification and for the determination of the physical properties and engineering characteristics. The number and selection of the types of testing for a given study are based on the geotechnical conditions of the site. A summary of the various laboratory tests performed for the project is presented below.

Moisture Content and Dry Density (D2937):

Data obtained from these test, performed on undisturbed samples are used to aid in the classification and correlation of the soils and to provide qualitative information regarding soil strength and compressibility.

Direct Shear (D3080):

Data obtained from this test performed at increased and field moisture conditions on relatively remolded soil sample is used to evaluate soil shear strengths. Samples contained in brass sampler rings, placed directly on test apparatus are sheared at a constant strain rate of 0.002 inch per minute under saturated conditions and under varying loads appropriate to represent anticipated structural loadings. Shearing deformations are recorded to failure. Peak and/or residual shear strengths are obtained from the measured shearing load versus deflection curve. Test results, plotted on graphical form, are presented on Plate B-1 of this section.

Consolidation (D2835):

Drive-tube samples are tested at their field moisture contents and at increased moisture conditions since the soils may become saturated during life-time use of the planned structure.

Data obtained from this test performed on relatively undisturbed and/or remolded samples, were used to evaluate the consolidation characteristics of foundation soils under anticipated foundation loadings. Preparation for this test involved trimming the sample, placing it in one inch high brass ring, and loading it into the test apparatus which contained porous stones to accommodate drainage during testing. Normal axial loads are applied at a load increment ratio, successive loads being generally twice the preceding.

Soil samples are usually under light normal load conditions to accommodate seating of the apparatus. Samples were tested at the field moisture conditions at a predetermined normal load. Potentially moisture sensitive soil typically demonstrated significant volume change with the introduction of free water. The results of the consolidation tests are presented in graphical forms on Plate B-2.

Laboratory Test Results

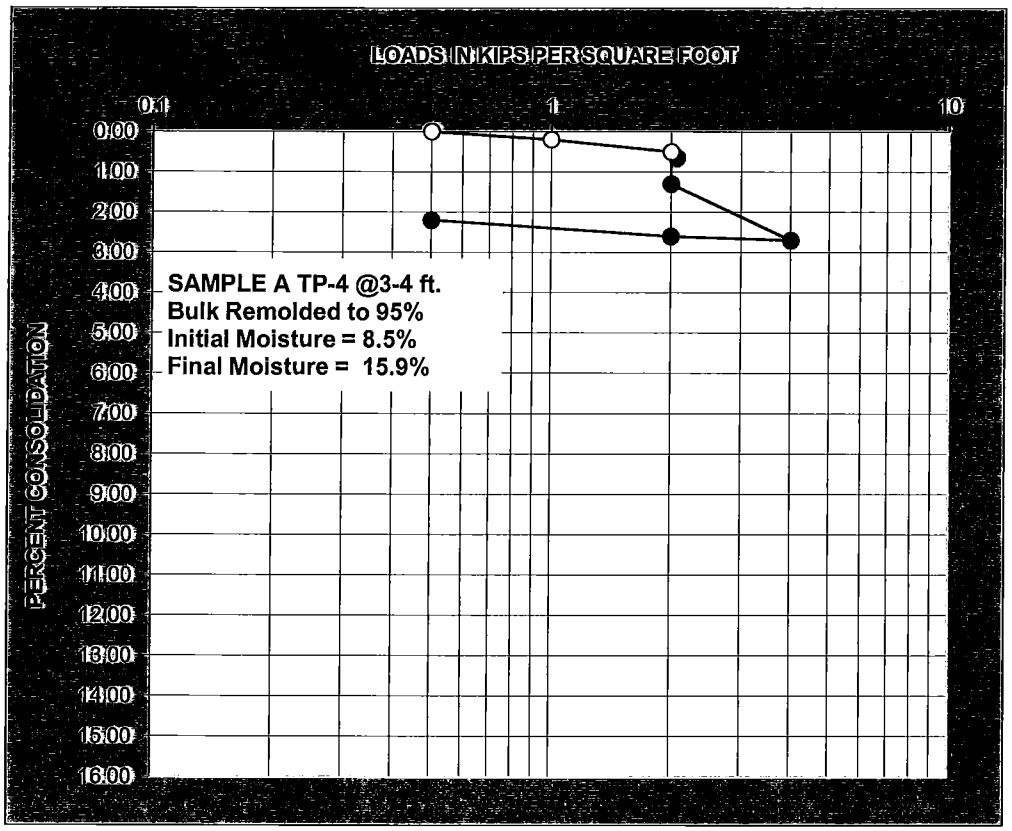
A. Table I: In-Situ Moisture-Density (ASTM D2937)

Test Boring No.	Sample Depth, ft.	Dry Density, pcf.	Moisture Content, %
1	3.0	113.3	7.69

B. Table II: Max. Density/Optimum Moisture Content (ASTM D1557)

Sample Location	Max. Dry Density, pcf	Opt. Moisture (%)
TP-1 @ 3-4 ft.	131	8.5

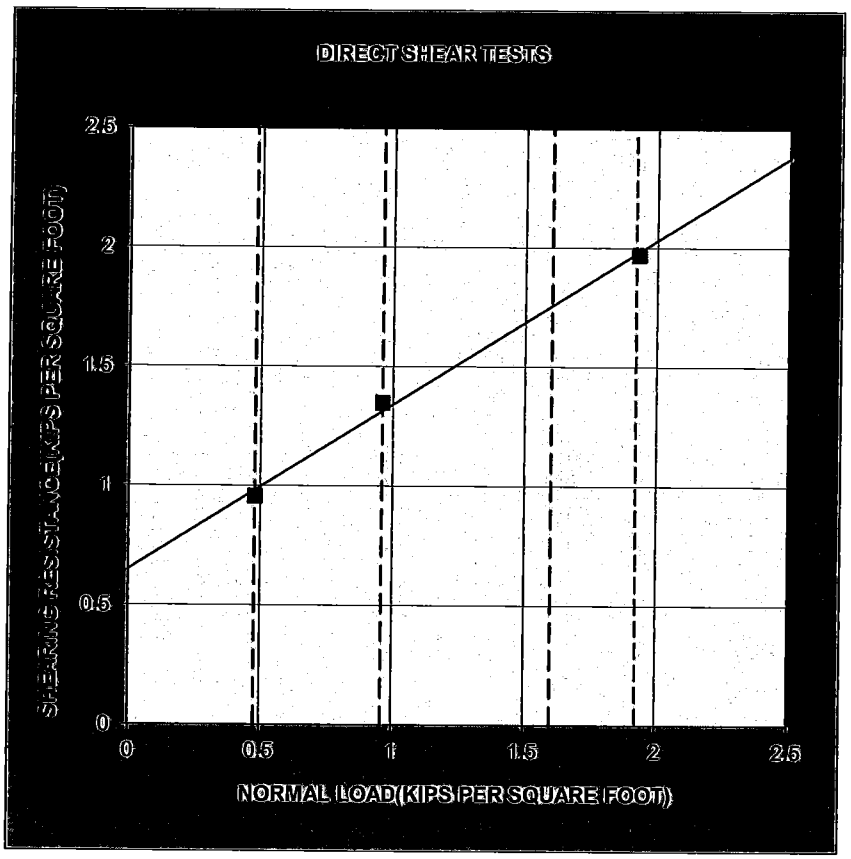
CONSOLIDATION TESTS



- **WATER PERMITTED TO CONTACT SAMPLE**

PROJECT	Marimina LLC / Nova Homes, Inc. 35775 Iodine Springs Road, Wildomar		
PROJECT NO.	15021-F	PLATE	B-2b

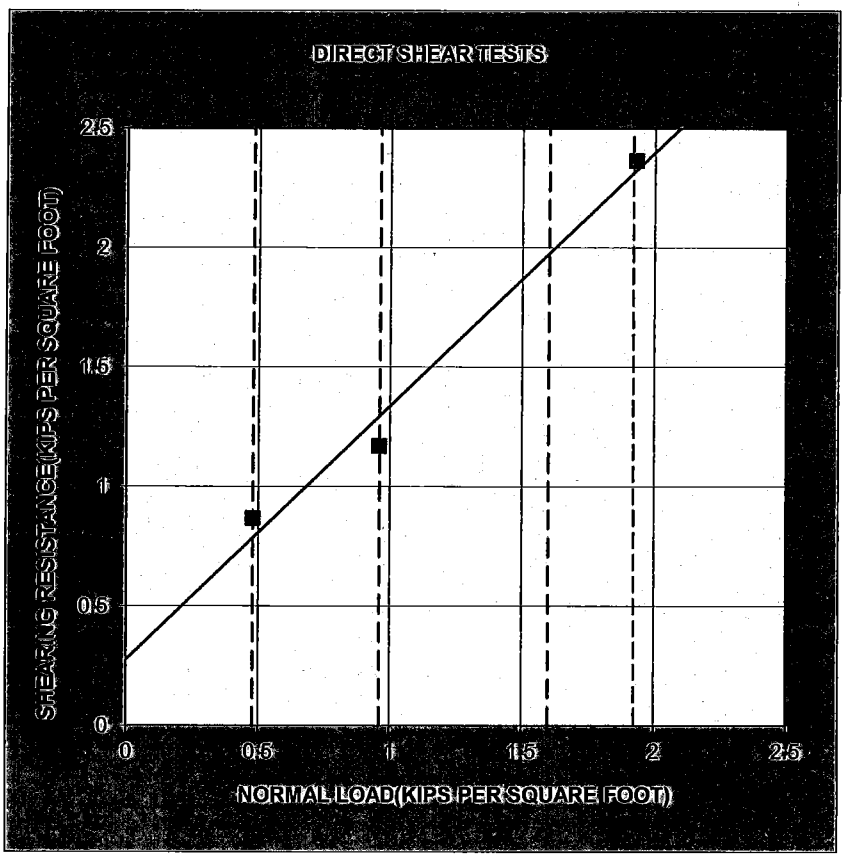
SOILS SOUTHWEST INC.
Consulting Foundation Engineers



SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	TP-4	3 to 4	Remolded to 90% Residual	650.08	34.63

Marimina, LLC / Nova Homes, Inc. 35775 Iodine Springs Road Wildomar, California	PROJECT NO.	15021-F
	PLATE	B-1a

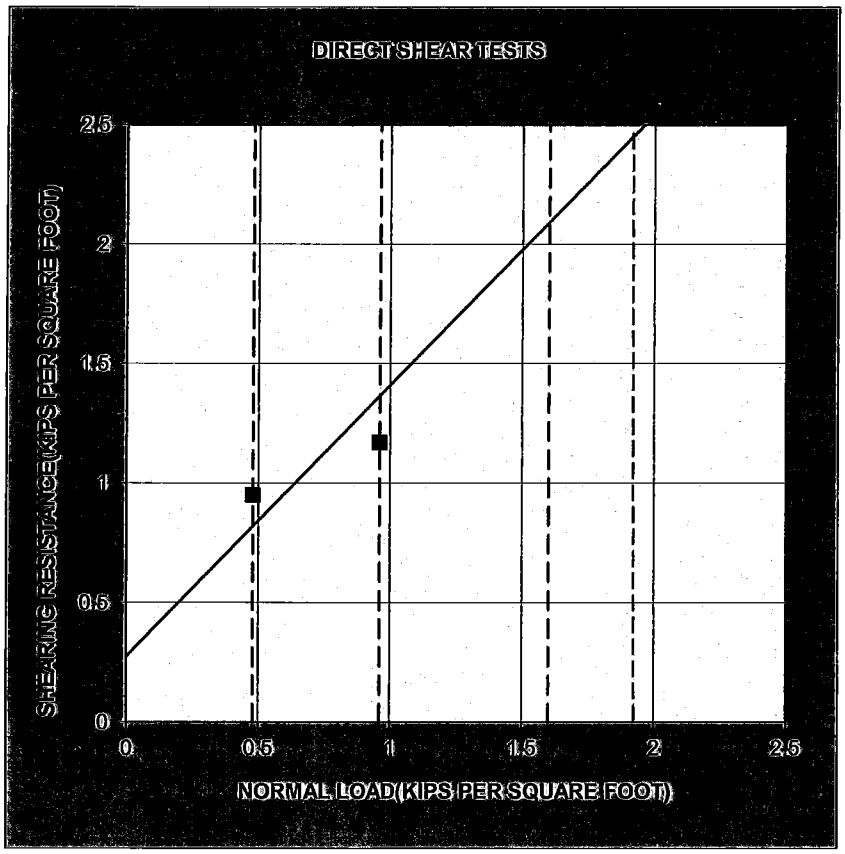
SOILS SOUTHWEST, INC.
Consulting Foundation Engineers



SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	TP-4	3 to 4	Remolded to 95% Residual	275.38	46.71

Marimina, LLC / Nova Homes, Inc. 35775 Iodine Springs Road Wildomar, California	PROJECT NO.	15021-F
	PLATE	B-1-1a

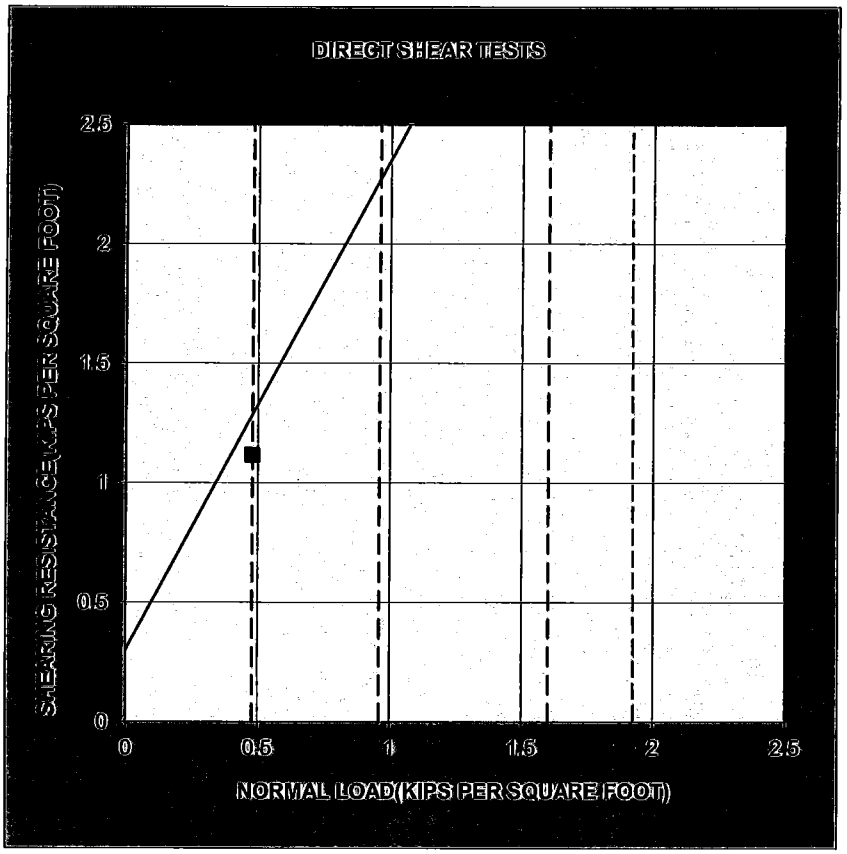
SOILS SOUTHWEST, INC.
Consulting Foundation Engineers



SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	TP-4	3 to 4	Remolded to 95% Peak	275.00	48.62

Marimina, LLC / Nova Homes, Inc. 35775 Iodine Springs Road Wildomar, California	PROJECT NO.	15021-F
	PLATE	B-1-1b

SOILS SOUTHWEST, INC.
Consulting Foundation Engineers

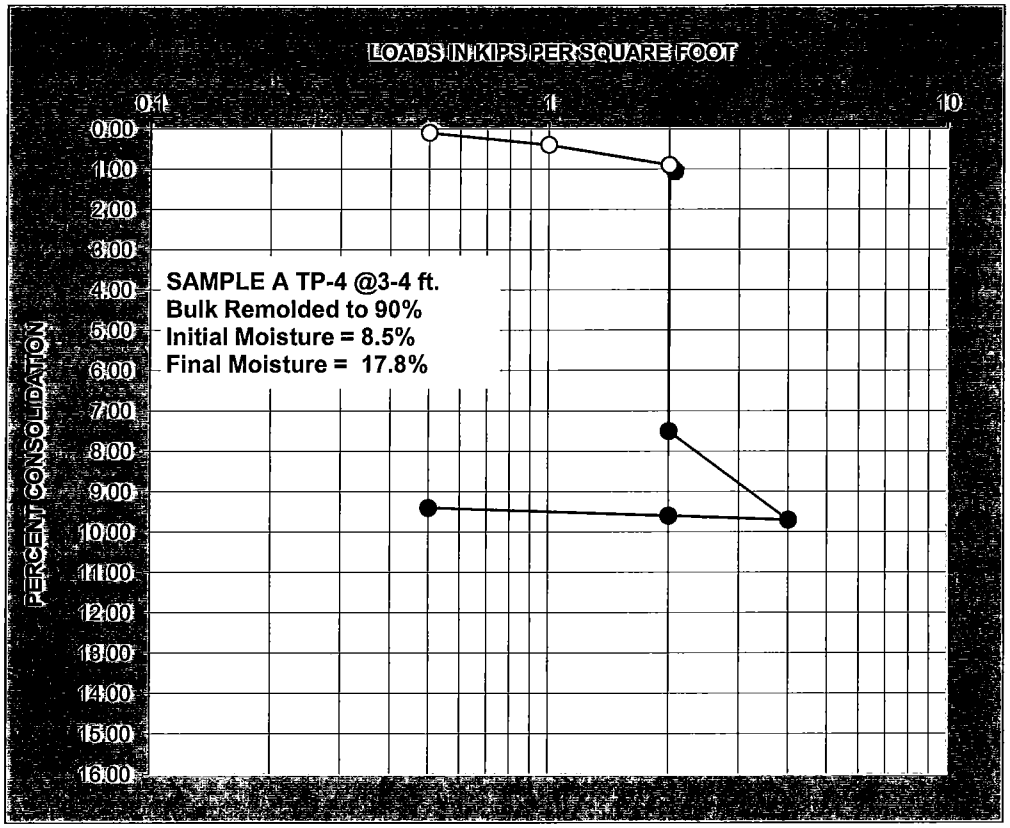


SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	TP-1	3 to 5	Remolded to 90% Residual	300.37	64.02

Marimina, LLC / Nova Homes, Inc. **35775 Iodine Springs Road** Wildomar, California	PROJECT NO.	15021-F
	PLATE	B-1-1

SOILS SOUTHWEST, INC.
Consulting Foundation Engineers

CONSOLIDATION TESTS

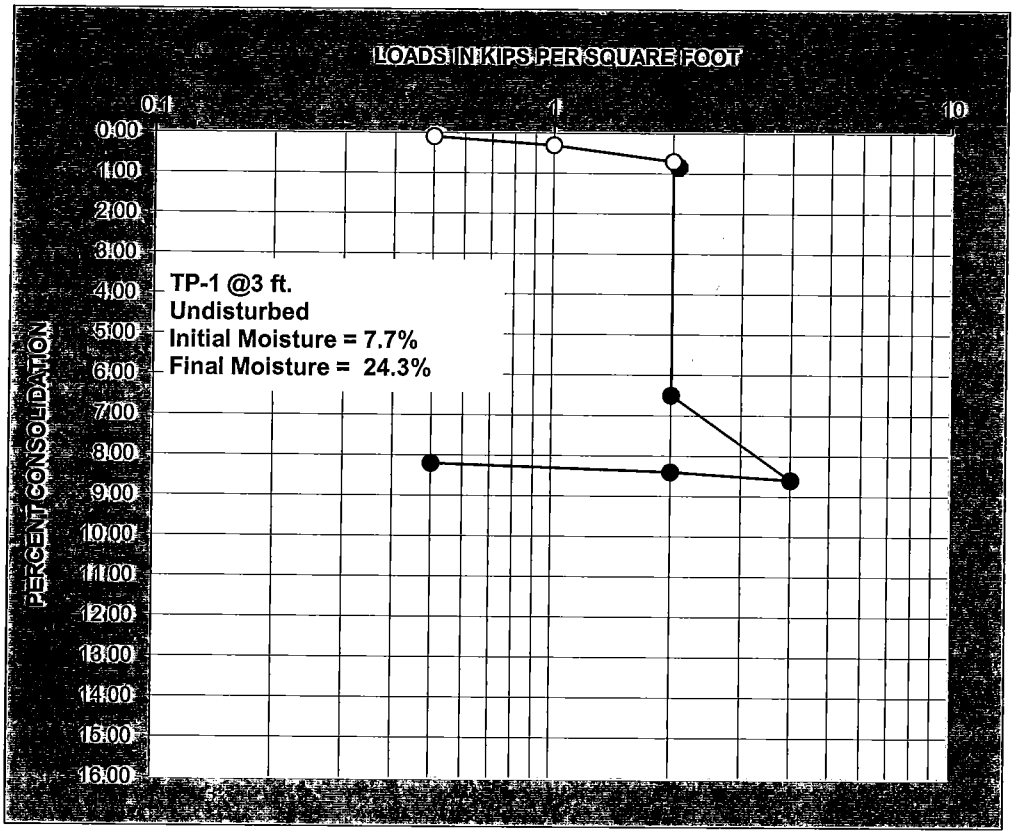


- **WATER PERMITTED TO CONTACT SAMPLE**

PROJECT	Marimina LLC / Nova Homes, Inc. 35775 Iodine Springs Road, Wildomar		
PROJECT NO.	15021-F	PLATE	B-2

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

CONSOLIDATION TESTS



- **WATER PERMITTED TO CONTACT SAMPLE**

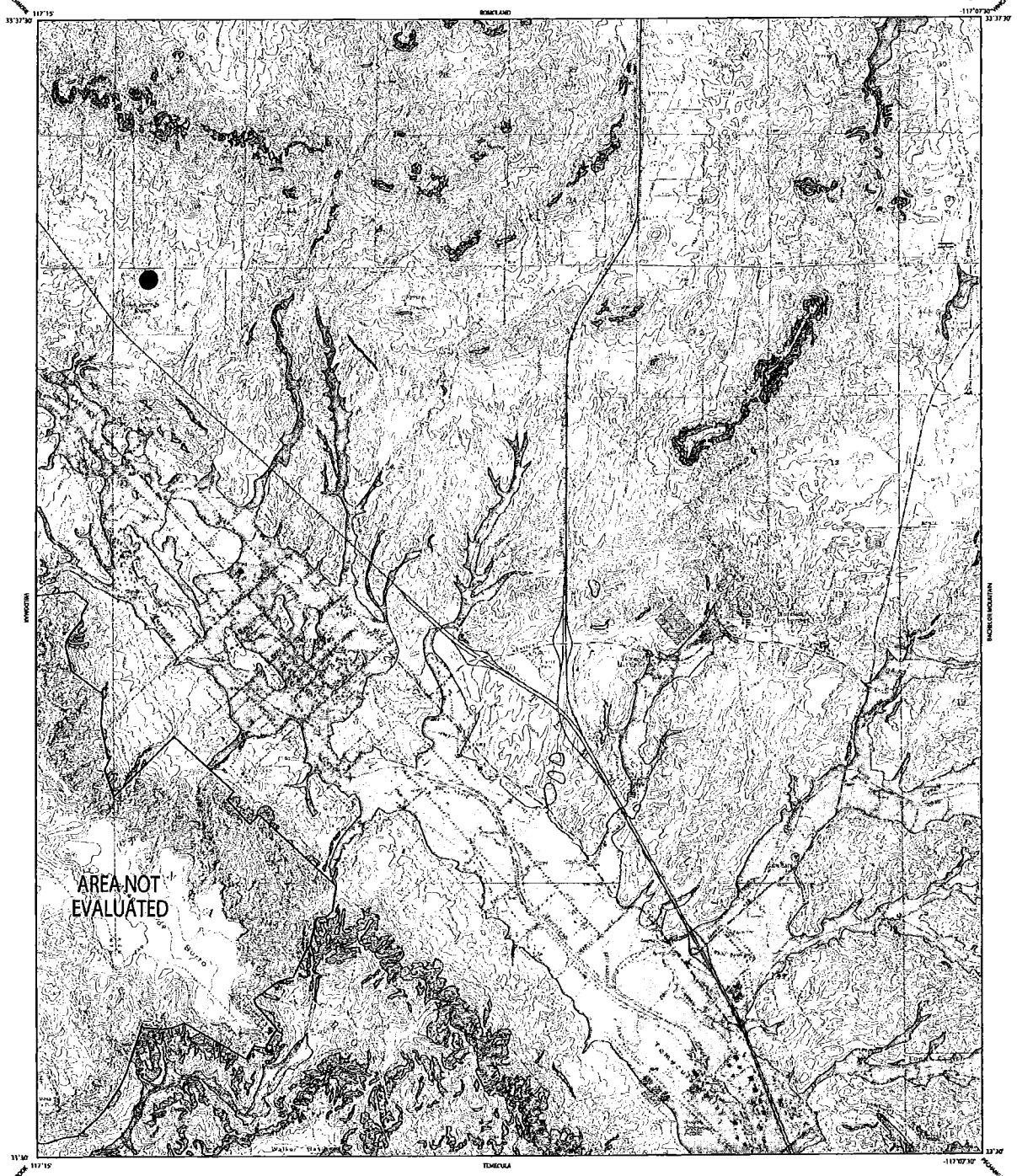
PROJECT	Marimina LLC / Nova Homes, Inc. 35775 Iodine Springs Road, Wildomar		
PROJECT NO.	15021-F	PLATE	B-2-1

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

APPENDIX C

Supplemental Seismic Design Parameters

As per 2013 CBC



Base Map prepared by U.S. Geological Survey, 1953, photorevised 1978.
Zones of required investigation boundaries may reflect updated digital topographic data that can differ significantly from contours shown on the base map.

PURPOSE OF MAP

This map will assist cities and counties in fulfilling their responsibilities for protecting the public from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).

For information regarding the general approach and recommended methods for preparing this map, see California Geological Survey Special Publication 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California.*

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see California Geological Survey Special Publication 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California.*

For a general description of the Seismic Hazard Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the website at www.conservation.ca.gov/cgs/.

1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.

2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosure and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and an index to available maps, see DMG Special Publication 42.

4) Landslide zones on this map were determined, in part, by adapting methods originally developed by the U.S. Geological Survey (USGS). Landslide hazard maps prepared by the USGS typically use experimental approaches to assess earthquake-induced and other types of landslide hazards. Although aspects of these new methodologies may be incorporated in future California Geological Survey (CGS) seismic hazard zone maps, USGS maps should not be used as substitutes for these Official SEISMIC HAZARD ZONES maps.

5) U.S. Geological Survey base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) in the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted here been drawn as accurately as possible at this scale.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 3 of the Public Resources Code.

7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

SCALE 1:24,000

STATE OF CALIFORNIA

California Geological Survey

SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8, Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

MURRIETA QUADRANGLE

OFFICIAL MAP

Released: December 5, 2007

STATE GEOLOGIST

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides

Areas where previous occurrence of landslide movement, or local topographic, geologic, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

NOTE: Seismic Hazard zones identified on this map may include developed land where deliniated hazards have already been mitigated to city or county standards. Check with your local building/planning department for information regarding the location of such mitigated areas.

DATA AND METHODOLOGY USED TO DEVELOP THIS MAP ARE PRESENTED IN THE FOLLOWING:

Seismic Hazard Zone Report of the Murrieta 7.5-minute Quadrangle, Riverside County, California: California Geological Survey, Seismic Hazard Zone Report 113.

For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to:
www.consrvmon.ca.gov/cgs/shzp/

California Geological Survey
Geologic Information and Publications
801 K Street, MS 14-34
Sacramento, CA 95814-3533
(916) 445-5716
www.consrvmon.ca.gov/cgs

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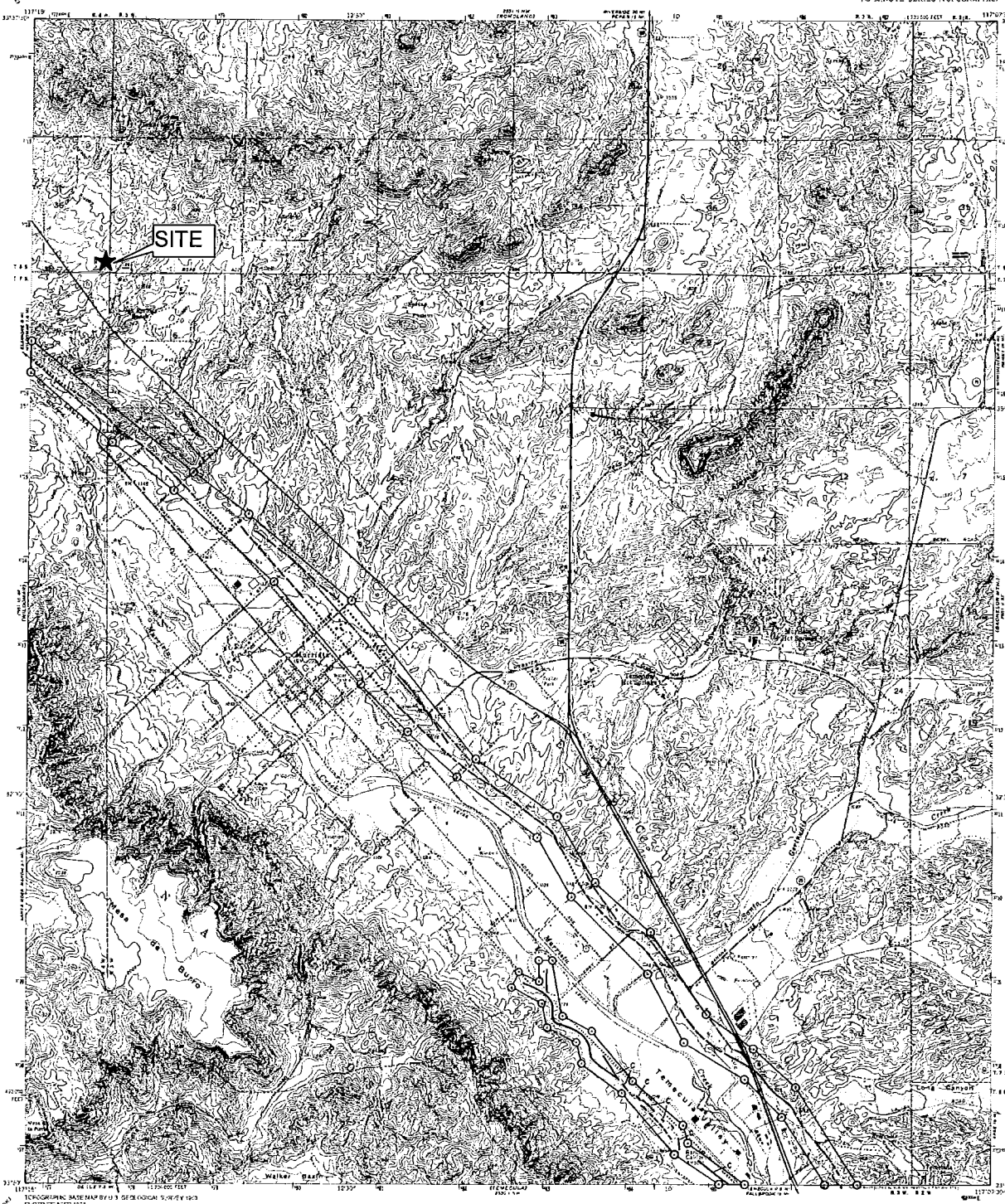
DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY
DEPARTMENT OF CONSERVATION—RANDALL M. WARD DIRECTOR

MURRIETA QUADRANGLE
CALIFORNIA—RIVERSIDE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY 1953
PHOTO REVISED 1973

Mapped, edited, and published by the Geological Survey

Control by NGS, USC&GS, and USGS

Topography from aerial photographs by multiplex method and by plane table survey 1953. Aerial photographs taken 1951

Projection is polyconic. 1927 North American datum
10,000-foot grid based on California coordinate system, zone 6

Dotted lines represent approximate contours

Underlined elevations are shown in feet

1000-meter Universal Transverse Mercator grid ticks, zone 11, shown in blue

MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION
1974, 2000, AND 2010
SEE MAP ON AT CENTER OF SHEET

SCALE 1:24,000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DASHED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U.S. Route — State Route

QUADRANGLE LOCATION

STATE OF CALIFORNIA
SPECIAL STUDIES ZONES

Delineated in compliance with
Chapter 7.5, Division 2 of the California Public Resources Code
(Alquist-Priolo Special Studies Zones Act)

Murrieta Quadrangle

REVISED OFFICIAL MAP

Effective: January 1, 1990

James F. Davis State Geologist

MAP EXPLANATION

Active Faults

906 C — Faults considered to have been active during Holocene time and to have a relatively high potential for surface rupture; solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed, query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by creep or possible creep.

Special Studies Zone Boundaries

These are delineated as straight-line segments that connect encircled turning points so as to define special studies zone segments.

Seaward projection of zone boundary.

REFERENCES USED TO COMPILE FAULT DATA

Murrieta Quadrangle

Kennedy, M.P., 1977, Recency and character of faulting along the Elsinore fault zone in southern Riverside County, California: California Division of Mines and Geology Special Report 131, 12 p.

Rockwell, D.L., 1988, Earthquake hazard along faults in Riverside County, California: California Division of Mines and Geology Fault Evaluation Report FER-180 and supplemental geologic study.

Weber, F.J., 1986, Ground mapping in Wolf and Temecula Valleys, Riverside County: Division of Mines and Geology Fault Evaluation Report FER-156 (unpublished).

For additional information on faults in the map area, the references used for zoning, and additional references cited, refer to Unpublished Fault Evaluation Reports on file at our office and offices of CGS.

IMPORTANT – PLEASE NOTE

1) *This map may not show all faults that have the potential for surface fault rupture either within the special studies zones or outside their boundaries.*
2) Faults shown are the basis for establishing the boundaries of the special studies zones.
3) The identification and location of these faults are based on the best available data. However, the quality of data used is varied. Traces have been drawn as accurately as possible at this map scale.
4) Fault information on this map is not sufficient to serve as a substitute for the geologic site investigations (special studies) required under Chapter 7.5 of Division 2 of the California Public Resources Code.

USGS science for a changing world

Earthquake Hazards Program

2008 National Seismic Hazard Maps - Source Parameters

Output Selected Faults (Excel)

Output	Distance in Kilometers	Name	St Fault parallel slip rate	Preferred Dip (degrees)	Dip Dir	Slip Sense	Rupture Top (km)	Rupture Bottom (km)	Length (km)
☑	1.56	Elsinore;GI+T	CA5	90	V	strike slip	0		78
☑	1.56	Elsinore;GI+T+J	CA	86	NE	strike slip	0		153
☑	1.56	Elsinore;GI+T+J+CM	CA	86	NE	strike slip	0		195
☑	1.56	Elsinore;T	CA5	90	V	strike slip	0		52
☑	1.56	Elsinore;T+J	CA	86	NE	strike slip	0		127
☑	1.56	Elsinore;T+J+CM	CA	85	NE	strike slip	0		169
☑	1.56	Elsinore;W+GI+T	CA	84	NE	strike slip	0		124
☑	1.56	Elsinore;W+GI+T+J	CA	84	NE	strike slip	0		200
☑	1.56	Elsinore;W+GI+T+J+CM	CA	84	NE	strike slip	0		242
☑	4.44	Elsinore;GI	CA5	90	V	strike slip	0		37
☑	4.44	Elsinore;W+GI	CA	81	NE	strike slip	0		83
☑	30.96	San Jacinto;A	CA9	90	V	strike slip	0		71
☑	30.96	San Jacinto;A+C	CA	90	V	strike slip	0		118
☑	30.96	San Jacinto;A+CC	CA	90	V	strike slip	0		118
☑	30.96	San Jacinto;A+CC+B	CA	90	V	strike slip	0.1		152
☑	30.96	San Jacinto;A+CC+B+SM	CA	90	V	strike slip	0.1		178
☑	32.55	San Jacinto;SBV+SJV+A	CA	90	V	strike slip	0		134
☑	32.55	San Jacinto;SBV+SJV+A+C	CA	90	V	strike slip	0		181
☑	32.55	San Jacinto;SBV+SJV+A+CC	CA	90	V	strike slip	0		181
☑	32.55	San Jacinto;SBV+SJV+A+CC+B	CA	90	V	strike slip	0.1		215
☑	32.55	San Jacinto;SBV+SJV+A+CC+B+SM	CA	90	V	strike slip	0.1		242
☑	32.55	San Jacinto;SJV+A	CA	90	V	strike slip	0		89
☑	32.55	San Jacinto;SJV+A+C	CA	90	V	strike slip	0		136
☑	32.55	San Jacinto;SJV+A+CC	CA	90	V	strike slip	0		136
☑	32.55	San Jacinto;SJV+A+CC+B	CA	90	V	strike slip	0.1		170
☑	32.55	San Jacinto;SJV+A+CC+B+SM	CA	90	V		0.1		196

Earthquake Hazards Program

2008 National Seismic Hazard Maps - Source Parameters

New Search

Fault Name	State
Elsinore;GI+T	California

MODEL VALUES

Fault parallel slip rate	5.00
Probability of activity	1

	ELLSWORTH	HANKS
Minimum magnitude	6.5	6.5
Maximum magnitude	7.288	7.187

FAULT GEOMETRY

Dip (degrees)	90
Dip direction	V
Sense of slip	strike slip
Rupture top (km)	0
Rupture bottom (km)	14
Rake (degrees)	180
Length (km)	78

Fault Model	Deformation Model	Char Mag[1]	Char Rate[1]	Apriori Rate	Weight
Moment Balanced	2.1	7.288/7.187	1.35e-04/ 1.35e-04	9.62e-04	0.5

[1] 1st Value is based on Ellsworth relation and 2nd value is based on Hanks and Bakun relation

Earthquake Hazards Program

Oops! — File Not Found (404)

Did you follow a link on our website?

If you reached this page from another part of earthquake.usgs.gov, please use our Contact Form so we can correct our mistake.

Did you follow a link from another website?

Please check our site map at the bottom of any of our webpages or Search our website to find the page's new location. Do not send us an email about the broken link because it's not on our site, and we can't fix it.

Did you type the URL?

You may have typed the address (URL) incorrectly. Check to make sure you have the correct spelling, capitalization, etc.

California Geological Survey

submit

Search This Site

Probabilistic Seismic Hazards Mapping Ground Motion Page

User Selected Site

Longitude	-117.239
Latitude	33.6005

Ground Motions for User Selected Site

Ground motions (10% probability of being exceeded in 50 years) are expressed as a fraction of the acceleration due to gravity (g). Three values of ground motion are shown, peak ground acceleration (Pga), spectral acceleration(Sa) at short (0.2 second) and moderately long (1.0 second) periods. Ground motion values are also modified by the local site soil conditions. Each ground motion value is shown for 3 different site conditions: firm rock (conditions on the boundary between site categories B and C as defined by the building code), soft rock (site category C) and alluvium (site category D).

Ground Motion	Firm Rock	Soft Rock	Alluvium
Pga	0.532	0.532	0.532
Sa 0.2 sec	1.24	1.24	1.245
Sa 1.0 sec	0.457	0.55	0.632

NEHRP Soil Corrections were used to calculate Soft Rock and Alluvium.
Ground Motion values were interpolated from a grid (0.05 degree spacing) of calculated values. Interpolated ground motion may not equal values calculated for a specific site, therefore these values are not intended for design or analysis.

USGS Design Maps Summary Report

User-Specified Input

Report Title Marimina, LLC/Nova Homes, Inc., 35775 Iodine Springs Road, Wildomar, CA

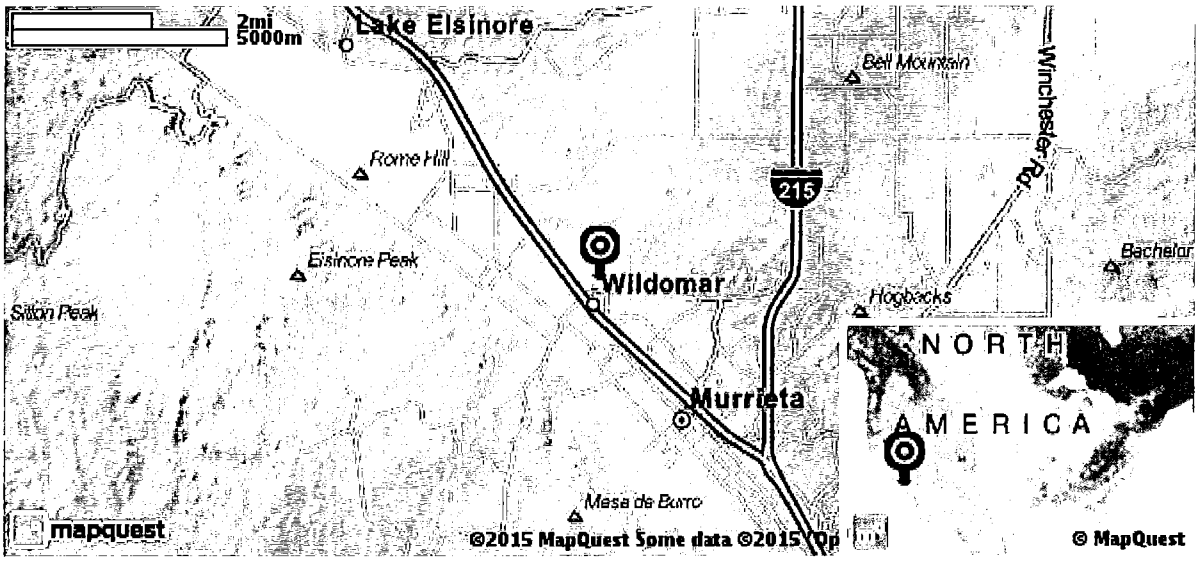
Tue June 23, 2015 21:32:12 UTC

Building Code Reference Document ASCE 7-10 Standard
(which utilizes USGS hazard data available in 2008)

Site Coordinates 33.60048°N, 117.23897°W

Site Soil Classification Site Class C – "Very Dense Soil and Soft Rock"

Risk Category I/II/III

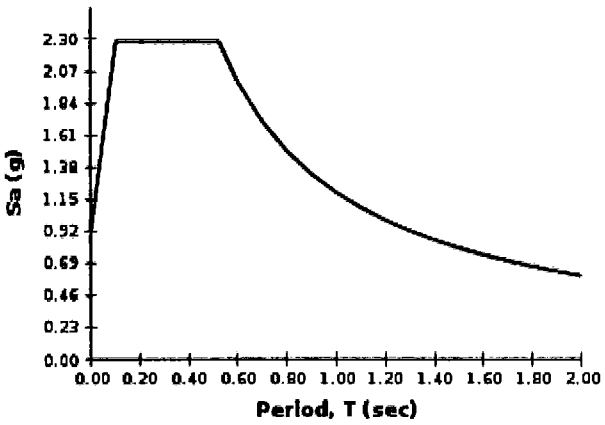


USGS-Provided Output

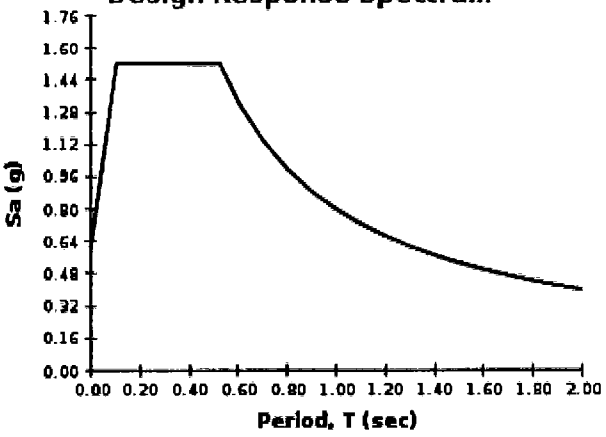
S_S =	2.279 g	S_{MS} =	2.279 g	S_{DS} =	1.519 g
S_1 =	0.921 g	S_{M1} =	1.198 g	S_{D1} =	0.799 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



USGS Design Maps Detailed Report

ASCE 7-10 Standard (33.60048°N, 117.23897°W)

Site Class C – "Very Dense Soil and Soft Rock", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1] $S_S = 2.279$ g

From Figure 22-2 [2] $S_1 = 0.921$ g

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class C, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index $PI > 20$, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4-1: Site Coefficient F_a

Site Class	Mapped MCE_R Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_S

For Site Class = C and S_S = 2.279 g, F_a = 1.000

Table 11.4-2: Site Coefficient F_v

Site Class	Mapped MCE_R Spectral Response Acceleration Parameter at 1-s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_1

For Site Class = C and S_1 = 0.921 g, F_v = 1.300

Equation (11.4-1): $S_{MS} = F_a S_S = 1.000 \times 2.279 = 2.279$ g

Equation (11.4-2): $S_{M1} = F_v S_1 = 1.300 \times 0.921 = 1.198$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

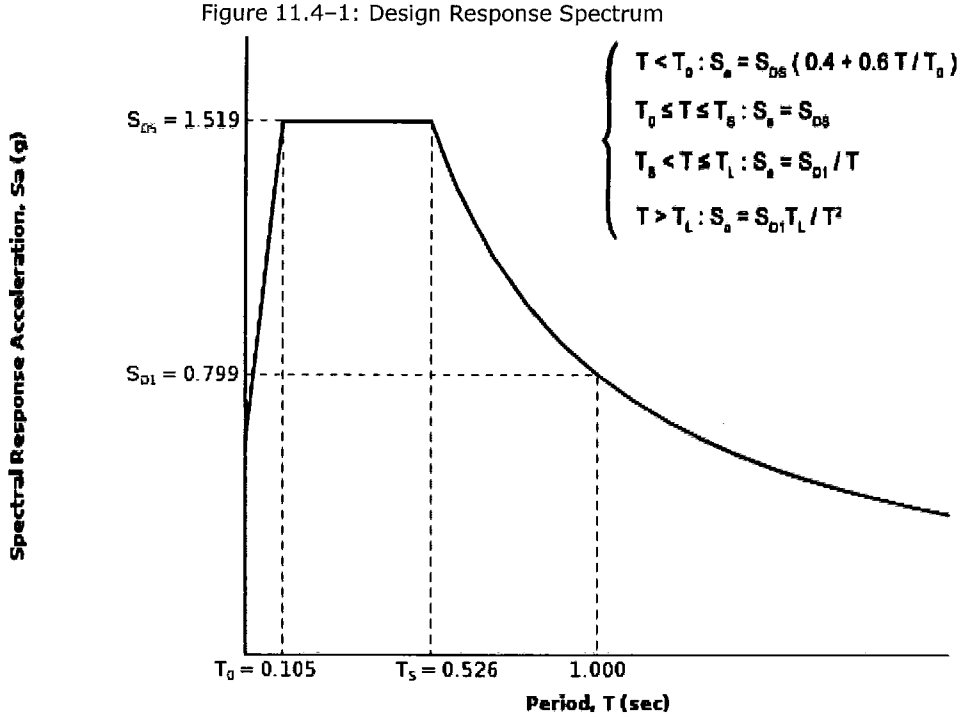
Equation (11.4-3): $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 2.279 = 1.519$ g

Equation (11.4-4): $S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 1.198 = 0.799$ g

Section 11.4.5 — Design Response Spectrum

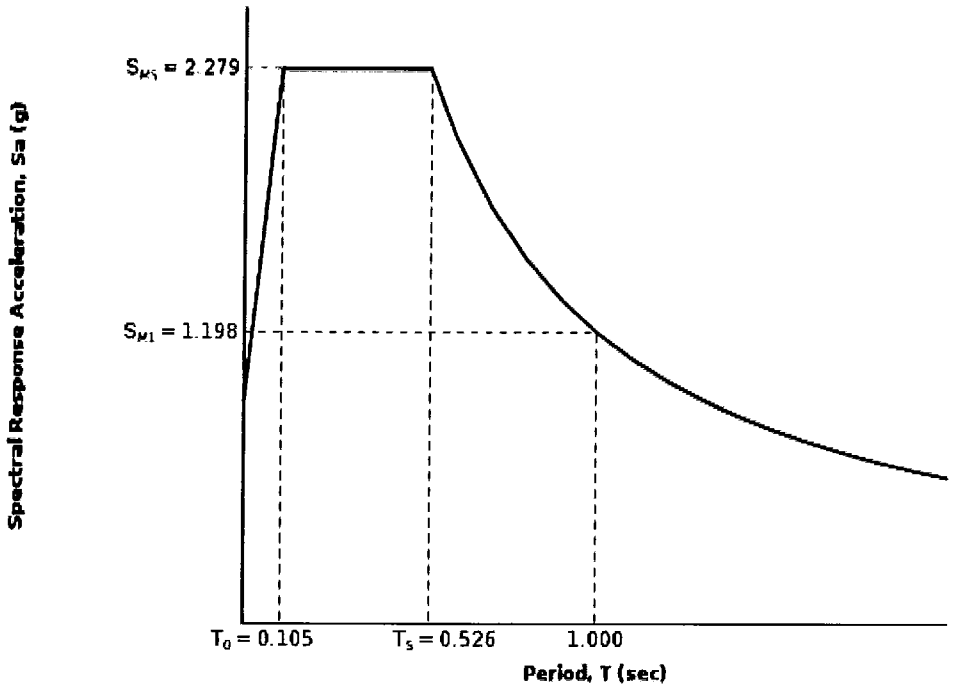
From Figure 22-12 [3] $T_L = 8$ seconds

Figure 11.4-1: Design Response Spectrum



Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4] PGA = 0.906

Equation (11.8-1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.906 = 0.906$ g

Table 11.8-1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of PGA

For Site Class = C and PGA = 0.906 g, F_{PGA} = 1.000

Section 21.2.1.1 — Method 1 (from Chapter 21 - Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] C_{RS} = 0.911

From Figure 22-18 [6] C_{R1} = 0.897

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.519 g, Seismic Design Category = D

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.799 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 11.6-1 or 11.6-2" = E

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 22-1*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

PROFESSIONAL LIMITATIONS

Our investigation was performed using the degree of care and skill ordinarily exercised, under similar circumstances by other reputable Soils Engineers practicing in these general or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

The investigations are based on soil samples only, consequently the recommendations provided shall be considered "preliminary'. The samples taken and used for testing and the observations made are believed representative of site conditions; however, soil and geologic conditions can vary significantly between test excavations. If this occurs, the Project Soils Engineer must evaluate the changed conditions, and designs adjusted as required or alternate design recommended.

The report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are brought to the attention of the project architect and engineers. Appropriate recommendations should be incorporated into structural plans. The necessary steps should be taken to see that out such recommendations in field.

The findings of this report are valid as of this present date. However, changes in the conditions of a property can occur with the passage of time, whether they due to natural process or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur from legislation or broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by change outside of our control. Therefore, this report is subject to review and should be updated after a period of one year.

RECOMMENDED SERVICES

The review of grading plans and specifications, field observations and testing by a geotechnical representative of this office is integral part of the conclusions and recommendations made in this report. If Soils Southwest, Inc. (SSW) is not retained for these services, the Client agrees to assume SSW's responsibility for any potential claims that may arise during and after construction, or during the life-time use of the structure and its appurtenants.

The recommendations supplied should be considered valid and applicable, provided the following conditions, in minimum, are met:

i. Pre-grade meeting with contractor, public agency and soils engineer,
ii. Excavated bottom inspections and verification s by soils engineer prior to backfill placement,
iii. Continuous observations and testing during site preparation and structural fill soils placement,
iv. Observation and inspection of footing trenching prior to steel and concrete placement,
v. Subgrade verifications including plumbing trench backfills prior to concrete slab-on-grade placement,
vi. On and off-site utility trench backfill testing and verifications,
vii. Precise-grading plan review, and
viii. Consultations as required during construction, or upon your request.

Soils Southwest, Inc. will assume no responsibility for any structural distresses during its life-time use; in event the above conditions are not strictly fulfilled.

SOILS SOUTHWEST, INC.

SOILS, MATERIALS AND ENVIRONMENTAL ENGINEERING CONSULTANTS

897 VIA LATA, SUITE N • COLTON, CA 92324 • (909) 370-0474 • (909) 370-0481 • FAX (909) 370-3156

Report of Water Infiltration Rate
Proposed WQMP-BMP Stormwater Detention Basin Design
Soils Percolation Testing Using Double-Ring Infiltrometer
Planned 11+ac. 77-lot Residential Development
35775 Iodine Springs Road
City of Wildomar
Riverside County, California
APN: 362-250-001 & 362-250-026

Project No. 15021-BMP
July 21, 2015

Prepared for:

Mr. Raffaele Suprano, CFO
% Marimina LLC.
245 Fischer Avenue, Suite A-8A
Costa Mesa, CA 92626

soilssouthwest@gmail.com
Established 1984

SOILS SOUTHWEST, INC.

SOILS, MATERIALS AND ENVIRONMENTAL ENGINEERING CONSULTANTS

897 VIA LATA, SUITE N • COLTON, CA 92324 • (909) 370-0474 • (909) 370-0481 • FAX (909) 370-3156

July 21, 2015 Project No. 15021-BMP

Nova Homes, Inc.
% Marimina LLC.
245 Fischer Avenue, Suite A-8A
Costa Mesa, CA 92626

Attention: Mr. Raffaele Suprano, CFO

Subject: Report of Water Infiltration Rate
Proposed WQMP-BMP Stormwater Detention Basin Design
Soils Percolation Testing Using Double-Ring Infiltrometer
Planned 11+ac. 77-lot Residential Development
35775 Iodine Springs Road
City of Wildomar, Riverside County, California
APN: 362-250-001 & 362-250-026

Reference: Site Plan & Project Data as supplied by Nova Homes, Inc.

Gentlemen:

Presented herewith is the result of soils percolation testing performed for the planned WQMP-BMP detention basin design for the project site described. Infiltration testing was conducted near the location and at the depth as described.

The in-situ soil infiltration rate is established by percolation testing using the standardized and well-documented Double-Ring Infiltrometer as per the general conformance to the ASTM Standard D3385. The soils encountered primarily consist of upper fine to medium coarse sand with minor silts, overlying dense well cemented gravely fine to coarse sands with traces of caliche over gravely medium coarse to coarse sands. No shallow depth groundwater, bedrock or other layers considered impermeable to water was encountered.

Based on the infiltration testing conducted at the locations and at the depth of 5 feet, it is our opinion that for WQMP-BMP detention basin design, a **soils infiltration rate of 0.295 inch/hour** may be considered. *Lower infiltration rate may be anticipated over prolong use of the systems installed due to continual deposits of fines and lack of adequate post-instillation maintenance.*

We offer no other warranty, express or implied.

Respectfully submitted,
Soils Southwest, Inc.

Moloy Gupta, RCE 31708

REGISTERED PROFESSIONAL ENGINEER
MOLOY K. GUPTA
NO. 31708 EXP. 12-31-16
CIVIL
STATE OF CALIFORNIA

soilssouthwest@gmail.com
Established 1984

1. 0 SITE DESCRIPTIONS

Primarily vacant and undeveloped, the near level 11.7 acres site is bounded by a residential development currently underway on the north, by other undeveloped properties on the south, by the paved Iodine Springs Road on the east, and by George Street followed by other residential tract homes on the west. Overall vertical relief is currently unknown, but sheet-flow from incidental rainfall appear to flow towards the south. With the exception of weeds, minor scattered brush and isolated debris, presence of no other significant features pertinent to the planned development are noted.

1.1 PROPOSED DEVELOPMENT

No grading plan, topographic map or detailed site improvement plans are available for review. However, based on the tentative development information supplied, it is understood that the subject site will be developed to include 77 detached single family dwellings, along with on and off-site street improvements. Use of conventional wood-frame and stucco construction with continuous wall footings and concrete slab-on-grades, are assumed in preparing this preliminary report. Moderate site preparations and grading should be anticipated with the development proposed.

2.0 EXCAVATED TEST TRENCH:

For soil percolation testing at the location as shown on the accompanying Plate A, two (2) test-trench excavation was made measuring about 10'x10' by using a backhoe advanced to about 5 feet below grade. Water used during percolation testing was supplied by using a 100 gallon tank with water supplied from a water truck available from Larry Jacinto Construction:

- Double Ring Infiltrometer within inner and outer rings of 12 inch and 24 inch (2 to 1 ratio) diameter, respectively
- Shovel (flat head)
- Level
- Mallet-like small sledge hammer
- 2" x 4" timber (for protecting plate while hammering in rings)
- Plastic measuring rulers (30 cm/12-inc) with millimeter and centimeter scale ruler
- Watch
- Rubber plash guards
- Umbrellas (for shading test area)

3.0 METHODOLOGY AND TEST PROCEDURES:

EQUIPMENT SET-UP (POST EXCAVATION) PROCEDURES

Soil infiltration test was performed using two described concentric rings established at the bottom of test excavation pit excavated as described. During testing, the 12-inch diameter inner ring was centered inside the 24-inch diameter outer-ring. Prior to actual testing, the outer ring was driven into local soils to about 5 centimeters, followed by the inner ring to about ½ of the outer ring penetration depth stated. Both the rings were pushed into soil using a sledge hammer and driving plate with a 2" x 4" timber for protecting the driving

plate. Water derived fro water tank was used to fill the annular-space to about 4-inch, followed by the inner-ring to the same level described.

TESTING

The observed falling head flow readings were recorded for both the inner and annular rings at time intervals as shown. Measuring rulers with millimeter and centimeter graduations were used for the inner and annular rings to measure flow readings in centimeters over time. A watch was used to keep time for recording the fall in water at the appropriate time intervals.

The following presents the soil infiltration test results for the test areas as described and as shown in the attached Field Data Sheets. The test was performed in general conformance of the test procedures as described in the ASTM Standard D 3385.

3.1 Suggested Correction Factors Applied to Measured Infiltration Rates

Total Correction Factor, $CF = CF_t \times CFv \times CF_s$, = 1.0 x 1.1 x1.1 =1.0, where

CF_t = correction for D'Ring Infiltrometer = 1.0
CFv = Correction for Site Variability (ranging from 1 to 3) = 1.0
CF_s = Correction for Long-Term Siltation Plugging (ranging from 1 to 3) = 1.0

4.0 INFILTRATION TEST RESULT

Based on the soils infiltration testing completed at this time, the following infiltration rate may be considered for the WQMP-BMP proposed. Actual field test data is attached.

Recommended Infiltration Rate for BMP Design

Test Date Test No. (6-30-15)	Test Depth (ft.) (below grade)	Initial Water Level (inch)	Observed Flow Rate **ANNULAR SPACE** (cm/min.)	Observed Flow Rate **INNER RING** (cm/min.)	Observed Rate **INNER RING** (inch/hour.)	**Uncorrected Soils Infiltration Rate (inch/hour)**
P-1	5.5	4.0	0.17	0.020	0.39	0.39
P-2	5.0	4.0	0.03	0.008	0.20	0.20

The suggested design rate:

Correction Factor Used = 1.0

Observed Average Rate = (0.39+0.2)/2.0 = 0.295 inch/hr.

For the Local Soils as Encountered, Suggested Design Rate = 0.295/1.0 = 0.295 inch/hr.

5.0 CONCLUSION

Based on the in-situ soil infiltration testing completed by using the "Double-Ring Infiltrometer" as Described at the locations and at the depths as dictated by the addressee, it is our opinion that for WQMP-BMP design a **soil infiltration rate of 0.295 inch/hr** may be considered for the depths and for the general areas of testing as shown on Plate A attached.

During construction, in event the soils explored appear considerably different from those as described herein, it will be the responsibility of the addressee to notify Soils Southwest for revised/updated soil infiltration rate.

The infiltration rate described is based on the in-situ testing completed within the trenches excavated at the locations and to the depths as dictated by the project civil engineer. In event the final basin location selected is different from that as described herein; supplemental soils infiltration testing should be considered.

General Statement:

Although, upon the geotechnical review and acceptance of the precise grading plan when prepared, along with the implementations of the recommendations in design and construction as described, it is our opinion that there may be additional areas of concern regarding drainage infiltration. Infiltrated water may perch above buried dense terrace deposits, if any, and may migrate laterally within fill deposits and along fill/rock contacts, when exist. Therefore, the saturated soil deposits may greatly affect stability of slopes, if any, concrete flatworks, pavement sections and foundations. In order to mitigate against adverse effects associated with saturated soils, it is suggested to line drainage infiltration basins with an impervious blanket and install a subdrain. In areas requiring permeable pavers, the subgrade should allow for a minimum 2.0 % grade to a subdrain. The subgrade should be compacted to a minimum of 95 percent of the laboratory maximum dry density. The actual design should be provided by the project civil engineer.

It should be noted that over prolong use and lack of maintenance the detention/infiltration basin constructed based on the suggested design rate may experience much lower infiltration rate due to the accumulation of silts, fines, oils and others. Accordingly **regular maintenance** of the basins surfaces, in form of silts and fines removals is strongly recommended. A record maintenance of such is suggested for future use.

We offer no other warranty, express or implied.

Suggested Site Requirements for Stormwater BMP installation

1. The invert of stormwater infiltration shall be at least 10 feet above the groundwater elevation. Stormwater infiltration BMPs shall not be placed on steep slopes and shall not create the condition or potential for slopes instability.

2. Stormwater infiltration shall not increase the potential for static or seismic settlement of structures on or adjacent to the site. Potential geotechnical hazards that shall be addressed including potentials for collapsible and liquefaction, if any.

3. Stormwater infiltration shall not place an increased surcharge on structures or foundations on or its adjacents. The pore-water pressure shall not be increased on soil retaining structures on or adjacent to the site.

4. The invert of stormwater infiltration shall be set back at least 15 feet, and outside a 1:1 plan drawn up from the bottom of adjacent foundations.

5. Stormwater infiltration shall not be located near utility lines where the introduction of stormwater could cause damage to utilities or settlement of trench backfill.

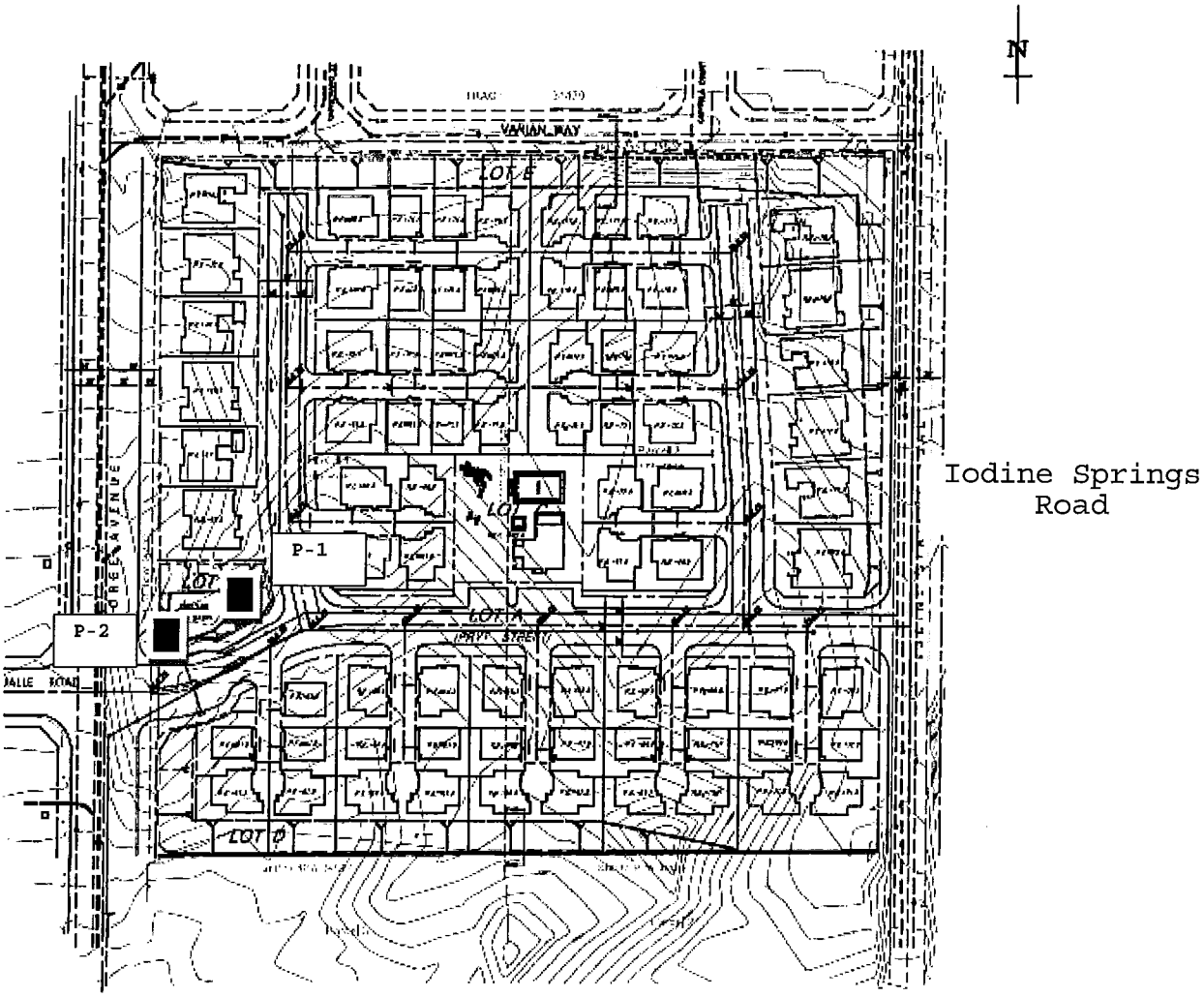
6. Stormwater infiltration is not allowed within 100 feet of any potable groundwater production well.

7. Once installed, regular maintenance of the detention basin is recommended.

APPENDIX

Plot Plan and Approximate Test Locations
Log of Test Pits
Field Data Sheet

PLOT PLAN AND TEST LOCATIONS
35775 Iodine Springs Road
City of Wildomar
Riverside County, California
APN: 362-250-001 & 362-250-026
(schematic-not to scale)



Legend: ■ P-1 Approximate location of WQMP-BMP soil infiltration testing

PLATE A

LOG OF TEST EXCAVATIONS

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF TEST PIT P-1

Project: Marimina, LLC / Nova Homes, Inc.		**Job No.:**	15021-F/BMP
Logged By: John F.	**Boring Diam.:** 18" Bucket	**Date:**	June 30, 2015

Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
				SP-SM			SOUTHEAST weeds
							SAND - brown to dark gray slightly silty, slightly cemented, fine to medium w/rock graments,
				SM			- color change to light gray to white well cemented, traces of caliche trace small pinholes, fine to medium coarse. pebbles, rock fragements
						5	
							SILTY SAND - color change to light brown, fine, rippible rock, damp
							- End of test pit @ 5.5 ft. - no bedrock - no groundwater
						10	
						15	
						20	
						25	
						30	

Groundwater: n/a Approx. Depth of Bedrock: n/a Datum: n/a Elevation: n/a	**Site Location** 35775 Iodine Springs Road n/o Clinton Keith Rd. Wildomar, California	**Plate #**

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF TEST PIT P-2

Project: Marimina, LLC / Nova Homes, Inc.		**Job No.:** 15021-F/BMP
Logged By: John F.	**Boring Diam.:** 18" Bucket	**Date:** June 30, 2015

Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
				SP-SM			SOUTHWEST weeds
							SAND - dark gray slightly cemented, dense, slightly silty, fine to medium, pebbles small pihholes
						5	- color change to light brown, slightly silty, fine to medium coarse, pebble, rock, dense fragments
							- End of test pit @ 5.0 ft. - no bedrock - no groundwater
						10	
						15	
						20	
						25	
						30	

Groundwater: n/a **Approx. Depth of Bedrock:** n/a **Datum:** n/a **Elevation:** n/a	**Site Location** 35775 Iodine Springs Road n/o Clinton Keith Rd. Wildomar, California	**Plate #**

FIELD INFILTRATION DATA SHEET

Double Ring Infiltrometer- BMP

Field Data Sheet

TEST PIT : P-1

Job No. 15021-BMP

Marimina, LLC/Nova Homes
Iodine Springs Road Wildomar

Date of Test: 6/30/2015

Tested By: Joaquin Rebollar

Outer Ring: 24-in. Inner Ring: 12-in DROP (cm)

Test Depth (ft) 5.0

Soil Description: CLAYEY SILTY SAND, fine to med. Crs. With rock fragments

pH = 8.4 Liquid Level Measurement by manual control

Trial No.	1 Test Time Interval (min)	2 Start/End	3 Time hr/min	Flow Reading ANNULAR SPACE/Field 4 cm	5 (cm/min)	Flow Reading INNER RING/Field 6 cm	7 DROP (cm)	Flow Rate Inner 8 (7)/1 cm/ minute	Flow Rate Inner 9 ((8)x60x0.39) in/hr	Remarks (weather conditions,etc. 1 cm = 0.39-in
1	15	S	10:30	10.00		10.00				Sunny, hot,humid
		E	10:45	8.00	0.13	9.00	1.00	0.07	1.56	
2	15	S	10:45	8.00		9.00				Water temp 85.8 degFAR
		E	11:00	6.00	0.13	8.50	0.50	0.03	0.78	
3	15	S	11:00	6.00		8.50				
		E	11:15	4.00	0.13	8.00	0.50	0.03	0.78	
4	15	S	11:15	4.00		8.00				
		E	11:30	2.50	0.10	7.50	0.50	0.03	0.78	
5	30	S	11:30	10.00		10.00				Refill
		E	12:00	6.50	0.23	9.00	1.00	0.03	0.78	
6	30	S	12:00	6.50		9.00				
		E	12:30	4.00	0.17	8.50	0.50	0.02	0.39	

S = Start
E = End

Double Ring Infiltrometer- BMP

Field Data Sheet

TEST PIT : P-2

Job No. 15021-BMP

Marimina, LLC/Nova Homes

Iodine Springs Road Wildomar

Date of Test 6/30/2015

Tested By: John Flippin

Outer Ring: 24-in. **Inner Ring: 12-ir** DROP (cm)

Test Depth (ft) 5.0

Soil Description: SILTY SAND - brown to gray, fine, occasional pebbles

pH = 8.4 Liquid Level Measurement by manual control

Trial No.	1 Test Time Interval (min)	2 Start/End	3 Time hr/min	Flow Reading ANNULAR SPACE/Field 4 cm	5 (cm/min)	Flow Reading INNER RING/Field 6 cm	7 DROP (cm)	Flow Rate Inner 8 (7)/1 cm/ minute	Flow Rate Inner 9 ((8)x60x0.39) in/hr	Remarks (weather conditions,etc. 1 cm = 0.39-in
1	15	S	12:47	10.00		10.00				Sunny, very warm
		E	1:02	8.50	0.10	7.75	2.25	0.150	3.51	
2	15	S	1:02	8.50		7.75				
		E	1:17	7.75	0.05	6.75	1.00	0.067	1.56	
3	15	S	1:19	10.00		10.00				Refill
		E	1:34	9.25	0.05	9.50	0.50	0.033	0.78	Water = +/- 85 DegFar
4	15	S	1:34	9.25		9.50				Overcast, breezy
		E	1:49	8.75	0.03	9.25	0.25	0.017	0.39	
5	30	S	1.52	10.00		10.00				Refill
		E	2:22	9.25	0.05	9.75	0.25	0.008	0.20	Overcast, windy
6	30	S	2:22	9.25		9.75				
		E	2:52	8.75	0.03	9.50	0.25	0.008	0.20	

S = Start

E = End

Appendix 4:Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

NOT APPLICABLE

Appendix 5:LID Infeasibility

LID Technical Infeasibility Analysis

NOT APPLICABLE - SEE SOILS REPORT

Appendix 6:BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

Santa Margarita Watershed

BMP Design Volume, V_{BMP} (Rev. 03-2012)

Legend: Required Entries / Calculated Cells

(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)

Company Name	TL Group Corp.	Date	7/3/2015
Designed by	Silvino Pascua	County/City Case No	TBD
Company Project Number/Name	Tentative Tract Map No. 36952		
Drainage Area Number/Name	DMA A		

Enter the Area Tributary to this Feature A_T = 10.48 acres

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

Site Location

Township

Range

Section

Enter the 85th Percentile, 24-hour Rainfall Depth D_{85} = 0.69

Determine the Effective Impervious Fraction

Type of post-development surface cover (use pull down menu): Mixed Surface Types

Effective Impervious Fraction I_f = 0.60

Calculate the composite Runoff Coefficient, C for the BMP Tributary Area

Use the following equation based on the WEF/ASCE Method

$C = 0.858I_f^3 - 0.78I_f^2 + 0.774I_f + 0.04$ C = 0.41

Determine Design Storage Volume, V_{BMP}

Calculate V_U, the 85% Unit Storage Volume $V_U = D_{85} \times C$ V_u = 0.28 (in*ac)/ac

Calculate the design storage volume of the BMP, V_{BMP}.

$$V_{BMP}\ (ft^3) = \frac{V_U\ (in\text{-}ac/ac) \times A_T\ (ac) \times 43{,}560\ (ft^2/ac)}{12\ (in/ft)}$$

V_{BMP} = 10,652 ft^3

Notes:

Santa Margarita Watershed

BMP Design Volume, V_{BMP} (Rev. 03-2012)

Legend: Required Entries / Calculated Cells

(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)

Company Name	TL Group Corp.	Date	7/3/2015
Designed by	Silvino Pascua	County/City Case No	TBD
Company Project Number/Name	Tentative Tract Map No. 36952		
Drainage Area Number/Name	DMA B		

Enter the Area Tributary to this Feature A_T = 0.42 acres

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

Site Location

Township

Range

Section

Enter the 85th Percentile, 24-hour Rainfall Depth D_{85} = 0.69

Determine the Effective Impervious Fraction

Type of post-development surface cover (use pull down menu): Ornamental Landscaping

Effective Impervious Fraction I_f = 0.10

Calculate the composite Runoff Coefficient, C for the BMP Tributary Area

Use the following equation based on the WEF/ASCE Method

$C = 0.858I_f^3 - 0.78I_f^2 + 0.774I_f + 0.04$ C = 0.11

Determine Design Storage Volume, V_{BMP}

Calculate V_U, the 85% Unit Storage Volume $V_U = D_{85} \times C$ V_u = 0.08 (in*ac)/ac

Calculate the design storage volume of the BMP, V_{BMP}.

$$V_{BMP}\ (ft^3) = \frac{V_U\ (in\text{-}ac/ac) \times A_T\ (ac) \times 43{,}560\ (ft^2/ac)}{12\ (in/ft)}$$

V_{BMP} = 122 ft^3

Notes:

Appendix 7:Hydromodification

Supporting Detail Relating to compliance with the HMP Performance Standards

RCFC & WCD HYDROLOGY MANUAL

RATIONAL METHOD CALCULATION FORM

PROJECT: Tentative Tract Map No. 36952 Calculated by: TL Group Corp. Date: 7/2/2015

FREQUENCY: **EXISTING 2 - YR STORM** Checked by: Date:

Drainage Area	Soil & Development	A Acres	I in/hr	C	Q cfs	Sum of Q cfs	SLOPE	SECTION	V fps	L ft	Tn min	Sum of T min		Volume cf
A-1	Undeveloped	1.16	1.45	0.699	1.179	1.179		56' Street		327	9	9	Initial Area	3,155.14
B-1	Undeveloped	2.30	1.25	0.687	1.973	1.97	0.0154	18" RCP	6.96	677	12.5	12.5	Initial Area	6,228.83
C-1	Undeveloped	1.72	1.55	0.814	2.168	2.168		56' Street		223	8.1	8.1	Initial Area	5,443.93
D-1	Undeveloped	2.90	1.45	0.699	2.939	2.939				286	9.1	9.1	Initial Area	7,862.53
E-1	Undeveloped	1.62	1.48	0.701	1.682	1.682				365	9.5	9.5	Initial Area	4,397.87
F-1	Undeveloped	0.80	1.65	0.708	0.936	0.936				219	7.3	7.3	Initial Area	2,171.88
TOTAL		**10.50**				**10.88**								**29,260.17**

Type	AMC	Soil Group	Ai	Area	RI	Fp	F	Fm	Ap	C	
			decimal percent		Plate E-6.1	inches/hr	Fp*(1-0.9*Ai)	0.50*F	1-Ai	(F-Fm)/54	0.9[Ai+((I-Fp)/I)*Ap]
A-1	II	D	0.00	1.16	89.00	0.14	0.14	0.07	0.86	0.0013	0.6993
B-1	II	D	0.00	2.30	89.00	0.14	0.14	0.07	0.86	0.0013	0.6873
C-1	II	D	0.10	1.72	89.60	0.13	0.12	0.06	0.88	0.0011	0.8145
D-1	II	D	0.00	2.90	89.00	0.14	0.14	0.07	0.86	0.0013	0.6993
E-1	II	D	0.00	1.62	89.00	0.14	0.14	0.07	0.86	0.0013	0.7008
F-1	II	D	0.00	0.80	89.00	0.14	0.14	0.07	0.86	0.0013	0.7083

RCFC & WCD **HYDROLOGY MANUAL**

RATIONAL METHOD CALCULATION FORM

PROJECT: Tentative Tract Map No. 36952 Calculated by: TL Group Corp. Date: 7/2/2015

FREQUENCY: **EXISTING 10 - YR STORM** Checked by: Date:

Drainage Area	Soil & Development	A Acres	I in/hr	C	Q cfs	Sum of Q cfs	SLOPE	SECTION	V fps	L ft	Tn min	Sum of T min		Volume cf
A-1	Undeveloped	1.16	2.44	0.730	2.071	2.071		56' Street		327	9	9	Initial Area	7,869.05
B-1	Undeveloped	2.30	2.08	0.722	3.448	3.45	0.0154	18" RCP	6.96	677	12.5	12.5	Initial Area	15,534.96
C-1	Undeveloped	1.72	2.58	0.841	3.729	3.729		56' Street		223	8.1	8.1	Initial Area	12,622.38
D-1	Undeveloped	2.90	2.44	0.730	5.160	5.160				286	9.1	9.1	Initial Area	19,609.49
E-1	Undeveloped	1.62	2.38	0.728	2.811	2.811				365	9.5	9.5	Initial Area	10,968.46
F-1	Undeveloped	0.80	2.75	0.735	1.618	1.618				219	7.3	7.3	Initial Area	5,416.75
TOTAL		**10.50**				**18.84**								**72,021.08**

Type	AMC	Soil Group	Ai	Area	RI	Fp	F	Fm	Ap	C	
			decimal percent		Plate E-6.1	inches/hr	Fp*(1-0.9*Ai)	0.50*F	1-Ai	(F-Fm)/54	0.9[Ai+((I-Fp)/I)*Ap]
A-1	II	D	0.00	1.16	89.00	0.14	0.14	0.07	0.86	0.0013	0.7296
B-1	II	D	0.00	2.30	89.00	0.14	0.14	0.07	0.86	0.0013	0.7219
C-1	II	D	0.10	1.72	89.60	0.13	0.12	0.06	0.88	0.0011	0.8414
D-1	II	D	0.00	2.90	89.00	0.14	0.14	0.07	0.86	0.0013	0.7296
E-1	II	D	0.00	1.62	89.00	0.14	0.14	0.07	0.86	0.0013	0.7285
F-1	II	D	0.00	0.80	89.00	0.14	0.14	0.07	0.86	0.0013	0.7346

EXISTING CONDITION

RAINFALL INTENSITY—INCHES PER HOUR

CATHEDRAL CITY			CHERRY VALLEY			CORONA			DESERT HOT SPRINGS			ELSINORE - WILDOMAR		
DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR
5	4.14	6.76	5	3.65	5.49	5	3.10	4.78	5	4.39	6.76	5	3.23	4.94
6	3.73	6.08	6	3.30	4.97	6	2.84	4.38	6	3.95	6.08	6	2.96	4.53
7	3.41	5.56	7	3.03	4.56	7	2.64	4.07	7	3.62	5.56	7	2.75	4.21
8	3.15	5.15	8	2.82	4.24	8	2.47	3.81	8	3.35	5.15	8	2.58	3.95
9	2.95	4.81	9	2.64	3.97	9	2.34	3.60	9	3.13	4.81	9	2.44	3.73
10	2.77	4.52	10	2.49	3.75	10	2.22	3.43	10	2.94	4.52	10	2.32	3.54
11	2.62	4.28	11	2.36	3.56	11	2.12	3.27	11	2.78	4.28	11	2.21	3.39
12	2.49	4.07	12	2.25	3.39	12	2.04	3.14	12	2.65	4.07	12	2.12	3.25
13	2.38	3.88	13	2.16	3.25	13	1.96	3.02	13	2.53	3.88	13	2.04	3.13
14	2.28	3.72	14	2.07	3.12	14	1.89	2.92	14	2.42	3.72	14	1.97	3.02
15	2.19	3.58	15	1.99	3.00	15	1.83	2.82	15	2.32	3.58	15	1.91	2.92
16	2.11	3.44	16	1.92	2.90	16	1.77	2.73	16	2.24	3.44	16	1.85	2.83
17	2.04	3.32	17	1.86	2.80	17	1.72	2.66	17	2.16	3.32	17	1.80	2.75
18	1.97	3.22	18	1.80	2.71	18	1.68	2.58	18	2.09	3.22	18	1.75	2.67
19	1.91	3.12	19	1.75	2.64	19	1.63	2.52	19	2.03	3.12	19	1.70	2.60
20	1.85	3.03	20	1.70	2.56	20	1.59	2.46	20	1.97	3.03	20	1.66	2.54
22	1.75	2.86	22	1.61	2.43	22	1.52	2.35	22	1.86	2.86	22	1.59	2.43
24	1.67	2.72	24	1.54	2.32	24	1.46	2.25	24	1.77	2.72	24	1.52	2.33
26	1.59	2.60	26	1.47	2.22	26	1.40	2.17	26	1.69	2.60	26	1.46	2.24
28	1.52	2.49	28	1.41	2.13	28	1.36	2.09	28	1.62	2.49	28	1.41	2.16
30	1.46	2.39	30	1.36	2.05	30	1.31	2.02	30	1.55	2.39	30	1.37	2.09
32	1.41	2.30	32	1.31	1.98	32	1.27	1.96	32	1.50	2.30	32	1.33	2.03
34	1.36	2.22	34	1.27	1.91	34	1.23	1.90	34	1.45	2.22	34	1.29	1.97
36	1.32	2.15	36	1.23	1.85	36	1.20	1.85	36	1.40	2.15	36	1.25	1.92
38	1.28	2.09	38	1.20	1.80	38	1.17	1.81	38	1.36	2.09	38	1.22	1.87
40	1.24	2.02	40	1.16	1.75	40	1.14	1.76	40	1.32	2.02	40	1.19	1.82
45	1.16	1.89	45	1.09	1.64	45	1.08	1.66	45	1.23	1.89	45	1.13	1.72
50	1.09	1.78	50	1.03	1.55	50	1.03	1.58	50	1.16	1.78	50	1.07	1.64
55	1.03	1.68	55	.98	1.47	55	.98	1.51	55	1.09	1.68	55	1.02	1.56
60	.98	1.60	60	.93	1.40	60	.94	1.45	60	1.04	1.60	60	.98	1.50
65	.94	1.53	65	.89	1.34	65	.90	1.40	65	.99	1.53	65	.94	1.44
70	.90	1.46	70	.85	1.29	70	.87	1.35	70	.95	1.46	70	.91	1.39
75	.86	1.41	75	.82	1.24	75	.84	1.30	75	.91	1.41	75	.88	1.35
80	.83	1.35	80	.79	1.20	80	.82	1.26	80	.88	1.35	80	.85	1.31
85	.80	1.31	85	.77	1.16	85	.80	1.23	85	.85	1.31	85	.83	1.27
SLOPE = .580			SLOPE = .550			SLOPE = .480			SLOPE = .580			SLOPE = .480		

9.5

12.5

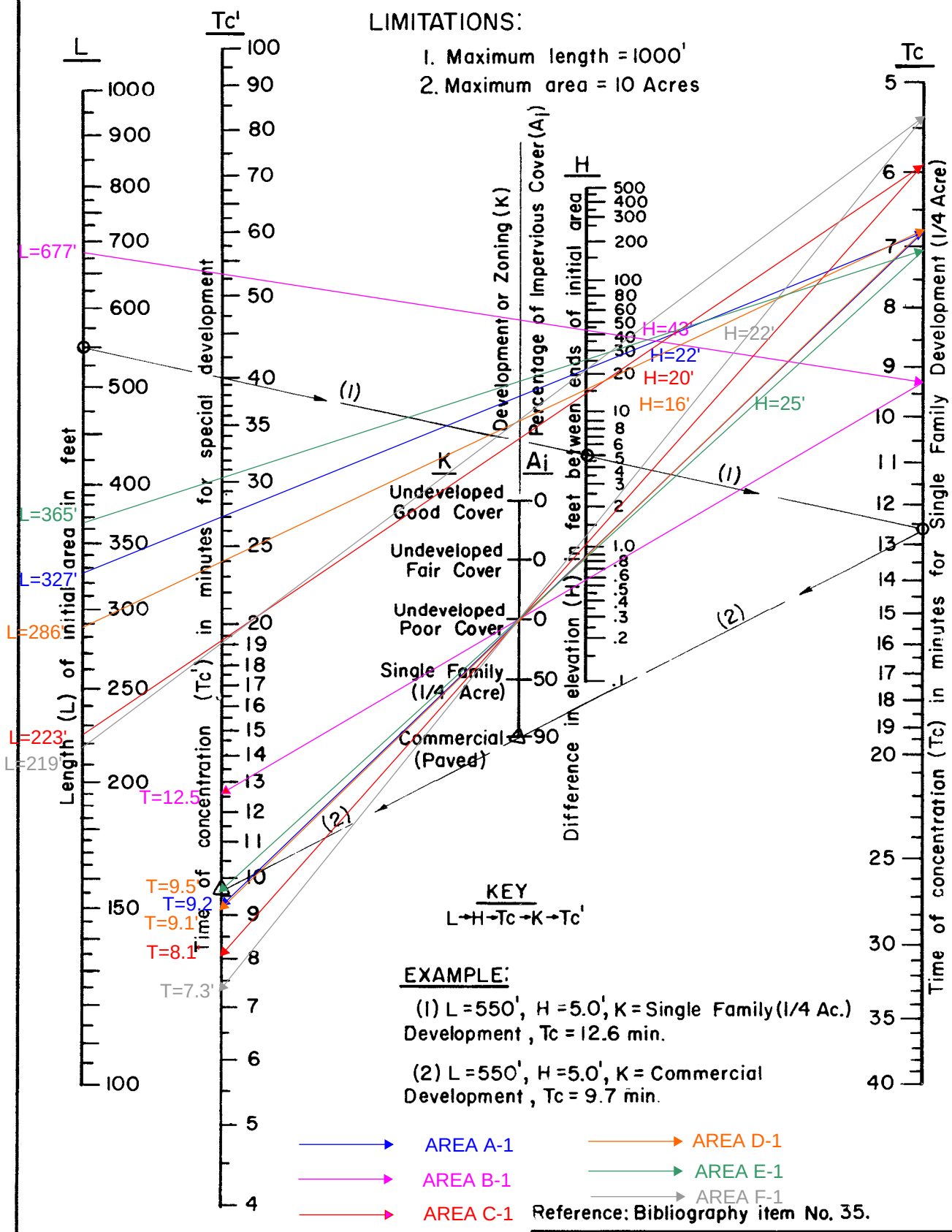
RCFC & WCD

HYDROLOGY MANUAL

STANDARD INTENSITY-DURATION CURVES DATA

PLATE D-4.1 (2 of 6)

EXISTING CONDITION



RCFC & WCD

HYDROLOGY MANUAL

TIME OF CONCENTRATION FOR INITIAL SUBAREA

PLATE D-3

RCFC & WCD **HYDROLOGY MANUAL**

RATIONAL METHOD CALCULATION FORM

PROJECT: Tentative Tract Map No. 36952 Calculated by: TL Group Corp. Date: 7/2/2015

FREQUENCY: **PROPOSED 2 - YR STORM** Checked by: Date:

Drainage Area	Soil & Development	A Acres	I in/hr	C	Q cfs	Sum of Q cfs	SLOPE	SECTION	V fps	L ft	Tn min	Sum of T min		Volume cf
A-1	Single Family Housing	3.21	1.28	0.873	3.585	3.585		56' Street		506	11	11	Initial Area	17,722.61
A-2	Single Family Housing	3.21	1.25	0.872	3.503	7.09	0.0154	18" RCP	6.96	456	1	12	18" RCP	17,761.56
A-3	Single Family Housing	3.26	1.33	0.875	3.792	3.792		56' Street		530	10.5	10.5	Initial Area	18,264.96
B-1	Landscaping	0.42	0.91	0.5934	0.227	0.227		Vegetated Swale		450	21.8	21.8	Initial Area	355.31
TOTAL		**10.10**			**10.88**									**54,104.43**
Confluence (Qp)	Qa=10.0 cfs, Ta=12, Ia=2.12 in/hr													
	Qb=5.20 cfs, Tb=10.5, Ib=2.27 in/hr													
	Qp = Qa + Qb*(Ia/Ib)				Qp = 10.65									

Type	AMC	Soil Group	Ai	Area	RI	Fp	F	Fm	Ap	C	
			decimal percent		Plate E-6.1	inches/hr	Fp*(1-0.9*Ai)	0.5*F	1-Ai	(F-Fm)/54	0.9[Ai+((I-Fp)/I)*Ap]
A-1	II	D	0.64	3.21	89.80	0.11	0.046	0.02	0.36	0.0004	0.8725
A-2	II	D	0.64	3.21	89.80	0.11	0.046	0.02	0.36	0.0004	0.8719
A-3	II	D	0.65	3.26	91.30	0.11	0.045	0.02	0.35	0.0004	0.8746
B-1	II	D	0.00	0.42	75	0.31	0.31	0.16	1.00	0.0029	0.5934

RCFC & WCD **HYDROLOGY MANUAL**

RATIONAL METHOD CALCULATION FORM

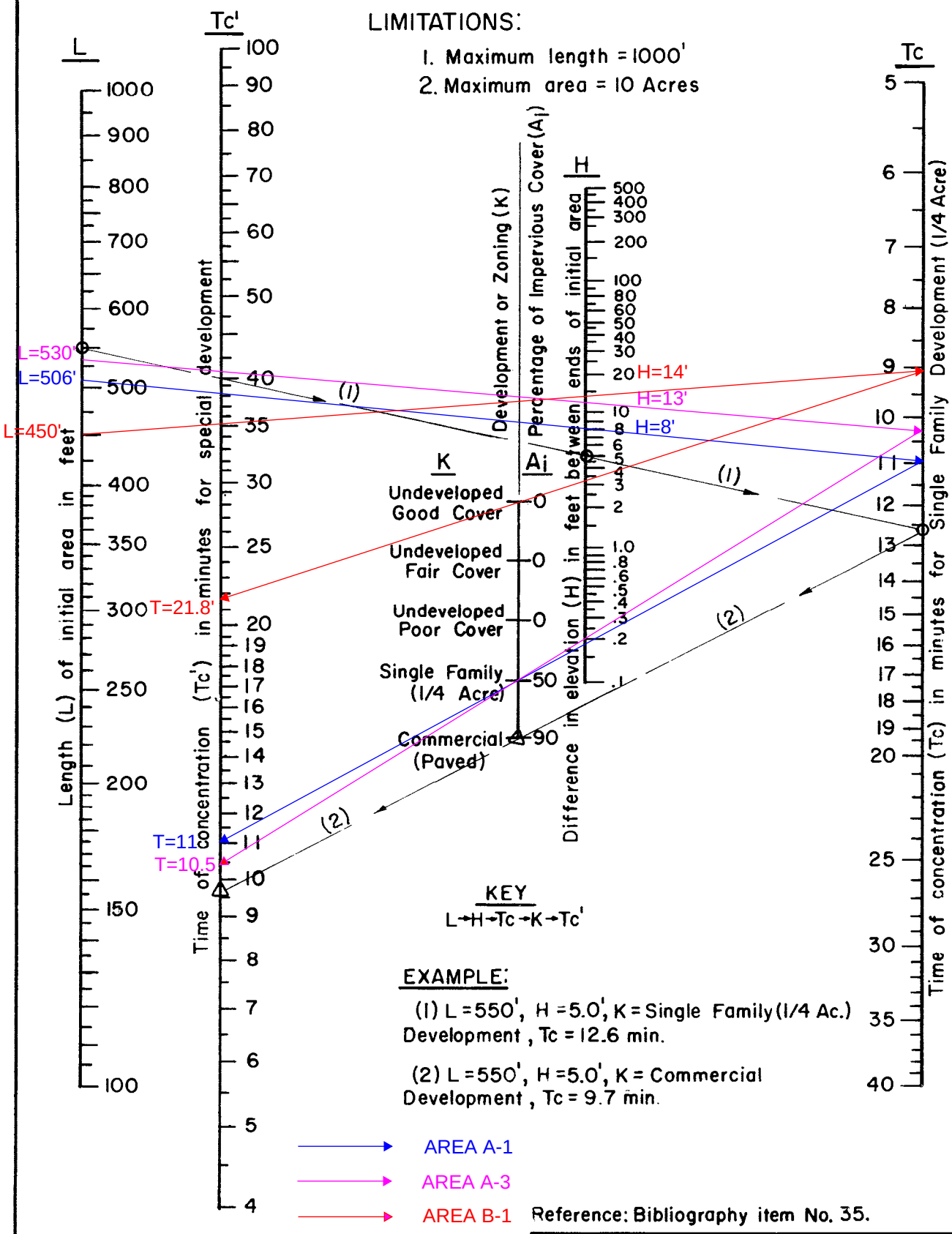
PROJECT: Tentative Tract Map No. 36952 Calculated by: TL Group Corp. Date: 7/2/2015

FREQUENCY: **PROPOSED 10 - YR STORM** Checked by: Date:

Drainage Area	Soil & Development	A Acres	I in/hr	C	Q cfs	Sum of Q cfs	SLOPE	SECTION	V fps	L ft	Tn min	Sum of T min		Volume cf
A-1	Single Family Housing	3.21	2.21	0.884	6.272	6.272		56' Street		506	11	11	Initial Area	34,579.58
A-2	Single Family Housing	3.21	2.12	0.883	6.020	12.29	0.0154	18" RCP	6.96	456	1	12	18" RCP	34,646.36
A-3	Single Family Housing	3.26	2.27	0.885	6.550	6.550		56' Street		530	10.5		Initial Area	35,472.71
B-1	Landscaping	0.42	1.59	0.7245	0.484	0.484		Vegetated Swale		450	21.8	21.8	Initial Area	1,249.99
TOTAL		**10.10**			**18.89**									**105,948.64**
Confluence (Qp)	Qa=10.0 cfs, Ta=12, Ia=2.12 in/hr													
	Qb=5.20 cfs, Tb=10.5, Ib=2.27 in/hr													
	Qp = Qa + Qb*(Ia/Ib)				Qp = 18.41									

Type	AMC	Soil Group	Ai	Area	RI	Fp	F	Fm	Ap	C	
			decimal percent		Plate E-6.1	inches/hr	Fp*(1-0.9*Ai)	0.5*F	1-Ai	(F-Fm)/54	0.9[Ai+((I-Fp)/I)*Ap]
A-1	II	D	0.64	3.21	89.80	0.11	0.046	0.02	0.36	0.0004	0.8841
A-2	II	D	0.64	3.21	89.80	0.11	0.046	0.02	0.36	0.0004	0.8835
A-3	II	D	0.65	3.26	91.30	0.11	0.045	0.02	0.35	0.0004	0.8851
B-1	II	D	0.00	0.42	75	0.31	0.31	0.16	1.00	0.0029	0.7245

PROPOSED CONDITION



RCFC & WCD

HYDROLOGY MANUAL

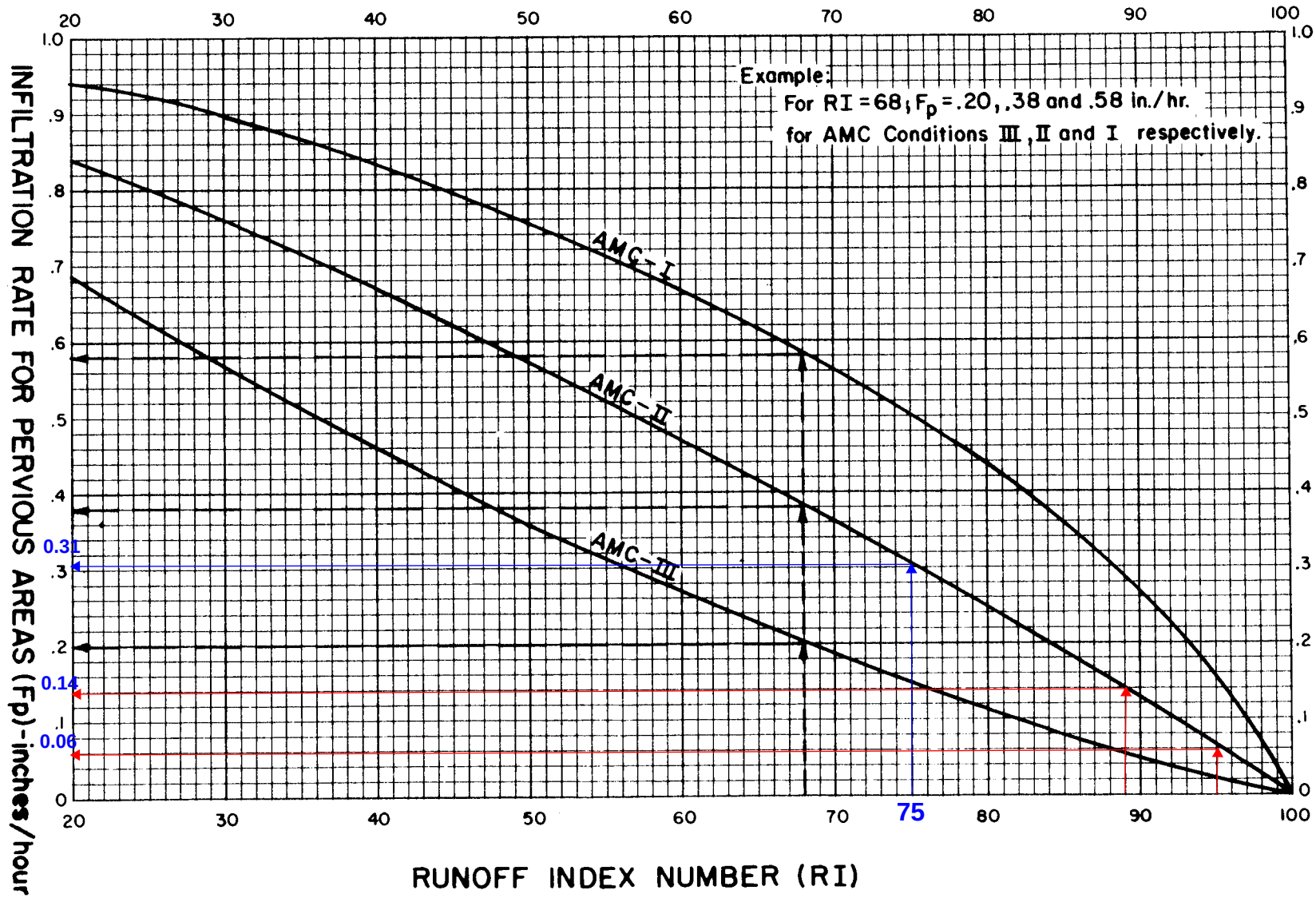
TIME OF CONCENTRATION FOR INITIAL SUBAREA

PLATE D-3

PROPOSED CONDITION

NOTES:

1. R.I. Number-Infiltration relationships are derived from rainfall-runoff relationships in Bibliography item No. 36.



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HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS RUNOFF INDEX NUMBERS

PROPOSED CONDITION

RAINFALL INTENSITY—INCHES PER HOUR

CATHEDRAL CITY			CHERRY VALLEY			CORONA			DESERT HOT SPRINGS			ELSINORE - WILDOMAR		
DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR
5	4.14	6.76	5	3.65	5.49	5	3.10	4.78	5	4.39	6.76	5	3.23	4.94
6	3.73	6.08	6	3.30	4.97	6	2.84	4.38	6	3.95	6.08	6	2.96	4.53
7	3.41	5.56	7	3.03	4.56	7	2.64	4.07	7	3.62	5.56	7	2.75	4.21
8	3.15	5.15	8	2.82	4.24	8	2.47	3.81	8	3.35	5.15	8	2.58	3.95
9	2.95	4.81	9	2.64	3.97	9	2.34	3.60	9	3.13	4.81	9	2.44	3.73
10	2.77	4.52	10	2.49	3.75	10	2.22	3.43	10	2.94	4.52	10	2.32	3.54
11	2.62	4.28	11	2.36	3.56	11	2.12	3.27	11	2.78	4.28	11	2.21	3.39
12	2.49	4.07	12	2.25	3.39	12	2.04	3.14	12	2.65	4.07	12	2.12	3.25
13	2.38	3.88	13	2.16	3.25	13	1.96	3.02	13	2.53	3.88	13	2.04	3.13
14	2.28	3.72	14	2.07	3.12	14	1.89	2.92	14	2.42	3.72	14	1.97	3.02
15	2.19	3.58	15	1.99	3.00	15	1.83	2.82	15	2.32	3.58	15	1.91	2.92
16	2.11	3.44	16	1.92	2.90	16	1.77	2.73	16	2.24	3.44	16	1.85	2.83
17	2.04	3.32	17	1.86	2.80	17	1.72	2.66	17	2.16	3.32	17	1.80	2.75
18	1.97	3.22	18	1.80	2.71	18	1.68	2.58	18	2.09	3.22	18	1.75	2.67
19	1.91	3.12	19	1.75	2.64	19	1.63	2.52	19	2.03	3.12	19	1.70	2.60
20	1.85	3.03	20	1.70	2.56	20	1.59	2.46	20	1.97	3.03	20	1.66	2.54
22	1.75	2.86	22	1.61	2.43	22	1.52	2.35	22	1.86	2.86	22	1.59	2.43
24	1.67	2.72	24	1.54	2.32	24	1.46	2.25	24	1.77	2.72	24	1.52	2.33
26	1.59	2.60	26	1.47	2.22	26	1.40	2.17	26	1.69	2.60	26	1.46	2.24
28	1.52	2.49	28	1.41	2.13	28	1.36	2.09	28	1.62	2.49	28	1.41	2.16
30	1.46	2.39	30	1.36	2.05	30	1.31	2.02	30	1.55	2.39	30	1.37	2.09
32	1.41	2.30	32	1.31	1.98	32	1.27	1.96	32	1.50	2.30	32	1.33	2.03
34	1.36	2.22	34	1.27	1.91	34	1.23	1.90	34	1.45	2.22	34	1.29	1.97
36	1.32	2.15	36	1.23	1.85	36	1.20	1.85	36	1.40	2.15	36	1.25	1.92
38	1.28	2.09	38	1.20	1.80	38	1.17	1.81	38	1.36	2.09	38	1.22	1.87
40	1.24	2.02	40	1.16	1.75	40	1.14	1.76	40	1.32	2.02	40	1.19	1.82
45	1.16	1.89	45	1.09	1.64	45	1.08	1.66	45	1.23	1.89	45	1.13	1.72
50	1.09	1.78	50	1.03	1.55	50	1.03	1.58	50	1.16	1.78	50	1.07	1.64
55	1.03	1.68	55	.98	1.47	55	.98	1.51	55	1.09	1.68	55	1.02	1.56
60	.98	1.60	60	.93	1.40	60	.94	1.45	60	1.04	1.60	60	.98	1.50
65	.94	1.53	65	.89	1.34	65	.90	1.40	65	.99	1.53	65	.94	1.44
70	.90	1.46	70	.85	1.29	70	.87	1.35	70	.95	1.46	70	.91	1.39
75	.86	1.41	75	.82	1.24	75	.84	1.30	75	.91	1.41	75	.88	1.35
80	.83	1.35	80	.79	1.20	80	.82	1.26	80	.88	1.35	80	.85	1.31
85	.80	1.31	85	.77	1.16	85	.80	1.23	85	.85	1.31	85	.83	1.27
SLOPE = .580			SLOPE = .550			SLOPE = .480			SLOPE = .580			SLOPE = .480		

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HYDROLOGY MANUAL

STANDARD INTENSITY-DURATION CURVES DATA

PLATE D-4.1 (2 of 6)

PROPOSED CONDITION

ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent(2)
Natural or Agriculture	0 - 10	0
Single Family Residential: (3)		
40,000 S. F. (1 Acre) Lots	10 - 25	20
20,000 S. F. (½ Acre) Lots	30 - 45	40
7,200 - 10,000 S. F. Lots	45 - 55	50
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 -100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

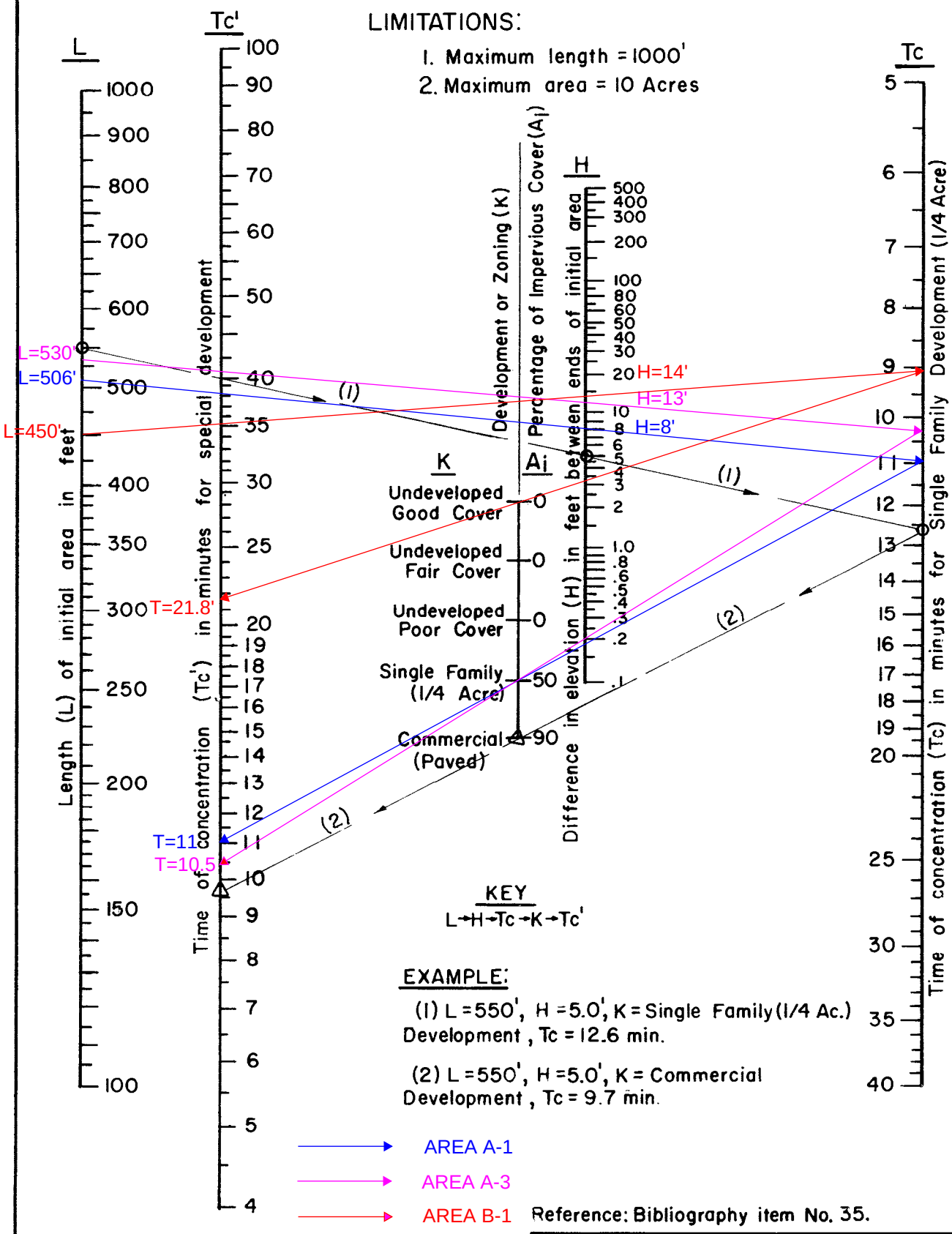
2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area should always be made, and a review of aerial photos, where available may assist in estimating the percentage of impervious cover in developed areas.

3. For typical horse ranch subdivisions increase impervious area 5 percent over the values recommended in the table above.

RCFC & WCD
HYDROLOGY MANUAL

IMPERVIOUS COVER FOR DEVELOPED AREAS

PROPOSED CONDITION

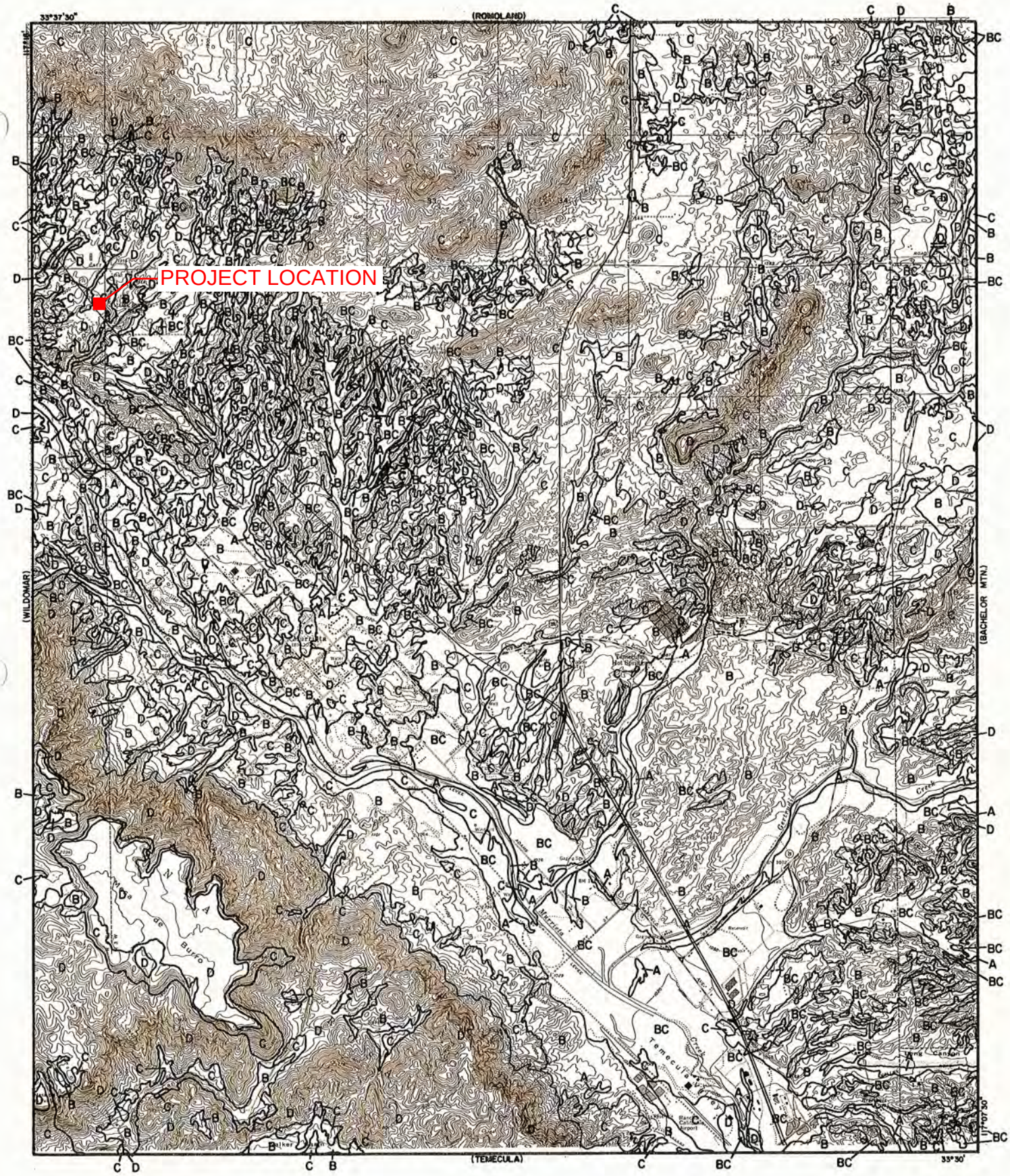


RCFC & WCD

HYDROLOGY MANUAL

TIME OF CONCENTRATION FOR INITIAL SUBAREA

PLATE D-3



LEGEND

—— SOILS GROUP BOUNDARY

A SOILS GROUP DESIGNATION

RCFC & WCD

HYDROLOGY MANUAL

N

0 FEET 5000

HYDROLOGIC SOILS GROUP MAP FOR MURRIETA

PLATE C-1.52

NOAA Atlas 14, Volume 6, Version 2
Location name: Wildomar, California, US*
Latitude: 33.5954°, Longitude: -117.2811°
Elevation: 1290 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.095 (0.080–0.115)	0.127 (0.107–0.154)	0.171 (0.143–0.207)	0.208 (0.172–0.253)	0.259 (0.207–0.328)	0.300 (0.235–0.388)	0.343 (0.261–0.454)	0.388 (0.287–0.529)	0.450 (0.318–0.642)	0.499 (0.340–0.738)
10-min	0.136 (0.114–0.164)	0.183 (0.153–0.220)	0.245 (0.205–0.297)	0.298 (0.247–0.363)	0.372 (0.297–0.470)	0.430 (0.336–0.556)	0.491 (0.374–0.651)	0.555 (0.411–0.759)	0.644 (0.456–0.920)	0.715 (0.488–1.06)
15-min	0.165 (0.138–0.199)	0.221 (0.185–0.266)	0.297 (0.248–0.359)	0.360 (0.298–0.439)	0.449 (0.359–0.568)	0.520 (0.407–0.672)	0.594 (0.453–0.788)	0.672 (0.497–0.918)	0.779 (0.552–1.11)	0.865 (0.590–1.28)
30-min	0.259 (0.217–0.311)	0.346 (0.290–0.417)	0.465 (0.389–0.562)	0.565 (0.468–0.689)	0.705 (0.563–0.891)	0.816 (0.638–1.05)	0.932 (0.710–1.24)	1.05 (0.779–1.44)	1.22 (0.865–1.74)	1.36 (0.925–2.01)
60-min	0.396 (0.332–0.476)	0.530 (0.444–0.638)	0.712 (0.595–0.860)	0.864 (0.716–1.05)	1.08 (0.862–1.36)	1.25 (0.976–1.61)	1.43 (1.09–1.89)	1.61 (1.19–2.20)	1.87 (1.32–2.67)	2.07 (1.42–3.07)
2-hr	0.587 (0.493–0.707)	0.769 (0.645–0.927)	1.02 (0.850–1.23)	1.22 (1.01–1.49)	1.51 (1.21–1.91)	1.75 (1.36–2.25)	1.98 (1.51–2.63)	2.24 (1.65–3.05)	2.58 (1.83–3.69)	2.86 (1.95–4.23)
3-hr	0.728 (0.611–0.876)	0.948 (0.795–1.14)	1.25 (1.04–1.51)	1.50 (1.24–1.82)	1.85 (1.48–2.33)	2.12 (1.66–2.74)	2.41 (1.84–3.19)	2.71 (2.00–3.70)	3.13 (2.21–4.46)	3.45 (2.36–5.11)
6-hr	1.03 (0.867–1.24)	1.35 (1.13–1.62)	1.77 (1.48–2.13)	2.11 (1.75–2.58)	2.60 (2.08–3.28)	2.98 (2.33–3.85)	3.37 (2.57–4.47)	3.79 (2.80–5.17)	4.35 (3.08–6.21)	4.80 (3.27–7.10)
12-hr	1.36 (1.14–1.64)	1.80 (1.51–2.17)	2.39 (2.00–2.89)	2.87 (2.38–3.50)	3.53 (2.83–4.46)	4.05 (3.16–5.23)	4.57 (3.48–6.06)	5.11 (3.78–6.98)	5.85 (4.14–8.34)	6.42 (4.38–9.50)
24-hr	1.79 (1.58–2.07)	2.44 (2.16–2.83)	3.30 (2.91–3.83)	4.00 (3.49–4.67)	4.94 (4.18–5.96)	5.67 (4.70–6.98)	6.41 (5.19–8.07)	7.16 (5.65–9.27)	8.19 (6.21–11.0)	8.98 (6.58–12.5)
2-day	2.15 (1.90–2.48)	3.02 (2.67–3.49)	4.18 (3.68–4.84)	5.12 (4.47–5.98)	6.41 (5.42–7.73)	7.41 (6.15–9.12)	8.43 (6.83–10.6)	9.49 (7.49–12.3)	10.9 (8.29–14.7)	12.1 (8.85–16.8)
3-day	2.32 (2.05–2.67)	3.31 (2.92–3.83)	4.64 (4.09–5.38)	5.74 (5.01–6.70)	7.25 (6.14–8.74)	8.43 (6.99–10.4)	9.65 (7.82–12.2)	10.9 (8.62–14.1)	12.7 (9.63–17.1)	14.1 (10.3–19.6)
4-day	2.49 (2.20–2.88)	3.60 (3.17–4.16)	5.08 (4.47–5.89)	6.31 (5.51–7.37)	8.02 (6.78–9.67)	9.36 (7.76–11.5)	10.8 (8.71–13.5)	12.2 (9.64–15.8)	14.3 (10.8–19.2)	15.9 (11.7–22.2)
7-day	2.84 (2.51–3.28)	4.13 (3.64–4.77)	5.87 (5.17–6.81)	7.34 (6.41–8.57)	9.39 (7.95–11.3)	11.0 (9.14–13.6)	12.7 (10.3–16.0)	14.5 (11.5–18.8)	17.1 (13.0–23.0)	19.2 (14.0–26.7)
10-day	3.02 (2.67–3.49)	4.39 (3.88–5.08)	6.28 (5.53–7.28)	7.87 (6.88–9.20)	10.1 (8.57–12.2)	11.9 (9.90–14.7)	13.8 (11.2–17.4)	15.9 (12.5–20.5)	18.7 (14.2–25.2)	21.0 (15.4–29.3)
20-day	3.61 (3.19–4.16)	5.30 (4.68–6.13)	7.67 (6.75–8.89)	9.70 (8.47–11.3)	12.6 (10.7–15.2)	15.0 (12.4–18.5)	17.5 (14.2–22.1)	20.3 (16.0–26.2)	24.1 (18.3–32.5)	27.3 (20.0–38.0)
30-day	4.24 (3.75–4.90)	6.24 (5.50–7.21)	9.05 (7.97–10.5)	11.5 (10.0–13.4)	15.0 (12.7–18.1)	17.9 (14.9–22.1)	21.0 (17.1–26.5)	24.4 (19.3–31.6)	29.3 (22.2–39.4)	33.2 (24.3–46.2)
45-day	4.93 (4.36–5.69)	7.22 (6.37–8.35)	10.5 (9.23–12.2)	13.3 (11.7–15.6)	17.6 (14.9–21.2)	21.0 (17.4–25.9)	24.8 (20.1–31.2)	28.8 (22.7–37.3)	34.7 (26.3–46.7)	39.5 (29.0–55.0)
60-day	5.66 (5.00–6.53)	8.22 (7.25–9.50)	11.9 (10.5–13.8)	15.2 (13.2–17.7)	19.9 (16.9–24.1)	23.9 (19.9–29.5)	28.3 (22.9–35.6)	33.0 (26.0–42.6)	39.8 (30.1–53.6)	45.4 (33.3–63.2)

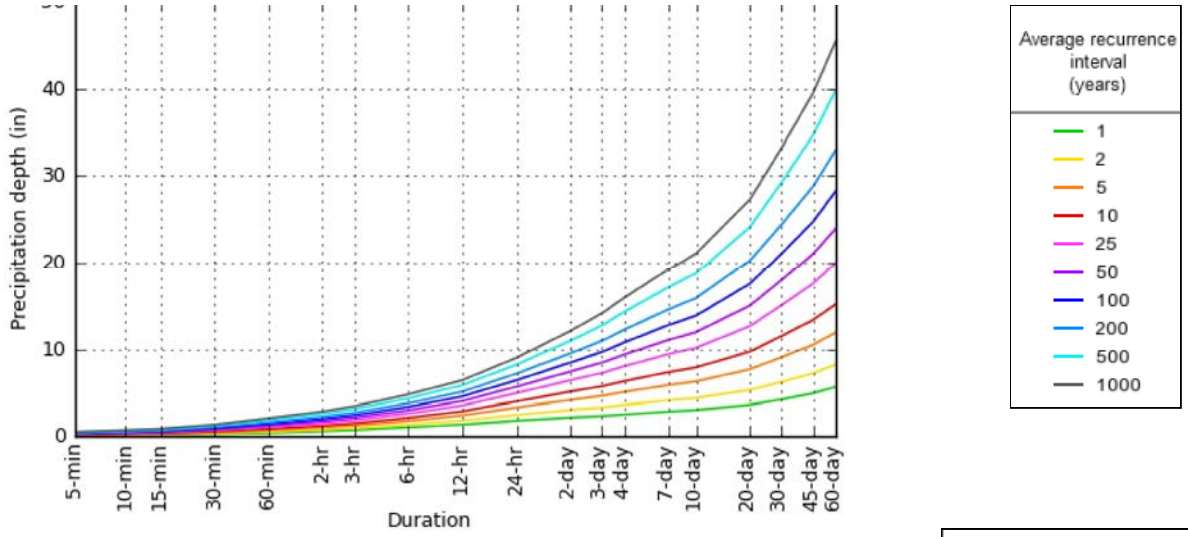
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

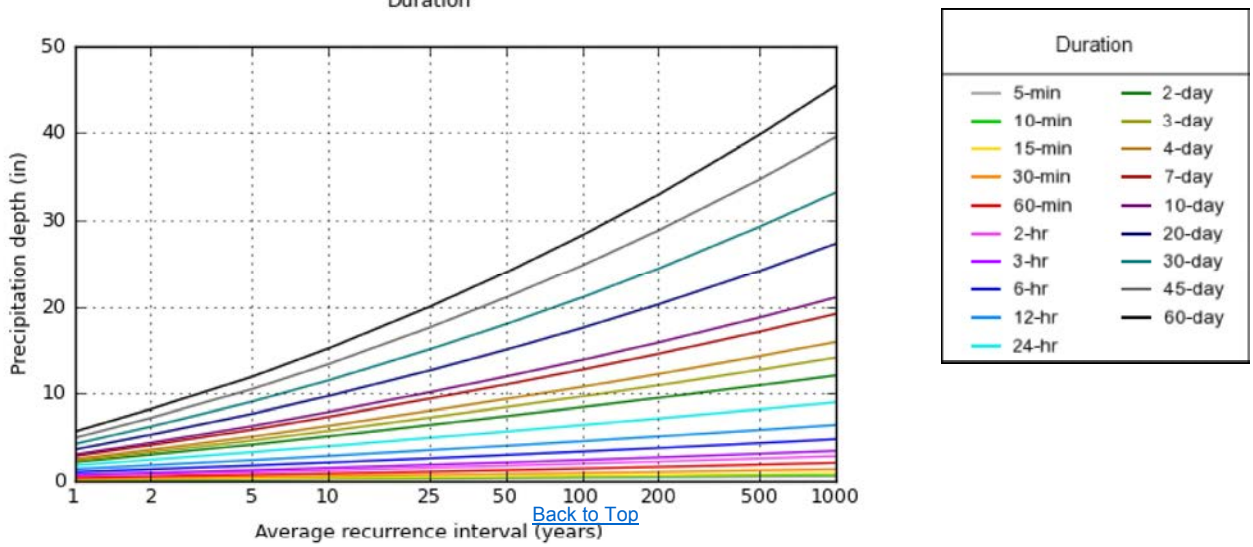
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





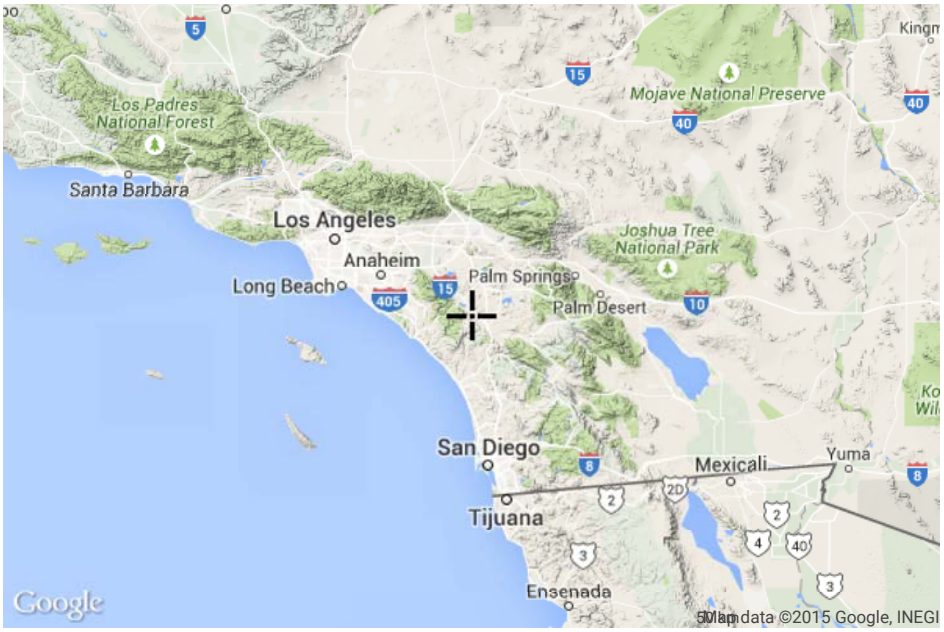
Back to Top

Maps & aerials

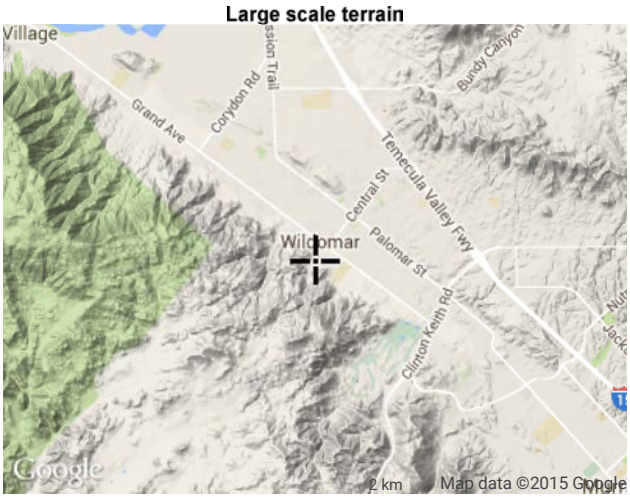
NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Sun Jul 12 05:19:48 2015

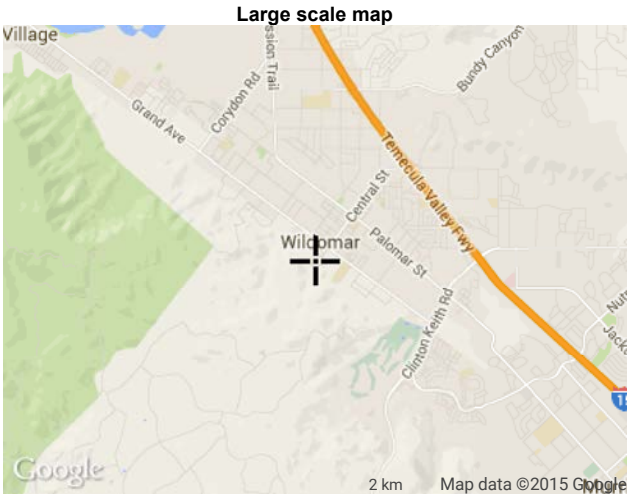
Small scale terrain



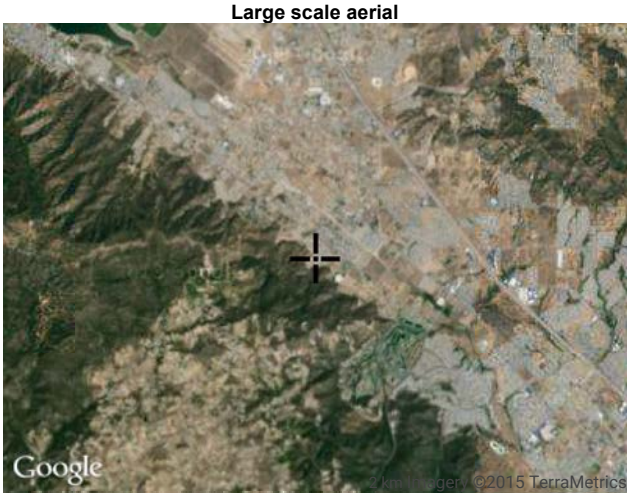
Large scale terrain



Large scale map



Large scale aerial



Back to Top

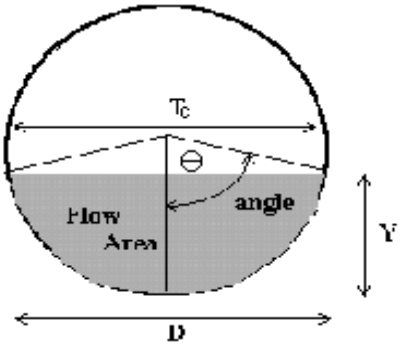
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910

Questions?: HDSC.Questions@noaa.gov

Disclaimer

Circular Pipe Flow

Project: Wildomar
Pipe ID: Outlet



Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**18.9**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	rad
Full-flow capacity	**Qf =**	**32.1**	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.68	rad
Flow area	An =	1.78	sq ft
Top width	Tn =	1.99	ft
Wetted perimeter	Pn =	3.35	ft
Flow depth	Yn =	1.10	ft
Flow velocity	Vn =	10.62	fps
Discharge	**Qn =**	**18.9**	**cfs**
Normal Depth Froude Number	**Fr_n =**	**1.98**	
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.17	rad
Critical flow area	Ac =	2.64	sq ft
Critical top width	Tc =	1.65	ft
Critical flow depth	Yc =	1.56	ft
Critical flow velocity	Vc =	7.17	fps
Critical Depth Froude Number	**Fr_c =**	**1.00**	

SMRHM

PROJECT REPORT

General Model Information

Project Name:	Wildomar
Site Name:	Tract 36952
Site Address:	
City:	Wildomar
Report Date:	8/3/2015
Gage:	Wildomar / North Murrieta
Data Start:	1949/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.00
Version:	2015/07/26

POC Thresholds

Low Flow Threshold for POC1:	10 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year

Landuse Basin Data

Predeveloped Land Use

DMA 1

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
C D,Shrub,Very(>20%)	10.33
Pervious Total	10.33
Impervious Land Use	Acres
Roof Area	0.172
Impervious Total	0.172
Basin Total	10.502

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

DMA 1

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
C D,Grass,Mod(5-10%)	3.88
Pervious Total	3.88
Impervious Land Use	Acres
Roof Area	6.22
Impervious Total	6.22
Basin Total	10.1

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

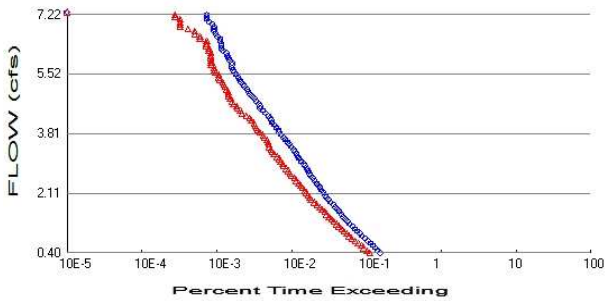
Bottom Length:	80.00 ft.
Bottom Width:	57.00 ft.
Depth:	5 ft.
Volume at riser head:	0.5362 acre-ft.
Side slope 1:	2 To 1
Side slope 2:	2 To 1
Side slope 3:	2 To 1
Side slope 4:	2 To 1
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	18 in.
Orifice 1 Diameter:	2.25 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

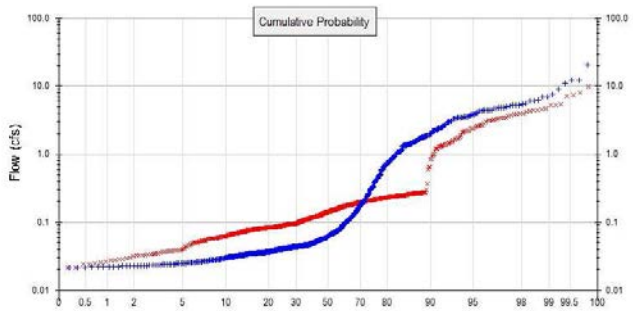
Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.104	0.000	0.000	0.000
0.0556	0.105	0.005	0.032	0.000
0.1111	0.106	0.011	0.045	0.000
0.1667	0.106	0.017	0.056	0.000
0.2222	0.107	0.023	0.064	0.000
0.2778	0.108	0.029	0.072	0.000
0.3333	0.108	0.035	0.079	0.000
0.3889	0.109	0.041	0.085	0.000
0.4444	0.110	0.047	0.091	0.000
0.5000	0.111	0.053	0.097	0.000
0.5556	0.111	0.060	0.102	0.000
0.6111	0.112	0.066	0.107	0.000
0.6667	0.113	0.072	0.112	0.000
0.7222	0.114	0.078	0.116	0.000
0.7778	0.114	0.085	0.121	0.000
0.8333	0.115	0.091	0.125	0.000
0.8889	0.116	0.098	0.129	0.000
0.9444	0.116	0.104	0.133	0.000
1.0000	0.117	0.111	0.137	0.000
1.0556	0.118	0.117	0.141	0.000
1.1111	0.119	0.124	0.144	0.000
1.1667	0.119	0.130	0.148	0.000
1.2222	0.120	0.137	0.151	0.000
1.2778	0.121	0.144	0.155	0.000
1.3333	0.122	0.151	0.158	0.000
1.3889	0.122	0.157	0.161	0.000
1.4444	0.123	0.164	0.165	0.000
1.5000	0.124	0.171	0.168	0.000
1.5556	0.125	0.178	0.171	0.000
1.6111	0.125	0.185	0.174	0.000
1.6667	0.126	0.192	0.177	0.000
1.7222	0.127	0.199	0.180	0.000
1.7778	0.128	0.206	0.183	0.000
1.8333	0.129	0.213	0.186	0.000
1.8889	0.129	0.221	0.188	0.000

1.9444	0.130	0.228	0.191	0.000
2.0000	0.131	0.235	0.194	0.000
2.0556	0.132	0.242	0.197	0.000
2.1111	0.132	0.250	0.199	0.000
2.1667	0.133	0.257	0.202	0.000
2.2222	0.134	0.265	0.204	0.000
2.2778	0.135	0.272	0.207	0.000
2.3333	0.136	0.280	0.209	0.000
2.3889	0.136	0.287	0.212	0.000
2.4444	0.137	0.295	0.214	0.000
2.5000	0.138	0.302	0.217	0.000
2.5556	0.139	0.310	0.219	0.000
2.6111	0.140	0.318	0.222	0.000
2.6667	0.140	0.326	0.224	0.000
2.7222	0.141	0.334	0.226	0.000
2.7778	0.142	0.341	0.229	0.000
2.8333	0.143	0.349	0.231	0.000
2.8889	0.144	0.357	0.233	0.000
2.9444	0.144	0.365	0.235	0.000
3.0000	0.145	0.374	0.237	0.000
3.0556	0.146	0.382	0.240	0.000
3.1111	0.147	0.390	0.242	0.000
3.1667	0.148	0.398	0.244	0.000
3.2222	0.149	0.406	0.246	0.000
3.2778	0.149	0.415	0.248	0.000
3.3333	0.150	0.423	0.250	0.000
3.3889	0.151	0.431	0.252	0.000
3.4444	0.152	0.440	0.255	0.000
3.5000	0.153	0.448	0.257	0.000
3.5556	0.154	0.457	0.259	0.000
3.6111	0.154	0.465	0.261	0.000
3.6667	0.155	0.474	0.263	0.000
3.7222	0.156	0.483	0.265	0.000
3.7778	0.157	0.491	0.267	0.000
3.8333	0.158	0.500	0.269	0.000
3.8889	0.159	0.509	0.270	0.000
3.9444	0.160	0.518	0.272	0.000
4.0000	0.160	0.527	0.274	0.000
4.0556	0.161	0.536	0.484	0.000
4.1111	0.162	0.545	0.866	0.000
4.1667	0.163	0.554	1.354	0.000
4.2222	0.164	0.563	1.919	0.000
4.2778	0.165	0.572	2.533	0.000
4.3333	0.166	0.581	3.168	0.000
4.3889	0.167	0.591	3.797	0.000
4.4444	0.167	0.600	4.393	0.000
4.5000	0.168	0.609	4.930	0.000
4.5556	0.169	0.619	5.390	0.000
4.6111	0.170	0.628	5.763	0.000
4.6667	0.171	0.638	6.051	0.000
4.7222	0.172	0.647	6.273	0.000
4.7778	0.173	0.657	6.550	0.000
4.8333	0.174	0.666	6.771	0.000
4.8889	0.175	0.676	6.985	0.000
4.9444	0.175	0.686	7.192	0.000
5.0000	0.176	0.696	7.393	0.000
5.0556	0.177	0.705	7.589	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 10.33
Total Impervious Area: 0.172

Mitigated Landuse Totals for POC #1
Total Pervious Area: 3.88
Total Impervious Area: 6.22

Flow Frequency Method: Cunnane

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	4.039415
5 year	5.424352
10 year	7.221962
25 year	12.37724

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	2.676975
5 year	4.172681
10 year	5.297641
25 year	7.407637

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4039	3311	2413	72	Pass
0.4728	3050	2189	71	Pass
0.5417	2852	2013	70	Pass
0.6105	2654	1866	70	Pass
0.6794	2461	1696	68	Pass
0.7483	2276	1541	67	Pass
0.8172	2084	1389	66	Pass
0.8860	1910	1280	67	Pass
0.9549	1766	1185	67	Pass
1.0238	1638	1091	66	Pass
1.0926	1518	1014	66	Pass
1.1615	1415	931	65	Pass
1.2304	1311	872	66	Pass
1.2992	1217	800	65	Pass
1.3681	1128	741	65	Pass
1.4370	1061	685	64	Pass
1.5058	1002	642	64	Pass
1.5747	938	604	64	Pass
1.6436	884	554	62	Pass
1.7125	830	518	62	Pass
1.7813	789	474	60	Pass
1.8502	727	437	60	Pass
1.9191	668	395	59	Pass
1.9879	630	376	59	Pass
2.0568	605	361	59	Pass
2.1257	580	343	59	Pass
2.1945	543	326	60	Pass
2.2634	523	304	58	Pass
2.3323	498	285	57	Pass
2.4011	471	270	57	Pass
2.4700	441	251	56	Pass
2.5389	419	238	56	Pass
2.6077	392	215	54	Pass
2.6766	375	207	55	Pass
2.7455	364	196	53	Pass
2.8144	351	183	52	Pass
2.8832	329	169	51	Pass
2.9521	313	164	52	Pass
3.0210	291	155	53	Pass
3.0898	278	150	53	Pass
3.1587	267	140	52	Pass
3.2276	252	126	50	Pass
3.2964	240	119	49	Pass
3.3653	229	115	50	Pass
3.4342	214	108	50	Pass
3.5030	200	108	54	Pass
3.5719	191	105	54	Pass
3.6408	179	102	56	Pass
3.7096	169	94	55	Pass
3.7785	159	91	57	Pass
3.8474	149	82	55	Pass
3.9163	145	76	52	Pass
3.9851	135	74	54	Pass

4.0540	128	71	55	Pass
4.1229	120	69	57	Pass
4.1917	115	63	54	Pass
4.2606	111	60	54	Pass
4.3295	106	54	50	Pass
4.3983	98	47	47	Pass
4.4672	90	45	50	Pass
4.5361	83	41	49	Pass
4.6049	83	40	48	Pass
4.6738	79	36	45	Pass
4.7427	73	35	47	Pass
4.8116	69	33	47	Pass
4.8804	64	31	48	Pass
4.9493	60	31	51	Pass
5.0182	57	31	54	Pass
5.0870	55	29	52	Pass
5.1559	51	28	54	Pass
5.2248	49	27	55	Pass
5.2936	46	26	56	Pass
5.3625	44	24	54	Pass
5.4314	42	23	54	Pass
5.5002	39	23	58	Pass
5.5691	37	21	56	Pass
5.6380	36	20	55	Pass
5.7068	35	20	57	Pass
5.7757	35	18	51	Pass
5.8446	35	18	51	Pass
5.9135	32	18	56	Pass
5.9823	31	18	58	Pass
6.0512	30	18	60	Pass
6.1201	29	18	62	Pass
6.1889	26	17	65	Pass
6.2578	25	17	68	Pass
6.3267	25	16	64	Pass
6.3955	25	16	64	Pass
6.4644	24	16	66	Pass
6.5333	24	13	54	Pass
6.6021	22	13	59	Pass
6.6710	21	11	52	Pass
6.7399	20	11	55	Pass
6.8087	20	9	45	Pass
6.8776	20	7	35	Pass
6.9465	19	7	36	Pass
7.0154	17	7	41	Pass
7.0842	16	7	43	Pass
7.1531	16	6	37	Pass
7.2220	16	6	37	Pass

Water Quality

Rational Method

Data for Rational Method is not available.

Model Default Modifications

Total of 0 changes have been made.

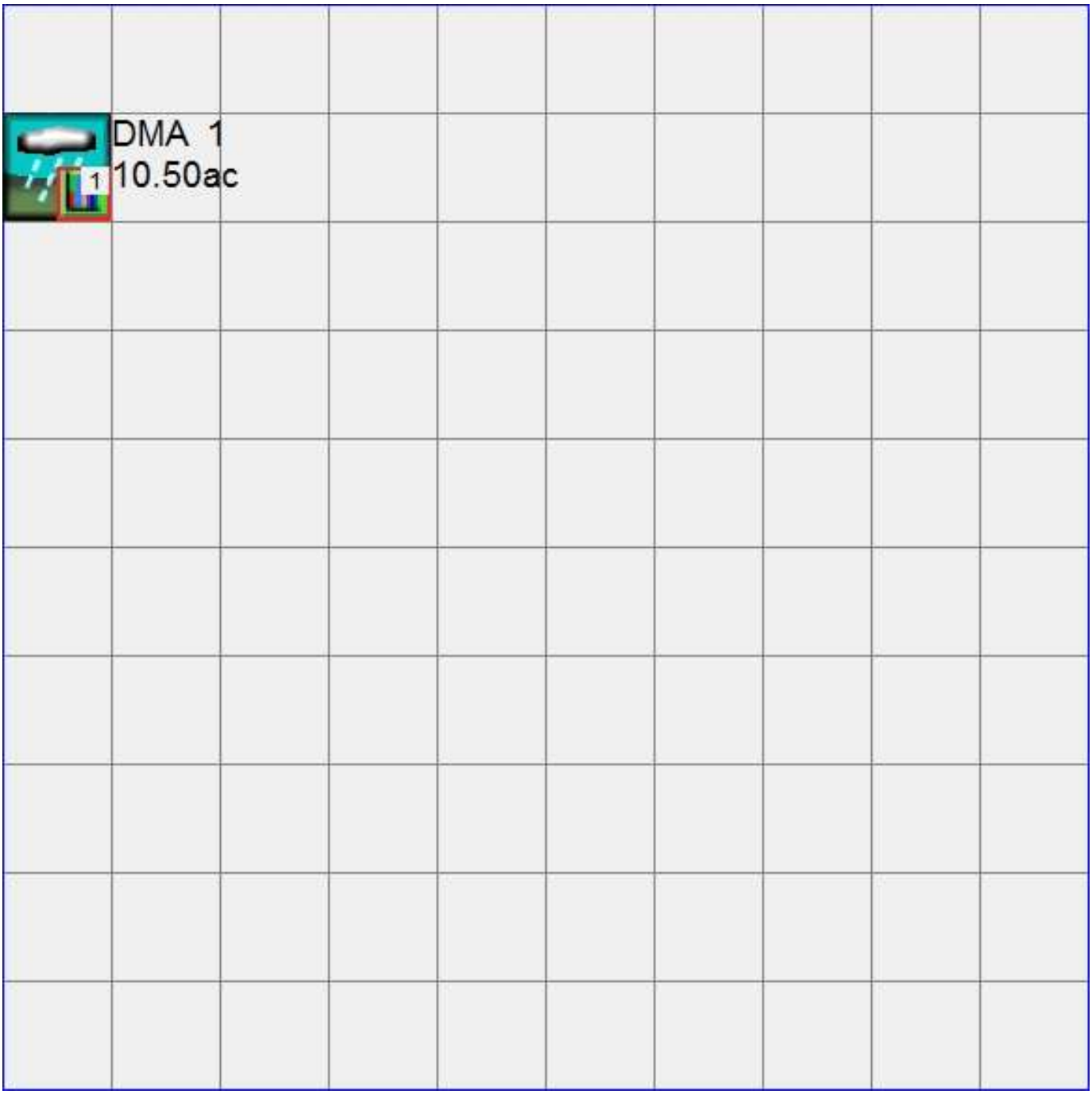
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1949 10 01        END    2011 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   Wildomar.wdm
MESSU      25   PreWildomar.MES
           27   PreWildomar.L61
           28   PreWildomar.L62
           30   POCWildomar1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      40
      IMPLND       5
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        DMA  1                     MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
   40     C/D,Shrub,Very(>20%)    1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   40         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   40         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   40         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   40              0         4     0.025       200      0.25         2      0.95
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   40             40        35         3         2      0.15      0.15         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   40              0       0.4       0.3       0.4      0.35         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   40       0.5  0.5  0.5  0.6 0.65 0.65 0.65 0.65 0.65 0.65 0.55  0.5
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   40      0.13 0.13 0.13 0.14 0.15 0.15 0.15 0.15 0.15 0.15 0.14 0.13
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   40              0         0      0.01         0       0.5       0.3      0.01
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    5     Roof Area               1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    5         0    0    0    0    0
  END IWAT-PARM1
```

```
  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    5            100      0.05       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    5               0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    5               0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
DMA  1***
PERLND  40                       10.33     COPY   501     12
PERLND  40                       10.33     COPY   501     13
IMPLND   5                       0.172     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                        in  out                              ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
```

```
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                        ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1949 10 01        END    2011 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   Wildomar.wdm
MESSU      25   MitWildomar.MES
           27   MitWildomar.L61
           28   MitWildomar.L62
           30   POCWildomar1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      42
      IMPLND       5
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
   42     C/D,Grass,Mod(5-10%)    1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   42         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
```

```
  42         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
  42         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  42             0       4.5      0.04       350       0.1         2      0.95
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  42            40        35         3         2      0.15      0.15         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  42             0       0.7      0.25       1.2      0.45         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
  42       0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
  42      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  42             0         0      0.01         0       0.5       0.3      0.01
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    5     Roof Area               1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    5         0    0    0    0    0
```

```
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    5            100      0.05       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    5              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    5              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
DMA  1***
PERLND  42                        3.88     RCHRES   1      2
PERLND  42                        3.88     RCHRES   1      3
IMPLND   5                        6.22     RCHRES   1      5

******Routing******
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                        in  out                              ***
    1     Trapezoidal Pond-007    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
```

```
            *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1       0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                          ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)    (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.104683  0.000000  0.000000
  0.055556  0.105383  0.005835  0.032381
  0.111111  0.106086  0.011709  0.045793
  0.166667  0.106790  0.017623  0.056085
  0.222222  0.107497  0.023575  0.064762
  0.277778  0.108206  0.029567  0.072406
  0.333333  0.108917  0.035598  0.079316
  0.388889  0.109631  0.041669  0.085672
  0.444444  0.110347  0.047779  0.091587
  0.500000  0.111065  0.053930  0.097142
  0.555556  0.111786  0.060120  0.102397
  0.611111  0.112508  0.066350  0.107395
  0.666667  0.113233  0.072621  0.112170
  0.722222  0.113961  0.078932  0.116751
  0.777778  0.114690  0.085283  0.121158
  0.833333  0.115422  0.091675  0.125410
  0.888889  0.116156  0.098108  0.129523
  0.944444  0.116892  0.104581  0.133509
  1.000000  0.117631  0.111096  0.137380
  1.055556  0.118372  0.117652  0.141145
  1.111111  0.119115  0.124248  0.144811
  1.166667  0.119860  0.130887  0.148387
  1.222222  0.120608  0.137566  0.151879
  1.277778  0.121358  0.144288  0.155293
  1.333333  0.122110  0.151051  0.158633
  1.388889  0.122864  0.157855  0.161904
  1.444444  0.123621  0.164702  0.165110
  1.500000  0.124380  0.171591  0.168256
  1.555556  0.125141  0.178522  0.171343
  1.611111  0.125905  0.185496  0.174376
  1.666667  0.126671  0.192512  0.177357
  1.722222  0.127439  0.199570  0.180289
  1.777778  0.128209  0.206672  0.183173
  1.833333  0.128982  0.213816  0.186014
  1.888889  0.129757  0.221003  0.188811
  1.944444  0.130534  0.228233  0.191567
  2.000000  0.131313  0.235507  0.194285
  2.055556  0.132095  0.242824  0.196965
  2.111111  0.132879  0.250184  0.199609
  2.166667  0.133665  0.257588  0.202218
  2.222222  0.134453  0.265036  0.204794
  2.277778  0.135244  0.272528  0.207338
  2.333333  0.136037  0.280063  0.209852
  2.388889  0.136832  0.287643  0.212335
  2.444444  0.137630  0.295267  0.214790
```

```
  2.500000  0.138430  0.302935  0.217217
  2.555556  0.139232  0.310648  0.219617
  2.611111  0.140036  0.318405  0.221992
  2.666667  0.140843  0.326208  0.224341
  2.722222  0.141652  0.334055  0.226666
  2.777778  0.142463  0.341947  0.228967
  2.833333  0.143276  0.349884  0.231245
  2.888889  0.144092  0.357866  0.233501
  2.944444  0.144910  0.365894  0.235736
  3.000000  0.145730  0.373968  0.237949
  3.055556  0.146553  0.382086  0.240142
  3.111111  0.147377  0.390251  0.242316
  3.166667  0.148204  0.398462  0.244470
  3.222222  0.149034  0.406718  0.246605
  3.277778  0.149865  0.415021  0.248722
  3.333333  0.150699  0.423370  0.250821
  3.388889  0.151535  0.431766  0.252902
  3.444444  0.152373  0.440207  0.254967
  3.500000  0.153214  0.448696  0.257015
  3.555556  0.154057  0.457231  0.259046
  3.611111  0.154902  0.465813  0.261062
  3.666667  0.155749  0.474443  0.263063
  3.722222  0.156599  0.483119  0.265048
  3.777778  0.157451  0.491843  0.267019
  3.833333  0.158305  0.500614  0.268975
  3.888889  0.159162  0.509432  0.270917
  3.944444  0.160021  0.518298  0.272845
  4.000000  0.160882  0.527212  0.274760
  4.055556  0.161745  0.536174  0.484933
  4.111111  0.162610  0.545184  0.866355
  4.166667  0.163478  0.554242  1.354695
  4.222222  0.164348  0.563348  1.919234
  4.277778  0.165221  0.572503  2.532977
  4.333333  0.166095  0.581706  3.168499
  4.388889  0.166972  0.590958  3.797727
  4.444444  0.167851  0.600259  4.393255
  4.500000  0.168733  0.609608  4.930519
  4.555556  0.169616  0.619007  5.390574
  4.611111  0.170502  0.628455  5.763345
  4.666667  0.171391  0.637952  6.051269
  4.722222  0.172281  0.647498  6.273296
  4.777778  0.173174  0.657094  6.550140
  4.833333  0.174069  0.666740  6.771241
  4.888889  0.174966  0.676435  6.985133
  4.944444  0.175866  0.686180  7.192483
  5.000000  0.176768  0.695976  7.393859
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL    1              RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    1              RCHRES   1     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS
```

```
MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1978/ 2/10  3:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.1369E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1978/ 2/10  3:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -5.324E+04    3.4445  3.4444E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1978/ 2/10  4: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.2195E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1978/ 2/10  4: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -8.297E+04    5.3418  5.3418E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1978/ 3/ 1  5:45

RCHRES:     1
```

```
The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.1181E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1978/ 3/ 1  5:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -4.648E+04    3.0103  3.0103E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1978/ 3/ 1  6:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.0502E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1978/ 3/ 1  6:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -2.203E+04    1.4328  1.4328E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1980/ 2/13 23: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.1068E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1980/ 2/13 23: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -4.242E+04    2.7491  2.7491E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1980/ 2/14  7:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.7181E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1980/ 2/14  7:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -2.625E+05   16.439   1.6438E+01      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1980/ 2/14  8: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.3459E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1980/ 2/14  8: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
```

```
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -1.285E+05    8.2131  8.2130E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1980/ 2/14  8:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.0809E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1980/ 2/14  8:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -3.308E+04    2.1473  2.1472E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1998/ 2/23 21:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 2.9890E+04 3.0317E+04 3.0878E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1998/ 2/23 21:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.9292E+01 1.5321E+04 -3.556E+04    2.3074     2.3074       3
```

Disclaimer

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Appendix 8:Source Control

Pollutant Sources/Source Control Checklist

Appendix 9:O&M

Operation and Maintenance Plan and Documentation of Finance, Maintenance and Recording Mechanisms

EXTENDED DETENTION BASIN BMP FACT SHEET

Maintenance Guidelines

Schedule	Inspection and Maintenance Activity
During every scheduled maintenance check (per below), and *as needed* at other times	• Maintain vegetation as needed. Use of fertilizers, pesticides and herbicides should be strongly avoided to ensure they don't contribute to water pollution. If appropriate native plant selections and other IPM methods are used, such products shouldn't be needed. If such projects are used: o Care should be taken to avoid contact with the low-flow or other trenches, and the media filter in the bottom stage. o Products shall be applied in accordance with their labeling, especially in relation to application to water, and in areas subjected to flooding. o Fertilizers should not be applied within 15 days before, after, or during the rainy season. • No ponded water should be present for more than 72 hours to avoid nuisance or vector problems. No algae formation should be visible. Correct problems as needed.
Annually. If possible, schedule these inspections before the beginning of the rain season to allow for any repairs to occur before rains occur.	• Remove debris and litter from the entire basin • Inspect hydraulic and structural facilities. Examine the outlet for clogging, the embankment and spillway integrity, as well as damage to any structural element. • Check for erosion, slumping and overgrowth. Repair as needed. • Inspect sand media at the filter drain to verify it is allowing acceptable infiltration. **Scarify top 3 inches by raking the filter drain's sand surface annually.** • Check the media filter underdrains (via the cleanout) for damage or clogging. Repair as needed. • Remove accumulated sediment and debris from the forebay, and ensure that the notch weir is clear and will allow proper drainage. • Check gravel filled low flow and collector trenches for sediment buildup and repair as needed.
Every 5 years or sooner (depending on whether observed drain times to empty the basin are less than 72 hours).	• Remove the top 3 inches of sand from the filter drain and backfill with 3 inches of new sand to return the sand layer to its original depth. When scarification or removal of the top 3 inches of sand is no longer effective, remove and replace sand filter layer.
Whenever substantial sediment accumulation has occurred.	• Remove accumulated sediment from the bottom of the basin. Removal should extend to original basin depth.

GENERAL SPECIFICATIONS FOR MAINTENANCE OF
FLOGARD® TRASH AND DEBRIS GUARD

SCOPE:

Federal, State and Local Clean Water Act regulations and those of insurance carriers require that stormwater filtration systems be maintained and serviced on a recurring basis. The intent of the regulations is to ensure that the systems, on a continuing basis, efficiently remove pollutants from stormwater runoff thereby preventing pollution of the nation's water resources. These specifications apply to the FloGard® Trash and Debris Guard.

RECOMMENDED FREQUENCY OF SERVICE:

Drainage Protection Systems (DPS) recommends that installed Flo-Gard® Trash and Debris Guards be serviced on a recurring basis. Ultimately, the frequency depends on the amount of runoff, pollutant loading and interference from debris (leaves, vegetation, cans, paper, etc.); however, it is recommended that each installation be serviced a minimum of three times per year, with a change of filter medium once per year. DPS technicians are available to do an on-site evaluation, upon request.

RECOMMENDED TIMING OF SERVICE:

DPS guidelines for the timing of service are as follows:

1. For areas with a definite rainy season: Prior to, during and following the rainy season.
2. For areas subject to year-round rainfall: On a recurring basis (at least three times per year).
3. For areas with winter snow and summer rain: Prior to and just after the snow season and during the summer rain season.
4. For installed devices not subject to the elements (washracks, parking garages, etc.): On a recurring basis (no less than three times per years).

SERVICE PROCEDURES:

1. The service will commence with the collection and removal of sediment and debris (litter, leaves, papers, cans, etc.).
2. The screen and frame shall be visually inspected for defects. Minor damage or defects found shall be corrected on-the-spot and a notation made on the Maintenance Record. More extensive deficiencies that affect the efficiency of the filter (torn liner, etc.), if approved by the customer representative, will be corrected and an invoice submitted to the representative along with the Maintenance Record.
3. The filter medium pouches shall be inspected for defects and continued serviceability and replaced as necessary and the pouch tethers re-attached to the liner's D-ring. See below.
4. If removed, the filter device (frame and screen) shall be replaced.

REPLACEMENT AND DISPOSAL OF EXPOSED FILTER MEDIUM AND COLLECTED DEBRIS

The frequency of filter medium pouch exchange will be in accordance with the existing DPS-Customer Maintenance Contract. DPS recommends that the medium be changed at least once per year. During the appropriate service, or if so determined by the service technician during a non-scheduled service, the filter medium pouches will be replaced with new pouches. Once the exposed pouches and debris have been removed, DPS has possession and must dispose of it in accordance with local, state and federal agency requirements.

DPS also has the capability of servicing all manner of catch basin inserts and catch basins without inserts, underground oil/water separators, stormwater interceptors and other such devices. All DPS personnel are highly qualified technicians and are confined space trained and certified. Call us at (888) 950-8826 for further information and assistance.

Appendix 10:Educational Materials

BMP Fact Sheets, Maintenance Guidelines and Other End-User BMP Information

Extended Detention Basin TC-22

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

TC-22 Extended Detention Basin

relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).
- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.
- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.
- Outlet designed to discharge the capture volume over a period of hours.
- Length to width ratio of at least 1.5:1 where feasible.
- Basin depths optimally range from 2 to 5 feet.
- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.
- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.
- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.
- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Extended Detention Basin TC-22

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

TC-22 Extended Detention Basin

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

Extended Detention Basin TC-22

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

TC-22 Extended Detention Basin

The discharge through a control orifice is calculated from:

$$Q = CA(2g(H-H_o))^{0.5}$$

where: Q = discharge (ft^3/s)
C = orifice coefficient
A = area of the orifice (ft^2)
g = gravitational constant (32.2)
H = water surface elevation (ft)
H_o= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_o. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation

Extended Detention Basin TC-22

management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and re-grade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the

TC-22 Extended Detention Basin

perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	**56**	**$668**	**$3,132**

References and Sources of Additional Information

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for Chesapeake Research Consortium. Edgewater, MD. Center for Watershed Protection. Ellicott City, MD.

Denver Urban Drainage and Flood Control District. 1992. *Urban Storm Drainage Criteria Manual—Volume 3: Best Management Practices*. Denver, CO.

Emmerling-Dinovo, C. 1995. Stormwater Detention Basins and Residential Locational Decisions. *Water Resources Bulletin 31(3)*: 515–521

Galli, J. 1990. *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices*. Metropolitan Washington Council of Governments. Prepared for Maryland Department of the Environment, Baltimore, MD.

GKY, 1989, *Outlet Hydraulics of Extended Detention Facilities* for the Northern Virginia Planning District Commission.

MacRae, C. 1996. Experience from Morphological Research on Canadian Streams: Is Control of the Two-Year Frequency Runoff Event the Best Basis for Stream Channel Protection? In *Effects of Watershed Development and Management on Aquatic Ecosystems*. American Society of Civil Engineers. Edited by L. Roesner. Snowbird, UT. pp. 144–162.

Extended Detention Basin TC-22

Maryland Dept of the Environment, 2000, Maryland Stormwater Design Manual: Volumes 1 & 2, prepared by MDE and Center for Watershed Protection. http://www.mde.state.md.us/environment/wma/stormwatermanual/index.html

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.

Santana, F., J. Wood, R. Parsons, and S. Chamberlain. 1994. Control of Mosquito Breeding in Permitted Stormwater Systems. Prepared for Southwest Florida Water Management District, Brooksville, FL.

Schueler, T. 1997. Influence of Ground Water on Performance of Stormwater Ponds in Florida. *Watershed Protection Techniques* 2(4):525–528.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Young, G.K., et al., 1996, *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032, U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning.

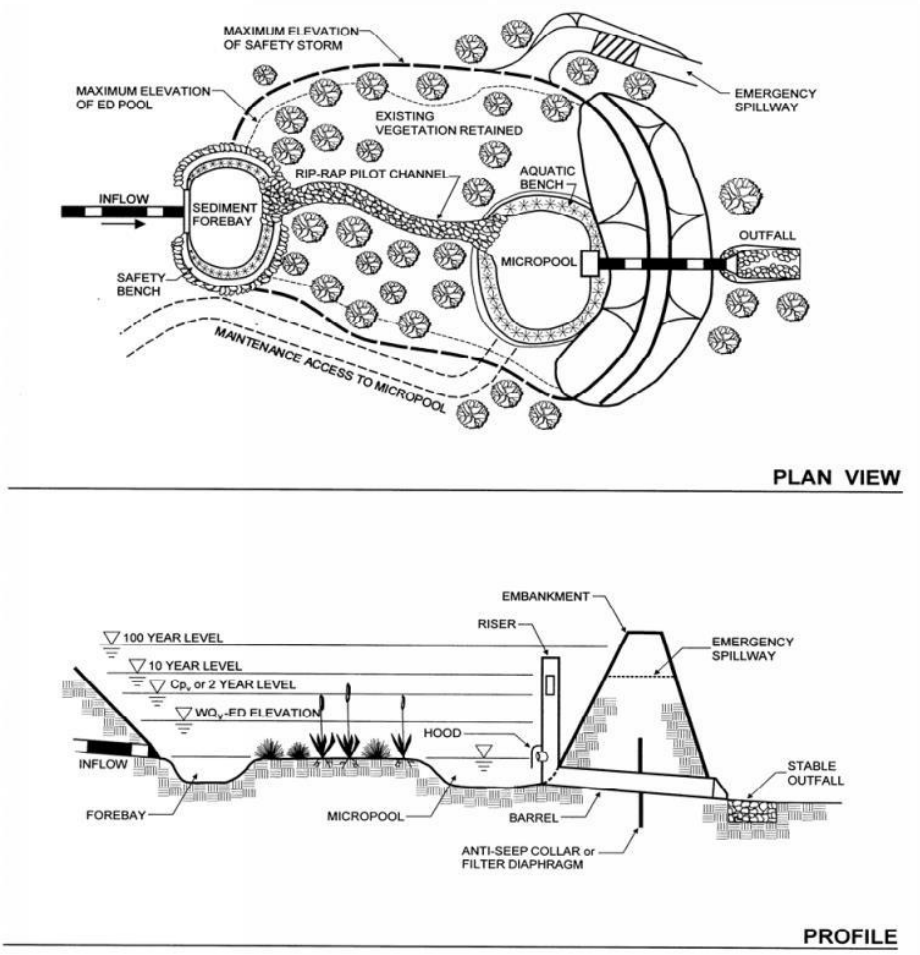
Information Resources

Center for Watershed Protection (CWP), Environmental Quality Resources, and Loiederman Associates. 1997. *Maryland Stormwater Design Manual*. Draft. Prepared for Maryland Department of the Environment, Baltimore, MD.

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. Washington, DC.

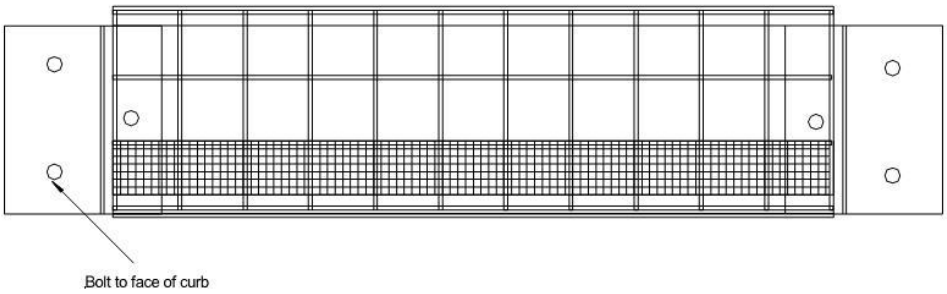
U.S. Environmental Protection Agency (USEPA). 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

TC-22 Extended Detention Basin

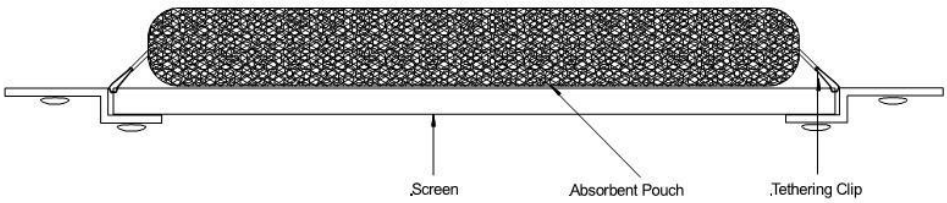


Schematic of an Extended Detention Basin (MDE, 2000)

FRONT VIEW



TOP VIEW



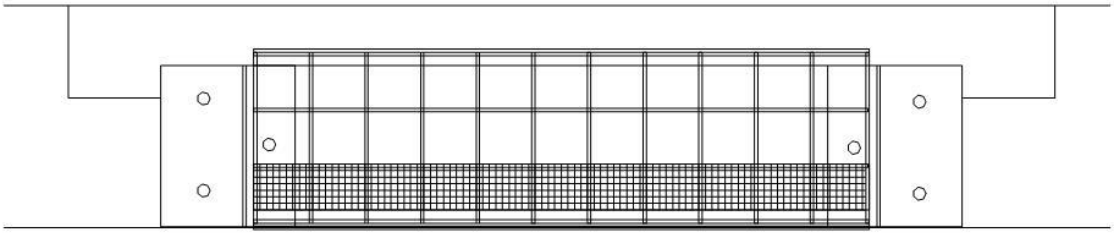
FLO-GARD™

TRASH & DEBRIS GUARD

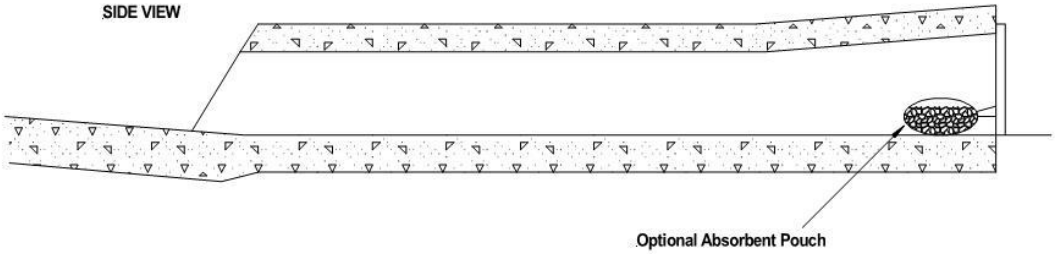
KriStar Enterprises, Inc., Santa Rosa, CA (800) 579-8819

06/04

FRONT VIEW



SIDE VIEW



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FloGard® Trash & Debris Guard

The FloGard® Trash & Debris Guard is often the only practical option to filter stormwater leaving sites with little fall from a parking surface through a parkway culvert to curb and gutter outfall. It is designed to remove debris and has an optional Fossil Rock pouch for hydrocarbon removal.

Since it is a careen, no true "design flow rates" can be given. Rather, the inlet capacity of the culvert is usually derated by a safety factor of 0.50 to 0.75 to account for debris buildup between maintenance cycles.

SPECIFICATIONS

MODEL	WIDTH (in)	HEIGHT (in)	FILTERED FLOW CUBIC FEET /SECOND	BYPASS CAPACITY CUBIC FEET /SECOND*
FG-TDG24	24	6	0.45	0.62
FG-TDG36	36	6	0.67	0.94
FG-TDG42	42	6	0.78	1.10
FG-TDG48	48	6	0.89	1.26
FG-TDG60	60	6	1.11	1.58

* Approximate – may vary with location and debris loading between maintenance

Questions? Contact Kristar at (800) 579-8819. *04/07*

Vegetated Swale TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

☑ Sediment	▲
☑ Nutrients	●
☑ Trash	●
☑ Metals	▲
☑ Bacteria	●
☑ Oil and Grease	▲
☑ Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

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TC-30 Vegetated Swale

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Vegetated Swale TC-30

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

TC-30 Vegetated Swale

Table 1 Grassed swale pollutant removal efficiency data

Removal Efficiencies (% Removal)							
Study	**TSS**	**TP**	**TN**	**NO_3**	**Metals**	**Bacteria**	**Type**
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Vegetated Swale TC-30

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

TC-30 Vegetated Swale

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.
- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.
- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.
- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Vegetated Swale TC-30

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately \$0.25 per ft^2. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately \$0.50 per ft^2, which compares favorably with other stormwater management practices.

TC-30 Vegetated Swale

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b].....	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c].....	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d].....	Yd^3	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e].....	Yd^2	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]..	Yd^2	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g].....	Yd^2	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	–	--	–	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	–	--	–	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right) \times$ swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Vegetated Swale TC-30

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	\$0.85 / 1,000 ft^2/ mowing	\$0.14 / linear foot	\$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	\$9.00 / 1,000 ft^2/ year	\$0.18 / linear foot	\$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	\$0.10 / linear foot / year	\$0.10 / linear foot	\$0.10 / linear foot	--
Grass Reseeding with Mulch and Fertilizer	\$0.30 / yd^2	\$0.01 / linear foot	\$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	\$0.15 / linear foot / year, plus \$25 / inspection	\$0.15 / linear foot	\$0.15 / linear foot	Inspect four times per year
Total	--	**\$0.58 / linear foot**	**\$ 0.75 / linear foot**	--

TC-30 Vegetated Swale

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

References and Sources of Additional Information

Barrett, Michael E., Walsh, Patrick M., Malina, Joseph F., Jr., Charbeneau, Randall J, 1998, "Performance of vegetative controls for treating highway runoff," *ASCE Journal of Environmental Engineering*, Vol. 124, No. 11, pp. 1121-1128.

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for the Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD.

Center for Watershed Protection (CWP). 1996. *Design of Stormwater Filtering Systems*. Prepared for the Chesapeake Research Consortium, Solomons, MD, and USEPA Region V, Chicago, IL, by the Center for Watershed Protection, Ellicott City, MD.

Colwell, Shanti R., Horner, Richard R., and Booth, Derek B., 2000. *Characterization of Performance Predictors and Evaluation of Mowing Practices in Biofiltration Swales*. Report to King County Land And Water Resources Division and others by Center for Urban Water Resources Management, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA

Dorman, M.E., J. Hartigan, R.F. Steg, and T. Quasebarth. 1989. *Retention, Detention and Overland Flow for Pollutant Removal From Highway Stormwater Runoff. Vol. 1*. FHWA/RD 89/202. Federal Highway Administration, Washington, DC.

Goldberg. 1993. *Dayton Avenue Swale Biofiltration Study*. Seattle Engineering Department, Seattle, WA.

Harper, H. 1988. *Effects of Stormwater Management Systems on Groundwater Quality*. Prepared for Florida Department of Environmental Regulation, Tallahassee, FL, by Environmental Research and Design, Inc., Orlando, FL.

Kercher, W.C., J.C. Landon, and R. Massarelli. 1983. Grassy swales prove cost-effective for water pollution control. *Public Works*, 16: 53–55.

Koon, J. 1995. *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins*. King County Surface Water Management, Seattle, WA, and Washington Department of Ecology, Olympia, WA.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.Oakland, P.H. 1983. An evaluation of stormwater pollutant removal

Vegetated Swale TC-30

through grassed swale treatment. In *Proceedings of the International Symposium of Urban Hydrology, Hydraulics and Sediment Control, Lexington, KY*. pp. 173–182.

Occoquan Watershed Monitoring Laboratory. 1983. Final Report: *Metropolitan Washington Urban Runoff Project*. Prepared for the Metropolitan Washington Council of Governments, Washington, DC, by the Occoquan Watershed Monitoring Laboratory, Manassas, VA.

Pitt, R., and J. McLean. 1986. *Toronto Area Watershed Management Strategy Study: Humber River Pilot Watershed Project*. Ontario Ministry of Environment, Toronto, ON.

Schueler, T. 1997. Comparative Pollutant Removal Capability of Urban BMPs: A reanalysis. *Watershed Protection Techniques* 2(2):379–383.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance: Recommendations and Design Considerations*. Publication No. 657. Water Pollution Control Department, Seattle, WA.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Technical report no. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1999, Stormwater Fact Sheet: Vegetated Swales, Report # 832-F-99-006 http://www.epa.gov/owm/mtb/vegswale.pdf, Office of Water, Washington DC.

Wang, T., D. Spyridakis, B. Mar, and R. Horner. 1981. *Transport, Deposition and Control of Heavy Metals in Highway Runoff*. FHWA-WA-RD-39-10. University of Washington, Department of Civil Engineering, Seattle, WA.

Washington State Department of Transportation, 1995, *Highway Runoff Manual*, Washington State Department of Transportation, Olympia, Washington.

Welborn, C., and J. Veenhuis. 1987. *Effects of Runoff Controls on the Quantity and Quality of Urban Runoff in Two Locations in Austin, TX*. USGS Water Resources Investigations Report No. 87-4004. U.S. Geological Survey, Reston, VA.

Yousef, Y., M. Wanielista, H. Harper, D. Pearce, and R. Tolbert. 1985. *Best Management Practices: Removal of Highway Contaminants By Roadside Swales*. University of Central Florida and Florida Department of Transportation, Orlando, FL.

Yu, S., S. Barnes, and V. Gerde. 1993. *Testing of Best Management Practices for Controlling Highway Runoff*. FHWA/VA-93-R16. Virginia Transportation Research Council, Charlottesville, VA.

Information Resources

Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2001.

Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest. *Watershed Protection Techniques* 1(3):117–119.

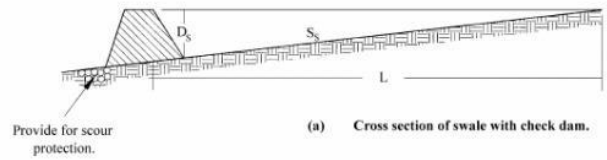
TC-30 Vegetated Swale

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance*. Recommendations and Design Considerations. Publication No. 657. Seattle Metro and Washington Department of Ecology, Olympia, WA.

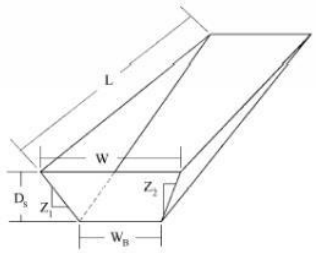
USEPA 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC, by the Watershed Management Institute, Ingleside, MD.

Vegetated Swale TC-30



(a) Cross section of swale with check dam.



(b) Dimensional view of swale impoundment area.

Notation:
L = Length of swale impoundment area per check dam (ft)
D_S = Depth of check dam (ft)
S_S = Bottom slpe of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1\&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)